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First Edition (September, 1985)

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Notes:

Preface

This manual describes the various units of the IBM Personal Computer AT and how they interact. It also has information about the basic input/output system (BIOS) and about programming support.

The information in this publication is for reference, and is intended for hardware and program designers, programmers, engineers, and anyone else who needs to understand the design and operation of the IBM Personal Computer AT.

This manual consists of nine sections:

- The first three sections describe the hardware aspects of the IBM Personal Computer AT including signal charts and register information.
- Section 4 describes keyboard operation, the commands to and from the system, and the various keyboard layouts.
- Section 5 contains information about the usage of BIOS and a system BIOS listing.
- Section 6 contains instruction sets for the 80286 microprocessor and the 80287 math coprocessor.
- Section 7 provides information about characters, keystrokes, and colors.
- Section 8 has general communications information.
- Section 9 contains information about the compatibility of the IBM Personal Computer AT and the rest of the IBM Personal Computer family.

A glossary of terms and a bibliography of related publications are included.

Prerequisite Publications

Guide to Operations for the IBM Personal Computer AT

Suggested Reading

- *BASIC* for the IBM Personal Computer
- *Disk Operating System (DOS)*
- *MACRO Assembler* for the IBM Personal Computer

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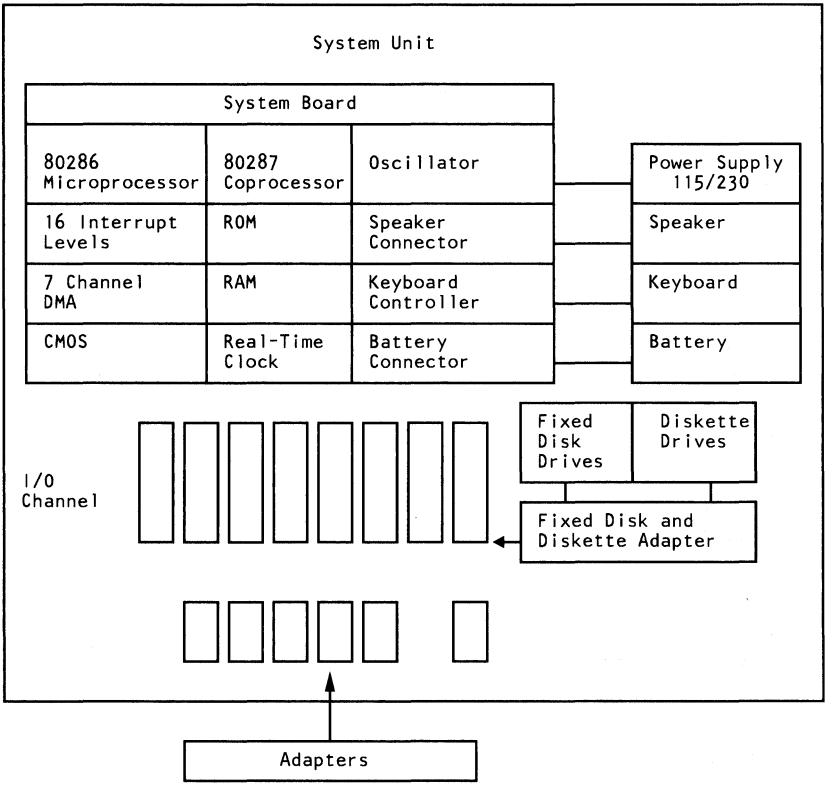


SECTION 1. SYSTEM BOARD

Contents

The type 1 system board is approximately 30.5 by 35 centimeters (12 by 13.8 inches). The type 2 system board is approximately 23.8 by 35 centimeters (9.3 by 13.8 inches). Both types of system boards use very large scale integration (VLSI) technology and have the following components:

- Intel 80286 Microprocessor
- System support function:
  - Seven-Channel Direct Memory Access (DMA)
  - Sixteen-level interrupt
  - Three programmable timers
  - System clock
- 64K read-only memory (ROM) subsystem, expandable to 128K
- A 512K random-access memory (RAM) Subsystem
- Eight input/output (I/O) slots:
  - Six with a 36-pin and a 62-pin card-edge socket
  - Two with only the 62-pin card-edge socket
- Speaker attachment
- Keyboard attachment
- Complementary metal oxide semiconductor (CMOS) memory RAM to maintain system configuration
- Real-Time Clock
- Battery backup for CMOS configuration table and Real-Time Clock

Memory

The type 1 system board has four banks of memory sockets, each supporting 9 128K-by-1-bit modules for a total memory size of 512K, with parity checking.

The type 2 system board has two banks of memory sockets, each supporting 9 256K-by-1-bit modules for a total memory size of 512K, with parity checking.

Microprocessor

The Intel 80286 microprocessor has a 24-bit address, 16-bit memory interface[1], an extensive instruction set, DMA and interrupt support capabilities, a hardware fixed-point multiply and divide, integrated memory management, four-level memory protection, 1G (1,073,741,824 bytes) of virtual address space for each task, and two operating modes: the 8086-compatible real address mode and the protected or virtual address mode. More detailed descriptions of the microprocessor may be found in the publications listed in the Bibliography of this manual.

Real Address Mode

In the real address mode, the microprocessor's physical memory is a contiguous array of up to one megabyte. The microprocessor addresses memory by generating 20-bit physical addresses.

The selector portion of the pointer is interpreted as the upper 16 bits of a 20-bit segment address. The lower 4 bits of the 20-bit segment address are always zero. Therefore, segment addresses begin on multiples of 16 bytes.

---

1 In this manual, the term interface refers to a device that carries signals between functional units.

All segments in the real address mode are 64K in size and may be read, written, or executed. An exception or interrupt can occur if data operands or instructions attempt to wrap around the end of a segment. For example, a word with its low-order byte at offset FFFF and its high-order byte at 0000. If, in the real address mode, the information contained in the segment does not use the full 64K, the unused end of the segment may be overlayed by another segment to reduce physical memory requirements.

Protected (Virtual Address) Mode

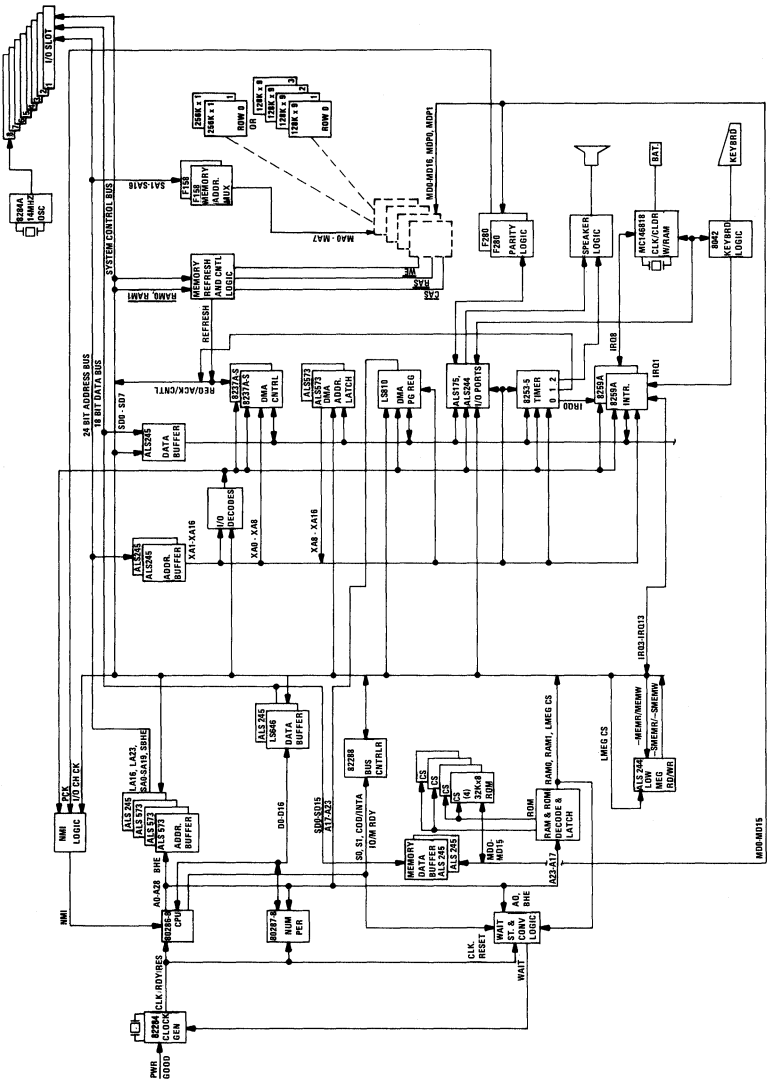
The protected mode offers extended physical and virtual memory address space, memory protection mechanisms, and new operations to support operating systems and virtual memory.

> **Note:** See "BIOS Programming Hints" in Section 5 for special cautions while operating in the protected mode.

The protected mode provides a 1G virtual address space for each task mapped into a 16M physical address space. The virtual address space may be larger than the physical address space, because any use of an address that does not map to a physical memory location will cause a restartable exception.

As in the real address mode, the protected mode uses 32-bit pointers, consisting of 16-bit selector and offset components. The selector, however, specifies an index into a memory resident table rather than the upper 16 bits of a real memory address. The 24-bit base address of the desired segment is obtained from the tables in memory. The 16-bit offset is added to the segment base address to form the physical address. The microprocessor automatically refers to the tables whenever a segment register is loaded with a selector. All instructions that load a segment register will refer to the memory-based tables without additional program support. The memory-based tables contain 8-byte values called *descriptors*.

Following is a block diagram of the system board.



System Performance

The 80286 microprocessor operates at 6 MHz, resulting in a clock cycle time of 167 nanoseconds.

A bus cycle requires 3 clock cycles (which includes 1 wait state) so that a 500-nanosecond, 16-bit, microprocessor cycle time is achieved. Eight-bit bus operations to 8-bit devices take 6 clock cycles (which include 4 wait states), resulting in a 1000-nanosecond microprocessor cycle. Sixteen-bit bus operations to 8-bit devices take 12 clock cycles (which include 10 wait states) resulting in a 2-microsecond microprocessor cycle.

The refresh controller steps one refresh address every 15 microseconds. Each refresh cycle requires 5 clock cycles to refresh all of the system's dynamic memory; 256 refresh cycles are required every 4 milliseconds. The following formula determines the percentage of bandwidth used for refresh.

$$\%\ \text{Bandwidth used for Refresh} = \frac{5\ \text{cycles} \times 256}{4\ \text{ms}/167\ \text{ns}} = \frac{1280}{24000} = 5.3\%$$

The DMA controller operates at 3 MHz, which results in a clock cycle time of 333 nanoseconds. All DMA data-transfer bus cycles are 5 clock cycles or 1.66 microseconds. Cycles spent in the transfer of bus control are not included.

DMA channels 0, 1, 2, and 3 are used for 8-bit data transfers, and channels 5, 6, and 7 process 16-bit transfers. Channel 4 is used to cascade channels 0 through 3 to the microprocessor.

The following figure is a system memory map.

Address	Name	Function
000000 to 07FFFF	512K system board	System board memory
080000 to 09FFFF	128K	I/O channel memory - IBM Personal Computer AT 128K Memory Expansion Option
0A0000 to 0BFFFF	128K video RAM	Reserved for graphics display buffer
0C0000 to 0DFFFF	128K I/O expansion ROM	Reserved for ROM on I/O adapters
0E0000 to 0EFFFF	64K reserved on system board	Duplicated code assignment at address FE0000
0F0000 to 0FFFFF	64K ROM on the system board	Duplicated code assignment at address FF0000
100000 to FDFFFF	Maximum memory 15M	I/O channel memory - 512K to 15M installed on memory expansion options
FE0000 to FEFFFF	64K reserved on system board	Duplicated code assignment at address 0E0000
FF0000 to FFFFFF	64K ROM on the system board	Duplicated code assignment at address 0F0000

System Memory Map

Direct Memory Access

The system supports seven direct memory access (DMA) channels. Two Intel 8237A-5 DMA Controller chips are used, with four channels for each chip. The DMA channels are assigned as follows:

Controller 1	Controller 2
Ch 0 - Reserved Ch 1 - SDLC Ch 2 - Diskette (IBM Personal Computer) Ch 3 - Reserved	Ch 4 - Cascade for Ctlr 1 Ch 5 - Reserved Ch 6 - Reserved Ch 7 - Reserved

DMA Channels

DMA controller 1 contains channels 0 through 3. These channels support 8-bit data transfers between 8-bit I/O adapters and 8- or 16-bit system memory. Each channel can transfer data throughout the 16M system-address space in 64K blocks.

The following figures show address generation for the DMA channels.

Source	DMA Page Registers	Controller
Address	A23<----------->A16	A15<----------->A0

Address Generation for DMA Channels 0 through 3

> **Note:** The addressing signal, 'byte high enable' (BHE), is generated by inverting address line A0.

DMA controller 2 contains channels 4 through 7. Channel 4 is used to cascade channels 0 through 3 to the microprocessor. Channels 5, 6, and 7 support 16-bit data transfers between 16-bit I/O adapters and 16-bit system memory. These DMA channels can transfer data throughout the 16M system-address space in 128K blocks. Channels 5, 6, and 7 cannot transfer data on odd-byte boundaries.

Source	DMA Page Registers	Controller
Address	A23<----------->A17	A16<----------->A1

Address Generation for DMA Channels 5 through 7

Note: The addressing signals, BHE and A0, are forced to a logical 0.

The following figure shows the addresses for the page register.

Page Register	I/O Hex Address
DMA Channel 0	0087
DMA Channel 1	0083
DMA Channel 2	0081
DMA Channel 3	0082
DMA Channel 5	008B
DMA Channel 6	0089
DMA Channel 7	008A
Refresh	008F

Page Register Addresses

Addresses for all DMA channels do not increase or decrease through page boundaries (64K for channels 0 through 3, and 128K for channels 5 through 7).

DMA channels 5 through 7 perform 16-bit data transfers. Access can be gained only to 16-bit devices (I/O or memory) during the DMA cycles of channels 5 through 7. Access to the DMA controller, which controls these channels, is through I/O addresses hex 0C0 through 0DF.

The DMA controller command code addresses follow.

Hex Address	Register Function
0C0	CH0 base and current address
0C2	CH0 base and current word count
0C4	CH1 base and current address
0C6	CH1 base and current word count
0C8	CH2 base and current address
0CA	CH2 base and current word count
0CC	CH3 base and current address
0CE	CH3 base and current word count
0D0	Read Status Register/Write Command Register
0D2	Write Request Register
0D4	Write Single Mask Register Bit
0D6	Write Mode Register
0D8	Clear Byte Pointer Flip-Flop
0DA	Read Temporary Register/Write Master Clear
0DC	Clear Mask Register
0DE	Write All Mask Register Bits

DMA Controller

All DMA memory transfers made with channels 5 through 7 must occur on even-byte boundaries. When the base address for these channels is programmed, the real address divided by 2 is the data written to the base address register. Also, when the base word count for channels 5 through 7 is programmed, the count is the number of 16-bit words to be transferred. Therefore, DMA channels 5 through 7 can transfer 65,536 words, or 128Kb maximum, for any selected page of memory. These DMA channels divide the 16M memory space into 128K pages. When the DMA page registers for channels 5 through 7 are programmed, data bits D7 through D1 contain the high-order seven address bits (A23 through A17) of the desired memory space. Data bit D0 of the page registers for channels 5 through 7 is not used in the generation of the DMA memory address.

At power-on time, all internal locations, especially the mode registers, should be loaded with some valid value. This is done even if some channels are unused.

System Interrupts

The 80286 microprocessor's non-maskable interrupt (NMI) and two 8259A Controller chips provide 16 levels of system interrupts.

> **Note:** Any or all interrupts may be masked (including the microprocessor's NMI).

Hardware Interrupt Listing

The following shows the interrupt-level assignments in decreasing priority.

Level	Function
Microprocessor NMI	Parity or I/O Channel Check
Interrupt Controllers CTRL 1 CTRL 2	
IRQ 0	Timer Output 0
IRQ 1	Keyboard (Output Buffer Full)
IRQ 2 ←	Interrupt from CTRL 2
IRQ 8	Realtime Clock Interrupt
IRQ 9	Software Redirected to INT 0AH PC Network * PC Network(Alt.) *
IRQ 10	Reserved
IRQ 11	Reserved
IRQ 12	Reserved
IRQ 13	Coprocessor
IRQ 14	Fixed Disk Controller
IRQ 15	Reserved
IRQ 3	Serial Port 2 BSC BSC (Alt.) Cluster (Primary) PC Network * PC Network (Alt.) * SDLC
IRQ 4	Serial Port 1 BSC BSC (Alt.) SDLC
IRQ 5	Parallel Port 2
IRQ 6	Diskette Controller Fixed Disk and Diskette Drive
IRQ 7	Parallel Port 1 Data Aquisition and Control *** GPIB ** Cluster (Secondary)

* The PC Network is jumper selectable.
** The GPIB Adapter can be set to interrupts 2 through 7.
*** The Data Acquisition Adapter can be set to interrupts 3 through 7. The default interrupt is 7.

Hardware Interrupt Listing

Interrupt Sharing

A definition for standardized hardware design has been established that enables multiple adapters to share an interrupt level. This section describes this design and discusses the programming support required.

> **Note:** Since interrupt routines do not exist in ROM for protected mode operations, this design is intended to run only in the microprocessor's real address mode.

Design Overview

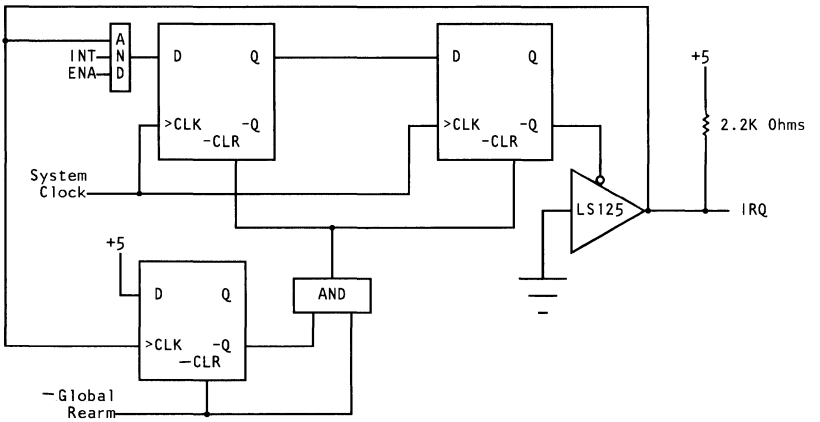
Most interrupt-supporting adapters hold the 'interrupt request' line (IRQ) at a low level and then drive the line high to cause an interrupt. In contrast, the shared-interrupt hardware design allows IRQ to float high through pull-up resistors on each adapter. Each adapter on the line may cause an interrupt by pulsing the line to a low level. The leading edge of the pulse arms the 8259A Interrupt Controller; the trailing edge signals the interrupt controller to cause the interrupt. The duration of this pulse must be between 125 and 1,000 nanoseconds.

The adapters must have an 'interrupt' status bit (INT) and a 'interrupt enable' bit (ENA) that can be controlled and monitored by its software.

Each adapter sharing an interrupt level must monitor the IRQ line. When any adapter drives the line low, all other adapters on that line must be prevented from issuing an interrupt request until they are rearmed.

If an adapter's INT status bit is at a high level when the interrupt sharing logic is rearmed, the adapter must reissue the interrupt. This prevents lost interrupts if two adapters issue an interrupt at the same time and an interrupt handler issues a Global Rearm after servicing one of the adapters.

The following diagram is an example of the shared interrupt hardware logic.



Shared Interrupt Logic Diagram

Program Support

During multitasking, tasks are constantly being activated and deactivated in no particular order. The interrupt-sharing program support described in this section provides for an orderly means to:

- Link a task's interrupt handler to a chain of interrupt handlers
- Share the interrupt level while the task is active
- Unlink the interrupt handler from the chain when the task is deactivated.

Linking to a Chain

Each newly activated task replaces the interrupt vector in low memory with a pointer to its own interrupt handler. The old interrupt vector is used as a forward pointer (FPTR) and is stored at a fixed offset from the new task's interrupt handler.

Sharing the Interrupt Level

When the new task's handler gains control as a result of an interrupt, the handler reads the contents of the adapter's interrupt status register to determine if its adapter caused the interrupt. If it did, the handler services the interrupt, disables the interrupts (CLI), issues a non-specific End of Interrupt (EOI), and then, to rearm the interrupt hardware, writes to address 02F*X*, where *X* corresponds to interrupt levels 3 through 7, and 9 (IRQ9 is 02F2). A write to address 06F*X*, where *X* may be 2 through 7, is required for interrupt levels 10 through 15, respectively. Each adapter in the chain decodes the address which results in a Global Rearm. An adapter is required to decode the least significant 11 bits for this Global Rearm command. The handler then issues a Return From Interrupt (IRET).

If its adapter did not cause the interrupt, the handler passes control to the next interrupt handler in the chain.

Unlinking from the Chain

To unlink from the chain, a task must first locate its handler's position within the chain. By starting at the interrupt vector in low memory, and using the offset of each handler's FPTR to find the entry point of each handler, the chain can be methodically searched until the task finds its own handler. The FPTR of the previous handler in the chain is replaced by the task's FPTR, thus removing the handler from the chain.

Error Recovery

Should the unlinking routine discover that the interrupt chain has been corrupted (an interrupt handler is linked but does not have a valid SIGNATURE), an unlinking error-recovery procedure must be in place. Each application can incorporate its own unlinking error procedure into the unlinking routine. One application may choose to display an error message requiring the operator to either correct the situation or power down the system. Another application may choose an error recovery procedure that restores the original interrupt vector in low memory, and bypasses the corrupt portion of the interrupt chain. This error recovery

procedure may not be suitable when adapters that are being serviced by the corrupt handler are actively generating interrupts, since unserviced interrupts lock up that interrupt level.

ROS Considerations

Adapters with their handlers residing in ROS may choose to implement chaining by storing the 4 byte FPTR (plus the FIRST flag if it is sharing interrupt 7 or 15) in on-adapter latches or ports. Adapter ROS without this feature must first test to see that it is the first in the chain. If it is the first in the chain, the adapter can complete the link; if not, the adapter must exit its routine without linking.

Precautions

The following precautions must be taken when designing hardware or programs using shared interrupts:

- Hardware designers should ensure the adapters:
  - Do not power up with the ENA line active or an interrupt pending.
  - Do not generate interrupts that are not serviced by a handler. Generating interrupts when a handler is not active to service the adapter causes the interrupt level to lock up. The design relies on the handler to clear its adapter's interrupt and issue the Global Rearm.
  - Can be disabled so that they do not remain active after their application has terminated.
- Programmers should:
  - Ensure that their programs have a short routine that can be executed with the AUTOEXEC.BAT to disable their adapter's interrupts. This precaution ensures that the adapters are deactivated if the user reboots the system.

- Treat words as words, not bytes. Remember that data is stored in memory using the Intel format (word 424B is stored as 4B42).

Interrupt Chaining Structure

```
ENTRY:  JMP         SHORT PAST          ; Jump around structure
        FPTR        DD      0           ; Forward Pointer
        SIGNATURE   DW      424BH       ; Used when unlinking to identify
                                        ;  compatible interrupt handlers
        FLAGS       DB                  ; Flags
        FIRST       EQU     80H         ; Flag for being first in chain
        JMP         SHORT   RESET
        RES_BYTES   DB      DUP 7 (0)   ; Future expansion
PAST:   ...                             ; Actual start of code
```

The interrupt chaining structure is a 16-byte format containing FPTR, SIGNATURE, and RES_BYTES. It begins at the third byte from the interrupt handler's entry point. The first instruction of every handler is a short jump around the structure to the start of the routine. Since the position of each interrupt handler's chaining structure is known (except for the handlers on adapter ROS), the FPTRs can be updated when unlinking.

The FIRST flag is used to determine the handler's position in the chain when unlinking when sharing interrupts 7 and 15. The RESET routine, an entry point for the operating system, must disable the adapter's interrupt and RETURN FAR to the operating system.

> **Note:** All handlers designed for interrupt sharing must use 424B as the signature to avoid corrupting the chain.

Examples

In the following examples, notice that interrupts are disabled before control is passed to the next handler on the chain. The next handler receives control as if a hardware interrupt had caused it to receive control. Also, notice that the interrupts are disabled before the non-specific EOI is issued, and not reenabled in the interrupt handler. This ensures that the IRET is executed (at which point the flags are restored and the interrupts

reenabled) before another interrupt is serviced, protecting the stack from excessive build up.

Example of an Interrupt Handler

```
YOUR_CARD  EQU     xxxx              ; Location of your card's interrupt
                                     ;  control/status register
ISB        EQU     xx                ; Interrupt bit in your card's interrupt
                                     ;  control status register
REARM      EQU     2F7H              ; Global Rearm location for interrupt
                                     ;  level 7
SPC_EOI    EQU     67H               ; Specific EOI for 8259's interrupt
                                     ;  level 7
EOI        EQU     20H               ; Non-specific EOI
OCR        EQU     20H               ; Location of 8259 operational control
                                     ;  register
IMR        EQU     21H               ; Location of 8259 interrupt mask
                                     ;  register

MYCSEG     SEGMENT PARA
           ASSUME  CS:MYCSEG,DS:DSEG
ENTRY      PROC    FAR
           JMP     SHORT PAST        ; Entry point of handler
FPTR       DD      0                 ; Forward Pointer
SIGNATURE  DW      424BH             ; Used when unlinking to identify
                                     ;  compatible interrupt handlers
FLAGS      DB      0                 ; Flags
FIRST      EQU     80H
JMP        SHORT   RESET
RES_BYTES  DB      DUP 7 (0)         ; Future expansion
PAST:      STI                       ; Actual start of handler code
           PUSH    ...               ; Save needed registers
           MOV     DX,YOUR_CARD      ; Select your status register
           IN      AL,DX             ; Read the status register
           TEST    AL,ISB            ; Your card caused the interrupt?
           JNZ     SERVICE           ; Yes, branch to service logic
           TEST    CS:FLAGS,FIRST    ; Are we the first ones in?
           JNZ     EXIT              ; If yes, branch for EOI and Rearm
           POP     ...               ; Restore registers
           CLI                       ; Disable interrupts
           JMP     DWORD PTR CS:FPTR ; Pass control to next guy on chain

SERVICE:   ...                       ; Service the interrupt
EXIT:
           CLI                       ; Disable the interrupts
           MOV     AL,EOI
           OUT     OCR,AL            ; Issue non-specific EOI to 8259
           MOV     DX,REARM          ; Rearm the cards
           OUT     DX,AL
           POP     ...               ; Restore registers
           IRET
RESET:     ...                       ; Disable your card
           RET                       ; Return FAR to operating system
ENTRY      ENDP
           MYCSEG  ENDS
           END     ENTRY
```

Linking Code Example

```
          PUSH      ES
          CLI                           ; Disable interrupts
; Set forward pointer to value of interrupt vector in low memory
          ASSUME    CS:CODESEG,DS:CODESEG
          PUSH      ES
          MOV       AX,350FH            ; DOS get interrupt vector
          INT       21H
          MOV       SI,OFFSET CS:FPTR   ; Get offset of your forward pointer
                                        ;  in an indexable register
          MOV       CS:[SI],BX          ; Store the old interrupt vector
          MOV       CS:[SI+2],ES        ;  in your forward pointer for chaining
          CMP       ES:BYTE PTR[BX],CFH ; Test for IRET
          JNZ       SETVECTR
          MOV       CS:FLAGS,FIRST      ; Set up first in chain flag
SETVECTR: POP       ES
          PUSH      DS
; Make interrupt vector in low memory point to your handler
          MOV       DX,OFFSET ENTRY     ; Make interrupt vector point to your handler
          MOV       AX,SEG ENTRY        ; If DS not = CS, get it
          MOV       DS,AX               ;  and put it in DS
          MOV       AX,250FH            ; DOS set interrupt vector
          INT       21H
          POP       DS
; Unmask (enable) interrupts for your level
          IN        AL,IMR              ; Read interrupt mask register
          JMP       $+2                 ; IO delay
          AND       AL,07FH             ; Unmask interrupt level 7
          OUT       IMR,AL              ; Write new interrupt mask
          MOV       AL,SPC_EOI          ; Issue specific EOI for level 7
          JMP       $+Z             ;  to allow pending level 7 interrupts
          OUT       OCR,AL              ;  (if any) to be serviced
          STI                           ; Enable interrupts
          POP       ES                  ;
```

Unlinking Code Example

```
            PUSH    DS
            PUSH    ES
            CLI                         ; Disable interrupts
            MOV     AX,350FH            ; DOS get interrupt vector
            INT     21H                 ; ES:BX points to first of chain
            MOV     CX,ES               ; Pickup segment part of interrupt vector
; Are we the first handler in the chain?
            MOV     AX,CS               ; Get code seg into comparable register
            CMP     BX,OFFSET ENTRY     ; Interrupt vector in low memory
                                        ;  pointing to your handler's offset?
            JNE     UNCHAIN_A           ; No, branch
            CMP     AX,CX               ; Vector pointing to your
                                        ;  handler's segment?
            JNE     UNCHAIN_A           ; No, branch
; Set interrupt vector in low memory to point to the handler
;  pointed to by your pointer

            PUSH    DS
            MOV     DX,WORD PTR CS:FPTR
            MOV     DS,WORD PTR CS FPTR[2]
            MOV     AX,250FH            ; DOS set interrupt vector
            INT     21H
            POP     DS
            JMP     UNCHAIN_X
UNCHAIN_A:    ; BX = FPTR offset, ES = FPTR segment, CX = CS
            CMP     ES:[BX+6],4B42H     ; Is handler using the appropriate
                                        ;  conventions (is SIGNATURE present in
                                        ;   the interrupt chaining structure)?
            JNE     exception           ; No, invoke error exception handler
            LDS     SI,ES:[BX+2]        ; Get FPTR's segment and offset
            CMP     SI,OFFSET ENTRY     ; Is this forward pointer pointing to
                                        ;  your handler's offset?
            JNE     UNCHAIN_B           ; No, branch
            MOV     CX,DS               ; Move to compare
            CMP     AX,CX               ; Is this forward pointer pointing to
                                        ;  your handler's segment?
            JNE     UNCHAIN_B           ; No, branch
; Located your handler in the chain
            MOV     AX,WORD PTR CS:FPTR ; Get your FPTR's offset
            MOV     ES:[BX+2],AX        ; Replace offset of FPTR of handler
                                        ;  that points to you
            MOV     AX,WORD PTR CS:FPTR[2] ; Get your FPTR's segment
            MOV     ES:[BX+4],AX        ; Replace segment of FPTR of handler
                                        ;  that points to you
            MOV     AL,CS:FLAGS         ; Get your flags
            AND     AL,FIRST            ; Isolate FIRST flag
            OR      ES:[BX + 6],AL      ; Set your first flag into prior routine
            JMP     UNCHAIN_X
UNCHAIN_B:  MOV     BX,SI               ; Move new offset to BX
            PUSH    DS
            PUSH    ES
            JMP     UNCHAIN_A           ; Examine next handler in chain
UNCHAIN_X:  STI                         ; Enable interrupts
            POP     ES
            POP     DS
```

System Timers

The system has three programmable timer/counters, Channels 0 through 2. They are controlled by an Intel 8254-2 Timer/Counter chip, and are defined as follows:

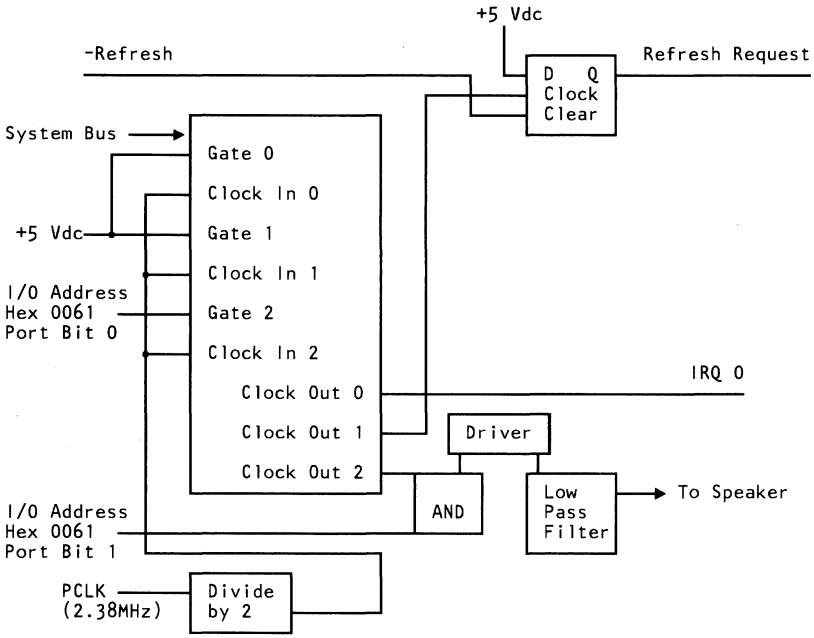
Channel 0	**System Timer**
GATE 0	Tied on
CLK IN 0	1.190 MHz OSC
CLK OUT 0	8259A IRQ 0

Channel 1	**Refresh Request Generator**
GATE 1	Tied on
CLK IN 1	1.190 MHz OSC
CLK OUT 1	Request refresh cycle

> **Note:** Channel 1 is programmed as a rate generator to produce a 15-microsecond period signal.

Channel 2	**Tone Generation for Speaker**
GATE 2	Controlled by bit 0 of port hex 61, PPI bit
CLK IN 2	1.190 MHz OSC
CLK OUT 2	Used to drive the speaker

The 8254-2 Timer/Counter is a programmable interval timer/counter that system programs treat as an arrangement of four external I/O ports. Three ports are treated as counters; the fourth is a control register for mode programming. The following is a system-timer block diagram.



System-Timer Block Diagram

System Clock

The 82284 System Clock Generator is driven by a 12-MHz crystal. Its output 'clock' signal (CLK) is the input to the system microprocessor, the coprocessor, and I/O channel.

ROM Subsystem

The system board's ROM subsystem consists of two 32K by 8-bit ROM/EPROM modules in a 32K-by-16-bit arrangement. The code for odd and even addresses resides in separate modules. ROM is assigned at the top of the first and last 1M address space (0F0000 and FF0000). ROM is not parity-checked. Its access time is 150 nanoseconds and its cycle time is 230 nanoseconds.

RAM Subsystem

The system board's RAM subsystem starts at address 000000 of the 16M address space. It is 512K of 128K-by-1-bit RAM modules (type 1 system board) or 512K of 256K-by-1-bit RAM modules (type 2 system board). Memory access time is 150 nanoseconds and the cycle time is 275 nanoseconds.

Memory refresh requests one memory cycle every 15 microseconds through the timer/counter (channel 1). The RAM initialization program performs the following functions:

- Initializes channel 1 of the timer/counter to the rate generation mode, with a period of 15 microseconds.
- Performs a memory write operation to any memory location.

  Note: The memory must be accessed or refreshed eight times before it can be used.

I/O Channel

The I/O channel supports:

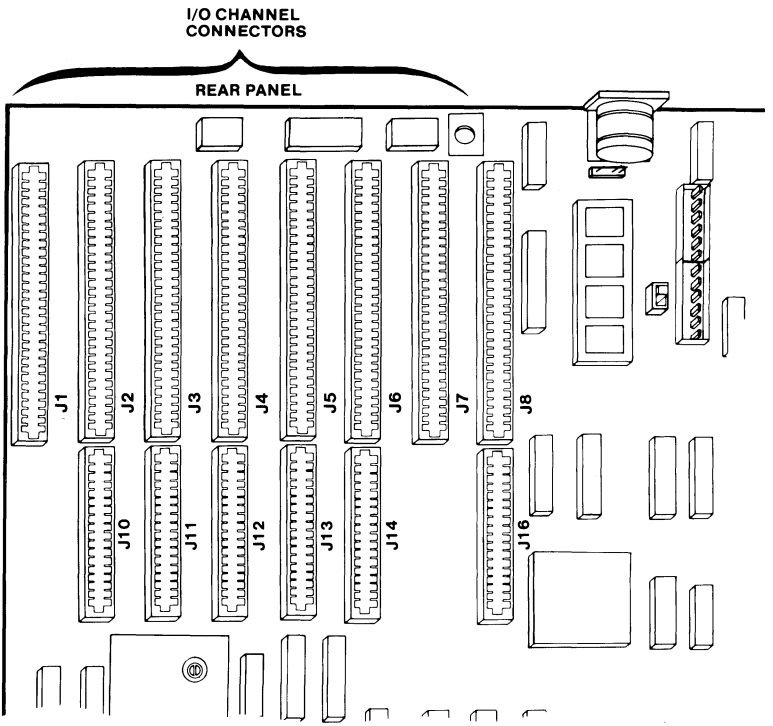
- I/O address space hex 100 to hex 3FF
- 24-bit memory addresses (16M)
- Selection of data accesses (either 8- or 16-bit)
- Interrupts
- DMA channels
- I/O wait-state generation

- Open-bus structure (allowing multiple microprocessors to share the system's resources, including memory)
- Refresh of system memory from channel microprocessors.

Connectors

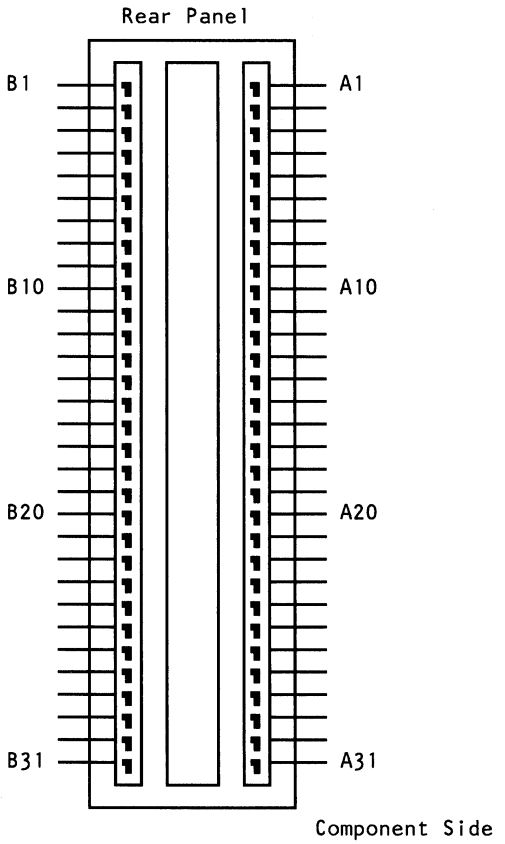
The following figure shows the location and the numbering of the I/O channel connectors. These connectors consist of six 36-pin and eight 62-pin edge connector sockets.

> **Note:** The 36-pin connector is not present in two positions on the I/O channel. These positions can support only 62-pin I/O bus adapters.



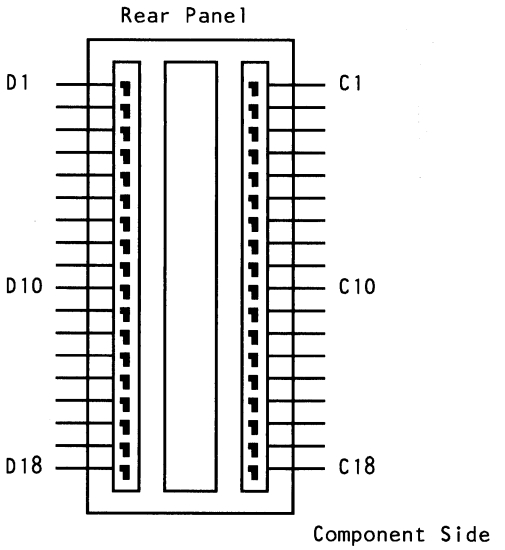
I/O Channel Connector Location

The following figure shows the pin numbering for I/O channel connectors J1 through J8.



I/O Channel Pin Numbering (J1-J8)

The following figure shows the pin numbering for I/O channel connectors J10 through J14 and J16.



I/O Channel Pin Numbering (J10-J14 and J16)

The following figures summarize pin assignments for the I/O channel connectors.

I/O Pin	Signal Name	I/O
A1	-I/O CH CK	I
A2	SD7	I/O
A3	SD6	I/O
A4	SD5	I/O
A5	SD4	I/O
A6	SD3	I/O
A7	SD2	I/O
A8	SD1	I/O
A9	SD0	I/O
A10	-I/O CH RDY	I
A11	AEN	O
A12	SA19	I/O
A13	SA18	I/O
A14	SA17	I/O
A15	SA16	I/O
A16	SA15	I/O
A17	SA14	I/O
A18	SA13	I/O
A19	SA12	I/O
A20	SA11	I/O
A21	SA10	I/O
A22	SA9	I/O
A23	SA8	I/O
A24	SA7	I/O
A25	SA6	I/O
A26	SA5	I/O
A27	SA4	I/O
A28	SA3	I/O
A29	SA2	I/O
A30	SA1	I/O
A31	SA0	I/O

I/O Channel (A-Side, J1 through J8)

I/O Pin	Signal Name	I/O
B1	GND	Ground
B2	RESET DRV	O
B3	+5 Vdc	Power
B4	IRQ 9	I
B5	-5 Vdc	Power
B6	DRQ2	I
B7	-12 Vdc	Power
B8	OWS	I
B9	+12 Vdc	Power
B10	GND	Ground
B11	-SMEMW	O
B12	-SMEMR	O
B13	-IOW	I/O
B14	-IOR	I/O
B15	-DACK3	O
B16	DRQ3	I
B17	-DACK1	O
B18	DRQ1	I
B19	-REFRESH	I/O
B20	CLK	O
B21	IRQ7	I
B22	IRQ6	I
B23	IRQ5	I
B24	IRQ4	I
B25	IRQ3	I
B26	-DACK2	O
B27	T/C	O
B28	BALE	O
B29	+5Vdc	Power
B30	OSC	O
B31	GND	Ground

I/O Channel (B-Side, J1 through J8)

I/O Pin	Signal Name	I/O
C1	SBHE	I/O
C2	LA23	I/O
C3	LA22	I/O
C4	LA21	I/O
C5	LA20	I/O
C6	LA19	I/O
C7	LA18	I/O
C8	LA17	I/O
C9	-MEMR	I/O
C10	-MEMW	I/O
C11	SD08	I/O
C12	SD09	I/O
C13	SD10	I/O
C14	SD11	I/O
C15	SD12	I/O
C16	SD13	I/O
C17	SD14	I/O
C18	SD15	I/O

I/O Channel (C-Side, J10 through J14 and 16)

I/O Pin	Signal Name	I/O
D1	-MEM CS16	I
D2	-I/O CS16	I
D3	IRQ10	I
D4	IRQ11	I
D5	IRQ12	I
D6	IRQ15	I
D7	IRQ14	I
D8	-DACK0	O
D9	DRQ0	I
D10	-DACK5	O
D11	DRQ5	I
D12	-DACK6	O
D13	DRQ6	I
D14	-DACK7	O
D15	DRQ7	I
D16	+5 Vdc	POWER
D17	-MASTER	I
D18	GND	GROUND

I/O Channel (D-Side, J10 through J14 and 16)

I/O Channel Signal Description

The following is a description of the system board's I/O channel signals. All signal lines are TTL compatible. I/O adapters should be designed with a maximum of two low-power Shottky (LS) loads per line.

SA0 through SA19 (I/O)

Address signals 0 through 19 are used to address memory and I/O devices within the system. These 20 address lines, in addition to LA17 through LA23, allow access of up to 16M of memory. SA0 through SA19 are gated on the system bus when 'buffered address latch enable' signal (BALE) is high and are latched on the falling edge of BALE. These signals are generated by the microprocessor or DMA Controller. They also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

LA17 through LA23 (I/O)

These signals (unlatched) are used to address memory and I/O devices within the system. They give the system up to 16M of addressability. These signals are valid when BALE is high. LA17 through LA23 are not latched during microprocessor cycles and therefore do not stay valid for the whole cycle. Their purpose is to generate memory decodes for 16-bit, 1 wait-state, memory cycles. These decodes should be latched by I/O adapters on the falling edge of BALE.

These signals also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

CLK (O)

This is the 6-MHz system 'clock' signal. It is a synchronous microprocessor cycle clock with a cycle time of 167 nanoseconds. The clock has a 50% duty cycle. This signal should be used only

for synchronization. It is not intended for uses requiring a fixed frequency.

RESET DRV (O)

The 'reset drive' signal is used to reset or initialize system logic at power-up time or during a low voltage condition. This signal is active high.

SD0 through SD15 (I/O)

These signals provide bus bits 0 through 15 for the microprocessor, memory, and I/O devices. D0 is the least-significant bit and D15 is the most-significant bit. All 8-bit devices on the I/O channel should use D0 through D7 for communications to the microprocessor. The 16-bit devices will use D0 through D15. To support 8-bit devices, the data on D8 through D15 will be gated to D0 through D7 during 8-bit transfers to these devices; 16-bit microprocessor transfers to 8-bit devices will be converted to two 8-bit transfers.

BALE (O) (buffered)

The 'buffered address latch enable' signal is provided by the 82288 Bus Controller and is used on the system board to latch valid addresses and memory decodes from the microprocessor. It is available to the I/O channel as an indicator of a valid microprocessor or DMA address (when used with 'address enable' signal, AEN). Microprocessor addresses SA0 through SA19 are latched with the falling edge of BALE. BALE is forced high (active) during DMA cycles.

-I/O CH CK (I)

The '-I/O channel check' signal provides the system board with parity (error) information about memory or devices on the I/O channel. When this signal is active (low), it indicates a non-correctable system error.

I/O CH RDY (I)

The 'I/O channel ready' signal is pulled low (not ready) by a memory or I/O device to lengthen I/O or memory cycles. Any slow device using this line should drive it low immediately upon detecting its valid address and a Read or Write command. Machine cycles are extended by an integral number of clock cycles (167 nanoseconds). This signal should be held low for no more than 2.5 microseconds.

IRQ3-IRQ7, IRQ9-IRQ12, IRQ14, and IRQ15 (I)

Interrupt requests 3 through 7, 9 through 12, 14, and 15 are used to signal the microprocessor that an I/O device needs attention. The interrupt requests are prioritized, with IRQ9 through IRQ12, IRQ14, and IRQ15 having the highest priority (IRQ9 is the highest), and IRQ3 through IRQ7 having the lowest priority (IRQ7 is the lowest). An interrupt request is generated when an IRQ line is raised from low to high. The line is high until the microprocessor acknowledges the interrupt request (Interrupt Service routine).

> **Note:** Interrupt 13 is used on the system board and is not available on the I/O channel. IRQ 8 is used for the real-time clock.

-IOR (I/O)

The '-I/O read' signal instructs an I/O device to drive its data onto the data bus. This signal may be driven by the system microprocessor or DMA controller, or by a microprocessor or DMA controller resident on the I/O channel. This signal is active low.

-IOW (I/O)

The '-I/O write' signal instructs an I/O device to read the data off the data bus. It may be driven by any microprocessor or DMA controller in the system. This signal is active low.

-SMEMR (O) -MEMR (I/O)

These signals instruct the memory devices to drive data onto the data bus. -SMEMR is active only when the memory decode is within the low 1M of memory space. -MEMR is active on all memory read cycles. -MEMR may be driven by any microprocessor or DMA controller in the system. -SMEMR is derived from -MEMR and the decode of the low 1M of memory. When a microprocessor on the I/O channel wishes to drive -MEMR, it must have the address lines valid on the bus for one clock cycle before driving -MEMR active. Both signals are active low.

-SMEMW (O) -MEMW (I/O)

These signals instruct the memory devices to store the data present on the data bus. -SMEMW is active only when the memory decode is within the low 1M of the memory space. -MEMW is active on all memory write cycles. -MEMW may be driven by any microprocessor or DMA controller in the system. -SMEMW is derived from -MEMW and the decode of the low 1M of memory. When a microprocessor on the I/O channel wishes to drive -MEMW, it must have the address lines valid on the bus for one clock cycle before driving -MEMW active. Both signals are active low.

DRQ0-DRQ3 and DRQ5-DRQ7 (I)

The 'DMA request' signals 0 through 3 and 5 through 7 are asynchronous channel requests used by peripheral devices and a microprocessor to gain DMA service (or control of the system). They are prioritized, with DRQ0 having the highest priority and DRQ7 the lowest. A request is generated by bringing a DRQ line to an active (high) level. A DRQ line is held high until the corresponding 'DMA acknowledge' (DACK) line goes active. DRQ0 through DRQ3 perform 8-bit DMA transfers; DRQ5 through DRQ7 perform 16-bit transfers. DRQ4 is used on the system board and is not available on the I/O channel.

-DACK0 to -DACK3 and -DACK5 to -DACK7 (O)

-DMA acknowledge 0 through 3 and 5 through 7 are used to acknowledge DMA requests. These signals are active low.

AEN (O)

The 'address enable' signal is used to degate the microprocessor and other devices from the I/O channel to allow DMA transfers to take place. When this line is active, the DMA controller has control of the address bus, the data-bus Read command lines (memory and I/O), and the Write command lines (memory and I/O). This signal is active high.

-REFRESH (I/O)

This signal is used to indicate a refresh cycle and can be driven by a microprocessor on the I/O channel. This signal is active low.

T/C (O)

The 'terminal count' signal provides a high pulse when the terminal count for any DMA channel is reached.

SBHE (I/O)

The 'system bus high enable' signal indicates a transfer of data on the upper byte of the data bus, SD8 through SD15. Sixteen-bit devices use SBHE to condition data bus buffers tied to SD8 through SD15. This signal is active high.

-MASTER (I)

This signal is used with a DRQ line to gain control of the system. A processor or DMA controller on the I/O channel may issue a DRQ to a DMA channel in cascade mode and receive a -DACK. Upon receiving the -DACK, a microprocessor may pull

-MASTER active (low), which will allow it to control the system address, data, and control lines (a condition known as *tri-state*). After -MASTER is low, the microprocessor must wait one clock cycle before driving the address and data lines, and two clock cycles before issuing a Read or Write command. If this signal is held low for more than 15 microseconds, the system memory may be lost because of a lack of refresh.

-MEM CS16 (I)

The '-memory 16-bit chip select' signal indicates to the system that the present data transfer is a 1 wait-state, 16-bit, memory cycle. It must be derived from the decode of LA17 through LA23. -MEM CS16 is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

-I/O CS16 (I)

The '-I/O 16-bit chip select' signal indicates to the system that the present data transfer is a 16-bit, 1 wait-state, I/O cycle. It is derived from an address decode. -I/O CS16 is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

OSC (O)

The 'oscillator' signal is a high-speed clock with a 70-nanosecond period (14.31818 MHz). This signal is not synchronous with the system clock. It has a 50% duty cycle.

0WS (I)

The 'zero wait state' signal tells the microprocessor that it can complete the present bus cycle without inserting any additional wait cycles. In order to run a memory cycle to a 16-bit device without wait cycles, 0WS is derived from an address decode gated with a Read or Write command. In order to run a memory cycle to an 8-bit device with a minimum of two wait states, 0WS should

be driven active one clock cycle after the Read or Write command is active, and gated with the address decode for the device. Memory Read and Write commands to an 8-bit device are active on the falling edge of CLK. 0WS is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

The following figure is an I/O address map.

Hex Range	Device
000-01F	DMA controller 1, 8237A-5
020-03F	Interrupt controller 1, 8259A, Master
040-05F	Timer, 8254-2
060-06F	8042 (Keyboard)
070-07F	Real-time clock, NMI (non-maskable interrupt) mask
080-09F	DMA page register , 74LS612
0A0-0BF	Interrupt Controller 2, 8259A
0C0-0DF	DMA controller 2, 8237A-5
0F0	Clear Math Coprocessor Busy
0F1	Reset Math Coprocessor
0F8-0FF	Math Coprocessor
Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel.	

I/O Address Map (Part 1 of 2)

Hex Range	Device
1F0-1F8	Fixed Disk
200-207	Game I/O
20C-20D	Reserved
21F	Reserved
278-27F	Parallel printer port 2
2B0-2DF	Alternate Enhanced Graphics Adapter
2E1	GPIB (Adapter 0)
2E2 & 2E3	Data Acquisition (Adapter 0)
2F8-2FF	Serial port 2
300-31F	Prototype card
360-363	PC Network (low address)
364-367	Reserved
368-36B	PC Network (high address)
36C-36F	Reserved
378-37F	Parallel printer port 1
380-38F	SDLC, bisynchronous 2
390-393	Cluster
3A0-3AF	Bisynchronous 1
3B0-3BF	Monochrome Display and Printer Adapter
3C0-3CF	Enhanced Graphics Adapter
3D0-3DF	Color/Graphics Monitor Adapter
3F0-3F7	Diskette controller
3F8-3FF	Serial port 1
6E2 & 6E3	Data Acquisition (Adapter 1)
790-793	Cluster (Adapter 1)
AE2 & AE3	Data Acquisition (Adapter 2)
B90-B93	Cluster (Adapter 2)
EE2 & EE3	Data Acquisition (Adapter 3)
1390-1393	Cluster (Adapter 3)
22E1	GPIB (Adapter 1)
2390-2393	Cluster (Adapter 4)
42E1	GPIB (Adapter 2)
62E1	GPIB (Adapter 3)
82E1	GPIB (Adapter 4)
A2E1	GPIB (Adapter 5)
C2E1	GPIB (Adapter 6)
E2E1	GPIB (Adapter 7)

Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel.

I/O Address Map (Part 2 of 2)

NMI and Coprocessor Controls

At power-on time, the non-maskable interrupt (NMI) into the 80286 is masked off. The mask bit can be set and reset with system programs as follows:

Mask On Write to I/O address hex 070, with data bit 7 equal to a logic 0.

Mask Off Write to I/O address hex 070, with data bit 7 equal to a logic 1.

Note: At the end of POST, the system sets the NMI mask on (NMI enabled).

The following is a description of the Math Coprocessor controls.

0F0 An 8-bit Out command to port F0 will clear the latched Math Coprocessor '-busy' signal. The '-busy' signal will be latched if the coprocessor asserts its '-error' signal while it is busy. The data output should be zero.

0F1 An 8-bit Out command to port F1 will reset the Math Coprocessor. The data output should be zero.

I/O address hex 080 is used as a diagnostic-checkpoint port or register. This port corresponds to a read/write register in the DMA page register (74LS612).

The '-I/O channel check' signal (-I/O CH CK) is used to report non-correctable errors on RAM adapters on the I/O channel. This check will create an NMI if the NMI is enabled. At power-on time, the NMI is masked off and -I/O CH CK is disabled. Follow these steps when enabling -I/O CH CK and the NMI.

1. Write data in all I/O RAM-adapter memory locations; this will establish good parity at all locations.

2. Enable -I/O CH CK.

3. Enable the NMI.

Note: All three of these functions are performed by POST.

When a check occurs, an interrupt (NMI) will result. Read the status bits to determine the source of the NMI (see the figure, "I/O Address Map", on page 1-37). To determine the location of the failing adapter, write to any memory location within a given

adapter. If the parity check was from that adapter, -I/O CH CK will be reset to inactive.

Other Circuits

Speaker

The system unit has a 2-1/4 inch permanent-magnet speaker, which can be driven from:

- The I/O-port output bit
- The timer/counter's CLK OUT 2
- Both of the above

RAM Jumpers

The system board has a 3-pin, Berg-strip connector (J18). Starting at the front of the system, the pins are numbered 1 through 3. Jumper placement across these pins determines how much system board RAM is enabled. Pin assignments follow.

Pin	Assignments
1	No Connection
2	- RAM SEL
3	Ground

RAM Jumper Connector (J18)

The following shows how the jumpers affect RAM.

Jumper Positions	Function
1 and 2	Enable 2nd 256K of system board RAM
2 and 3	Disable 2nd 256K of system board RAM

RAM Jumper

> **Note:** The normal mode is the enable mode. The other mode permits the additional RAM to reside on adapters plugged into the I/O bus.

Display Switch

Set the slide switch on the system board to select the primary display adapter. Its positions are assigned as follows:

On (toward the front of the system unit): The primary display is attached to the Color/Graphics Monitor Adapter or Professional Graphics Controller.

Off (toward the rear of the system unit): The primary display is attached to the Monochrome Display and Printer Adapter.

The switch may be set to either position if the primary display is attached to an Enhanced Graphics Adapter.

> **Note:** The primary display is activated when the system is powered on.

Variable Capacitor

The system board has a variable capacitor. Its purpose is to adjust the 14.31818 MHz oscillator signal (OSC), used to obtain the color-burst signal required for color televisions.

Keyboard Controller

The keyboard controller is a single-chip microcomputer (Intel 8042) that is programmed to support the keyboard serial interface. The keyboard controller receives serial data from the keyboard, checks the parity of the data, translates scan codes, and presents the data to the system as a byte of data in its output buffer. The controller can interrupt the system when data is placed in its output buffer, or wait for the system to poll its status register to determine when data is available.

Data is sent the keyboard by first polling the controller's status register to determine when the input buffer is ready to accept data and then writing to the input buffer. Each byte of data is sent to the keyboard serially with an odd parity bit automatically inserted. The keyboard is required to acknowledge all data transmissions, another byte of data should not be sent to the keyboard until acknowledgement is received for the previous byte sent. The output-buffer-full interrupt may be used for both send and receive routines.

Keyboard Controller Initialization

At power on, the keyboard controller set the system flag bit to 0. After a power-on reset or the execution of the Self Test command, the keyboard controller disables the keyboard interface by forcing the 'keyboard clock' line low. The keyboard interface parameters are specified at this time by writing to locations within the 8042 RAM. The keyboard-inhibit function is then disabled by setting the inhibit-override bit in the command byte. A hex 55 is then placed in the output buffer if no errors are detected during the self test. Any value other than hex 55 indicates that the 8042 is defective. The keyboard interface is now enabled by lifting the 'keyboard data' and 'keyboard clock' signal lines, and the system flag is set to 1. The keyboard controller is then ready to accept commands from the system unit microprocessor or receive keyboard data.

Receiving Data from the Keyboard

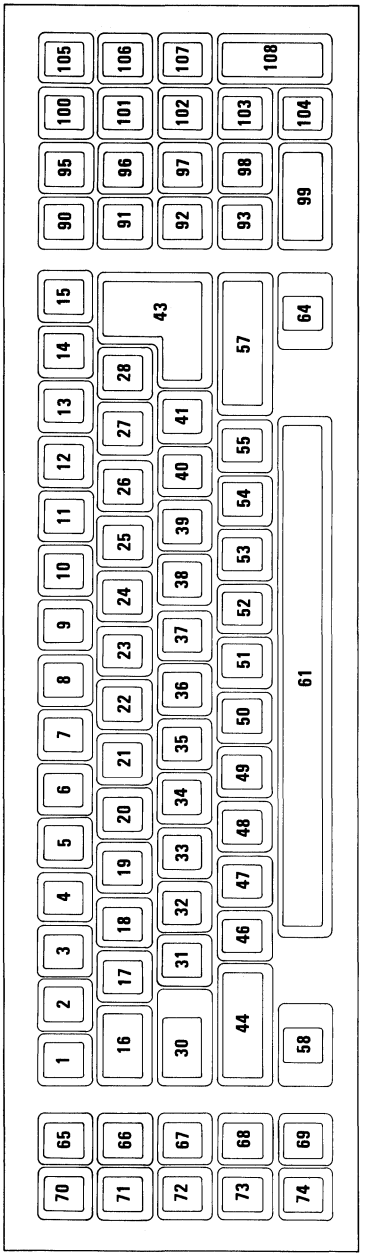
The keyboard sends data in a serial format using an 11-bit frame. The first bit is a start bit, and is followed by eight data bits, an odd parity bit, and a stop bit. Data sent is synchronized by a clock supplied by the keyboard. At the end of a transmission, the keyboard controller disables the interface until the system accepts the byte. If the byte of data is received with a parity error, a Resend command is automatically sent to the keyboard. If the keyboard controller is unable to receive the data correctly after a set number of retries, a hex FF is placed in its output buffer, and the parity bit in the status register is set to 1, indicating a receive parity error. The keyboard controller will also time a byte of data from the keyboard. If a keyboard transmission does not end within two milliseconds, a hex FF is placed in the keyboard controller's output buffer, and the receive time-out bit in the status register is set. No retries will be attempted on a receive time-out error.

> **Note:** When a receive error occurs in the default mode (bits 5, 6, and 7 of the command byte set to 0), hex 00 is placed in the output buffer instead of hex FF. See "Commands (I/O Address Hex 64)" on page 1-51 for a detailed description of the command byte.

Scan Code Translation

Scan codes received from the keyboard are converted by the keyboard controller before being placed into the controller's output buffer. The following figure shows the keyboard layout. Each key position is numbered for reference.

Keyboard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The following figure is the scan-code translation table.

System Scan Code	Keyboard Scan Code	Key
01	76	90
02	16	2
03	1E	3
04	26	4
05	25	5
06	2E	6
07	36	7
08	3D	8
09	3E	9
0A	46	10
0B	45	11
0C	4E	12
0D	55	13
0E	66	15
0F	0D	16
10	15	17
11	1D	18
12	24	19
13	2D	20
14	2C	21
15	35	22
16	3C	23
17	43	24
18	44	25
19	4D	26
1A	54	27
1B	5B	28
1C	5A	43
1D	14	30
1E	1C	31
1F	1B	32
20	23	33
21	2B	34
22	34	35
23	33	36
24	3B	37
25	42	38
26	4B	39
27	4C	40
28	52	41
29	0E	1
2A	12	44
2B	5D	14
2C	1A	46
2D	22	47
2E	21	48
2F	2A	49

Scan-Code Translation Table (Part 1 of 2)

System Scan Code	Keyboard Scan Code	Key
30	32	50
31	31	51
32	3A	52
33	41	53
34	49	54
35	4A	55
36	59	57
38	11	58
39	29	61
3A	58	64
3B	05	70
3C	06	65
3D	04	71
3E	0C	66
3F	03	72
40	0B	67
41	02 or 83	73
42	0A	68
43	01	74
44	09	69
45	77	95
46	7E	100
47	6C	91
48	75	96
49	7D	101
4A	7B	107
4B	6B	92
4C	73	97
4D	74	102
4E	79	108
4F	69	93
50	72	98
51	7A	103
52	70	99
53	71	104
54	7F or 84	105

Scan-Code Translation Table (Part 2 of 2)

The following scan codes are reserved.

Key	System Scan Code	Keyboard Scan Code
Reserved	55	60
Reserved	56	61
Reserved	57	78
Reserved	58	07
Reserved	59	0F
Reserved	5A	17
Reserved	5B	1F
Reserved	5C	27
Reserved	5D	2F
Reserved	5E	37
Reserved	5F	3F
Reserved	60	47
Reserved	61	4F
Reserved	62	56
Reserved	63	5E
Reserved	64	08
Reserved	65	10
Reserved	66	18
Reserved	67	20
Reserved	68	28
Reserved	69	30
Reserved	6A	38
Reserved	6B	40
Reserved	6C	48
Reserved	6D	50
Reserved	6E	57
Reserved	6F	6F
Reserved	70	13
Reserved	71	19
Reserved	72	39
Reserved	73	51
Reserved	74	53
Reserved	75	5C
Reserved	76	5F
Reserved	77	62
Reserved	78	63
Reserved	79	64
Reserved	7A	65
Reserved	7B	67
Reserved	7C	68
Reserved	7D	6A
Reserved	7E	6D
Reserved	7F	6E

Reserved Scan-Code Translation Table

Sending Data to the Keyboard

The keyboard sends data in the same serial format used to receive data from the keyboard. A parity bit is automatically inserted by the keyboard controller. If the keyboard does not start clocking the data from the keyboard controller within 15 milliseconds, or complete that clocking within 2 milliseconds, a hex FE is placed in the keyboard controller's output buffer, and the transmit time-out error bit is set in the status register.

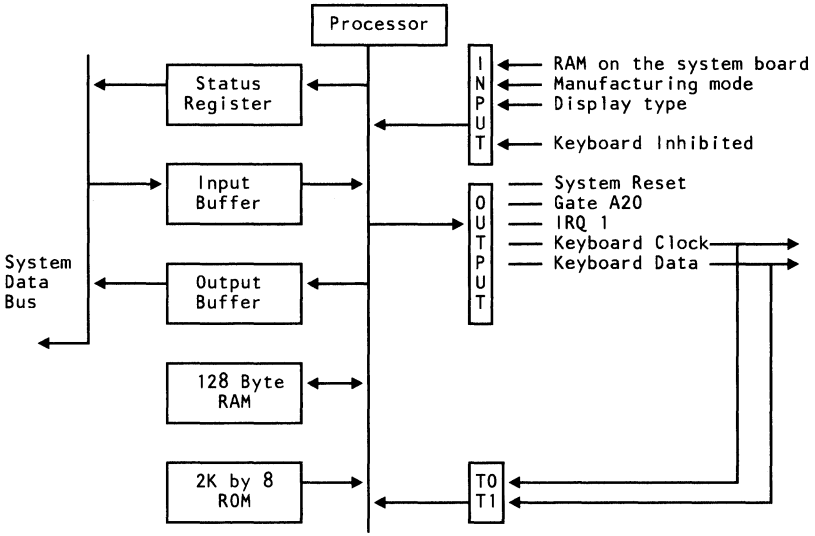
The keyboard is required to respond to all transmissions. The keyboard responds to any valid command and parameter, other than Echo and Resend, with an Acknowledge (ACK) response, hex FA. If the response contains a parity error, the keyboard controller places a hex FE in its output buffer, and the transmit time-out and parity error bits are set in the status register. The keyboard controller is programmed to set a 25-millisecond time limit for the keyboard to respond. If this time limit is exceeded, the keyboard controller places a hex FE in its output buffer and sets the transmit time-out and receive time-out error bits in the status register. No retries are attempted by the keyboard controller for any transmission error.

Inhibit

The keyboard interface may be inhibited by setting input port bit 7 (keyboard inhibit switch) to 0. All transmissions to the keyboard will be allowed regardless of the state of this bit. The keyboard controller tests data received from the keyboard to determine if the byte received is a command response or a scan code. If the byte is a command response, it is placed in the keyboard controller's output buffer. If the byte is a scan code, it is ignored.

Keyboard Controller System Interface

The keyboard controller communicates with the system through a status register, an output buffer, and an input buffer. The following figure is a block diagram of the keyboard interface.



Keyboard Controller Interface Block Diagram

Status Register

The status register is an 8-bit read-only register at I/O address hex 64. It has information about the state of the keyboard controller (8042) and interface. It may be read at any time.

Status-Register Bit Definition

Bit 7 Parity Error—A 0 indicates the last byte of data received from the keyboard had odd parity. A 1 indicates the last byte had even parity. The keyboard should send data with odd parity.

Bit 6 Receive Time-Out—A 1 indicates that a transmission was started by the keyboard but did not finish within the programmed receive time-out delay.

Bit 5 Transmit Time-Out—A 1 indicates that a transmission started by the keyboard controller was not properly completed. If the transmit byte was not clocked out within the specified time limit, this will be the only error.

If the transmit byte was clocked out but a response was not received within the programmed time limit, the transmit time-out and receive time-out error bits are set to 1. If the transmit byte was clocked out but the response was received with a parity error, the transmit time-out and parity error bits are set to 1.

Bit 4 Inhibit Switch—This bit is updated whenever data is placed in the keyboard controller's output buffer. It reflects the state of the keyboard-inhibit switch. A 0 indicates the keyboard is inhibited.

Bit 3 Command/Data—The keyboard controller's input buffer may be addressed as either I/O address hex 60 or 64. Address hex 60 is defined as the data port, and address hex 64 is defined as the command port. Writing to address hex 64 sets this bit to 1; writing to address hex 60 sets this bit to 0. The controller uses this bit to determine if the byte in its input buffer should be interpreted as a command byte or a data byte.

Bit 2 System Flag—This bit is monitored by the system during the reset routine. If it is a 0, the reset was caused by a power on. The controller sets this bit to 0 at power on and it is set to 1 after a successful self test. This bit can be changed by writing to the system flag bit in the command byte (hex 64).

Bit 1 Input Buffer Full—A 0 indicates that the keyboard controller's input buffer (I/O address hex 60 or 64) is empty. A 1 indicates that data has been written into the buffer but the controller has not read the data. When the controller reads the input buffer, this bit will return to 0.

Bit 0 Output Buffer Full—A 0 indicates that the keyboard controller's output buffer has no data. A 1 indicates that the controller has placed data into its output buffer but the system has not yet read the data. When the system reads the output buffer (I/O address hex 60), this bit will return to a 0.

Output Buffer

The output buffer is an 8-bit read-only register at I/O address hex 60. The keyboard controller uses the output buffer to send scan codes received from the keyboard, and data bytes requested by command, to the system. The output buffer should be read only when the output-buffer-full bit in the status register is 1.

Input Buffer

The input buffer is an 8-bit write-only register at I/O address hex 60 or 64. Writing to address hex 60 sets a flag, which indicates a data write; writing to address hex 64 sets a flag, indicating a command write. Data written to I/O address hex 60 is sent to the keyboard, unless the keyboard controller is expecting a data byte following a controller command. Data should be written to the controller's input buffer only if the input buffer's full bit in the status register is 0. The following are valid keyboard controller commands.

Commands (I/O Address Hex 64)

20 Read Keyboard Controller's Command Byte—The controller sends its current command byte to its output buffer.

60 Write Keyboard Controller's Command Byte—The next byte of data written to I/O address hex 60 is placed in the controller's command byte. Bit definitions of the command byte are as follows:

Bit 7 Reserved—Should be written as a 0.

Bit 6 IBM Personal Computer Compatibility Mode—Writing a 1 to this bit causes the controller to convert the scan codes received from the keyboard to those used by the IBM Personal Computer. This includes converting a 2-byte break sequence to the 1-byte IBM Personal Computer format.

Bit 5 IBM Personal Computer Mode—Writing a 1 to this bit programs the keyboard to support the IBM Personal Computer keyboard interface. In this mode the controller does not check parity or convert scan codes.

Bit 4 Disable Keyboard—Writing a 1 to this bit disables the keyboard interface by driving the 'clock' line low. Data is not sent or received.

Bit 3 Inhibit Override—Writing a 1 to this bit disables the keyboard inhibit function.

Bit 2 System Flag—The value written to this bit is placed in the system flag bit of the controller's status register.

Bit 1 Reserved—Should be written as a 0.

Bit 0 Enable Output-Buffer-Full Interrupt—Writing a 1 to this bit causes the controller to generate an interrupt when it places data into its output buffer.

AA Self-Test—This commands the controller to perform internal diagnostic tests. A hex 55 is placed in the output buffer if no errors are detected.

AB Interface Test—This commands the controller to test the 'keyboard clock' and 'keyboard data' lines. The test result is placed in the output buffer as follows:

00 No error detected.
01 The 'keyboard clock' line is stuck low.
02 The 'keyboard clock' line is stuck high.
03 The 'keyboard data' line is stuck low.
04 The 'keyboard data' line is stuck high.

AC Diagnostic Dump—Sends 16 bytes of the controller's RAM, the current state of the input port, the current state of the output port, and the controller's program status word to the system. All items are sent in scan-code format.

AD Disable Keyboard Feature—This command sets bit 4 of the controller's command byte. This disables the keyboard interface by driving the clock line low. Data will not be sent or received.

AE Enable Keyboard Interface—This command clears bit 4 of the command byte, which releases the keyboard interface.

C0 Read Input Port—This commands the controller to read its input port and place the data in its output buffer. This command should be used only if the output buffer is empty.

D0 Read Output Port—This command causes the controller to read its output port and place the data in its output buffer. This command should be issued only if the output buffer is empty.

D1 Write Output Port—The next byte of data written to I/O address hex 60 is placed in the controller's output port.

> **Note:** Bit 0 of the controller's output port is connected to System Reset. This bit should not be written low as it will reset the microprocessor.

E0 Read Test Inputs—This command causes the controller to read its T0 and T1 inputs. This data is placed in the output buffer. Data bit 0 represents T0, and data bit 1 represents T1.

F0–FF Pulse Output Port—Bits 0 through 3 of the controller's output port may be pulsed low for approximately 6 microseconds. Bits 0 through 3 of this command indicate which bits are to be pulsed. A 0 indicates that the bit should be pulsed, and a 1 indicates the bit should not be modified.

> **Note:** Bit 0 of the controller's output port is connected to System Reset. Pulsing this bit resets the microprocessor.

I/O Ports

The keyboard controller has two I/O ports, one assigned for input and the other for output. Two test inputs are used by the controller to read the state of the keyboard's 'clock' (T0) and 'data' (T1) lines.

The following figures show bit definitions for the input and output ports, and the test-inputs.

Bit 7	Keyboard inhibit switch 0 = Keyboard inhibited 1 = Keyboard not inhibited
Bit 6	Display switch - Primary display attached to: 0 = Color/Graphics adapter 1 = Monochrome adapter
Bit 5	Manufacturing Jumper 0 = Manufacturing jumper installed 1 = Jumper not installed
Bit 4	RAM on the system board 0 = Enable 512K of system board RAM 1 = Enable 256K of system board RAM
Bit 3	Reserved
Bit 2	Reserved
Bit 1	Reserved
Bit 0	Reserved

Input-Port Bit Definitions

Bit 7	Keyboard data (output)
Bit 6	Keyboard clock (output)
Bit 5	Input buffer empty
Bit 4	Output buffer full
Bit 3	Reserved
Bit 2	Reserved
Bit 1	Gate A20
Bit 0	System reset

Output-Port Bit Definitions

T1	Keyboard data (input)
T0	Keyboard clock (input)

Test-Input Bit Definitions

Real-Time Clock/CMOS RAM Information

The RT/CMOS RAM chip (Motorola MC146818) contains the real-time clock and 64 bytes of CMOS RAM. The internal clock circuitry uses 14 bytes of this RAM, and the rest is allocated to configuration information. The following figure shows the CMOS RAM addresses.

Addresses	Description
00 - 0D	* Real-time clock information
0E	* Diagnostic status byte
0F	* Shutdown status byte
10	Diskette drive type byte - drives A and B
11	Reserved
12	Fixed disk type byte - types 1-14
13	Reserved
14	Equipment byte
15	Low base memory byte
16	High base memory byte
17	Low expansion memory byte
18	High expansion memory byte
19	Disk C extended byte
1A	Disk D extended byte
1B - 2D	Reserved
2E - 2F	2-byte CMOS checksum
30	* Low expansion memory byte
31	* High expansion memory byte
32	* Date century byte
33	* Information flags (set during power on)
34 - 3F	Reserved

CMOS RAM Address Map

* These bytes are not included in the checksum calculation and are not part of the configuration record.

Real-Time Clock Information

The following figure describes real-time clock bytes and specifies their addresses.

Byte	Function	Address
0	Seconds	00
1	Second Alarm	01
2	Minutes	02
3	Minute Alarm	03
4	Hours	04
5	Hour Alarm	05
6	Day of Week	06
7	Date of Month	07
8	Month	08
9	Year	09
10	Status Register A	0A
11	Status Register B	0B
12	Status Register C	0C
13	Status Register D	0D

Real-Time Clock Information (Addresses 00 - 0D)

Note: The setup program initializes registers A, B, C, and D when the time and date are set. Also Interrupt 1A is the BIOS interface to read/set the time and date. It initializes the status bytes the same as the Setup program.

Status Register A

Bit 7 Update in Progress (UIP)—A 1 indicates the time update cycle is in progress. A 0 indicates the current date and time are available to read.

Bit 6–Bit 4 22-Stage Divider (DV2 through DV0)—These three divider-selection bits identify which time-base frequency is being used. The system initializes the stage divider to 010, which selects a 32.768-kHz time base.

Bit 3–Bit 0 Rate Selection Bits (RS3 through RS0)—These bits allow the selection of a divider output frequency. The system initializes the rate selection bits to 0110, which selects a 1.024-kHz square wave output frequency and a 976.562-microsecond periodic interrupt rate.

Status Register B

Bit 7 Set—A 0 updates the cycle normally by advancing the counts at one-per-second. A 1 aborts any update cycle in progress and the program can initialize the 14 time-bytes without any further updates occurring until a 0 is written to this bit.

Bit 6 Periodic Interrupt Enable (PIE)—This bit is a read/write bit that allows an interrupt to occur at a rate specified by the rate and divider bits in register A. A 1 enables an interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 5 Alarm Interrupt Enable (AIE)—A 1 enables the alarm interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 4 Update-Ended Interrupt Enabled (UIE)—A 1 enables the update-ended interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 3 Square Wave Enabled (SQWE)—A 1 enables the the square-wave frequency as set by the rate selection bits in register A, and a 0 disables the square wave. The system initializes this bit to 0.

Bit 2 Date Mode (DM)—This bit indicates whether the time and date calendar updates are to use binary or binary coded decimal (BCD) formats. A 1 indicates binary, and a 0 indicates BCD. The system initializes this bit to 0.

Bit 1 24/12—This bit indicates whether the hours byte is in the 24-hour or 12-hour mode. A 1 indicates the 24-hour mode and a 0 indicates the 12-hour mode. The system initializes this bit to 1.

Bit 0 Daylight Savings Enabled (DSE)—A 1 enables daylight savings and a 0 disables daylight savings (standard time). The system initializes this bit to 0.

Status Register C

Bit 7–Bit 4 IRQF, PF, AF, UF—These flag bits are read-only and are affected when the AIE, PIE, and UIE bits in register B are set to 1.

Bit 3–Bit 0 Reserved—Should be written as a 0.

Status Register D

Bit 7 Valid RAM Bit (VRB)—This bit is read-only and indicates the status of the power-sense pin (battery level). A 1 indicates battery power to the real-time clock is good. A 0 indicates the battery is dead, so RAM is not valid.

Bits 6–Bit 0 Reserved—Should be written as a 0.

CMOS RAM Configuration Information

The following lists show bit definitions for the CMOS configuration bytes (addresses hex 0E – 3F).

Diagnostic Status Byte (Hex 0E)

Bit 7 Power status of the real-time clock chip—A 0 indicates that the chip has not lost power, and a 1 indicates that the chip lost power.

Bit 6 Configuration Record (Checksum Status Indicator)—A 0 indicates that checksum is good, and a 1 indicates it is bad.

Bit 5 Incorrect Configuration Information—This is a check, at power-on time, of the equipment byte of the configuration record. A 0 indicates that the configuration information is valid, and a 1 indicates it is invalid. Power-on checks require:

- At least one diskette drive to be installed (bit 0 of the equipment byte set to 1).
- The primary display adapter setting in configuration matches the system board's display switch setting and the actual display adapter hardware in the system.

Bit 4 Memory Size Comparison—A 0 indicates that the power-on check determined the same memory size as in the configuration record, and a 1 indicates the memory size is different.

Bit 3 Fixed Disk Adapter/Drive C Initialization Status—A 0 indicates that the adapter and drive are functioning properly and the system can attempt "boot up." A 1 indicates that the adapter and/or drive C failed initialization, which prevents the system from attempting to "boot up."

Bit 2 Time Status Indicator (POST validity check)— A 0 indicates that the time is valid, and a 1 indicates that it is invalid.

Bit 1–Bit 0 Reserved

Shutdown Status Byte (Hex 0F)

The bits in this byte are defined by the power on diagnostics. For more information about this byte, see "BIOS Listing."

Diskette Drive Type Byte (Hex 10)

Bit 7–Bit 4 Type of first diskette drive installed:

0000 No drive is present.
0001 Double Sided Diskette Drive (48 TPI).
0010 High Capacity Diskette Drive (96 TPI).

Note: 0011 through 1111 are reserved.

Bit 3–Bit 0 Type of second diskette drive installed:

0000 No drive is present.
0001 Double Sided Diskette Drive (48 TPI).
0010 High Capacity Diskette Drive (96 TPI).

Note: 0011 through 1111 are reserved.

Hex address 11 contains a reserved byte.

Fixed Disk Type Byte (Hex 12)

Bit 7–Bit 4 Defines the type of first fixed disk drive installed (drive C):

0000 No fixed disk drive is present.

0001 to 1110 Define type 1 through type 14 as shown in the following table (also see BIOS listing at label FD_TBL)

1111 Type 16 through 255. See "Drive C Extended Byte (Hex 19)" on page 1-65 .

Bit 3–Bit 0 Defines the type of second fixed disk drive installed (drive D):

0000 No fixed disk drive is present.

0001 to 1110 Define type 1 through type 14 as shown in the following table (also see BIOS listing at label FD_TBL)

1111 Type 16 through 255. See "Drive D Extended Byte (Hex 1A)" on page 1-65 .

The following figure shows the BIOS fixed disk parameters.

Type	Cylinders	Heads	Write Pre-Comp	Landing Zone
1	306	4	128	305
2	615	4	300	615
3	615	6	300	615
4	940	8	512	940
5	940	6	512	940
6	615	4	None	615
7	462	8	256	511
8	733	5	None	733
9	900	15	None	901
10	820	3	None	820
11	855	5	None	855
12	855	7	None	855
13	306	8	128	319
14	733	7	None	733
15	Extended Parameters (hex 19 and 1A)			

BIOS Fixed Disk Parameters

Hex address 13 contains a reserved byte.

Equipment Byte (Hex 14)

Bit 7–Bit 6 Indicates the number of diskette drives installed:

00 1 drive
01 2 drives
10 Reserved
11 Reserved

Bit 5–Bit 4 Primary display

00 Primary display is attached to an adapter that has its own BIOS, such as one of the following:

- the Enhanced Graphics Adapter
- the Professional Graphics Controller.

01 Primary display is in the 40-column mode and attached to the Color/Graphics Monitor Adapter.

10 Primary display is in the 80-column mode and attached to the Color/Graphics Monitor Adapter.

11 Primary display is attached to the Monochrome Display and Printer Adapter.

Bit 3–Bit 2 Not used.

Bit 1 Math Coprocessor presence bit:

0 Math Coprocessor not installed
1 Math Coprocessor installed

Bit 0 Diskette drive presence bit:

0 Diskette drive not installed
1 Diskette drive installed

Note: The equipment byte defines basic equipment in the system for power-on diagnostics.

Low and High Base Memory Bytes (Hex 15 and 16)

Bit 7–Bit 0 Address hex 15—Low-byte base size

Bit 7–Bit 0 Address hex 16—High-byte base size

Valid Sizes:

0100H 256K–system board RAM
0200H 512K–system board RAM
0280H 640K–512K system board RAM and the IBM Personal Computer AT 128KB Memory Expansion Option

Low and High Expansion Memory Bytes (Hex 17 and 18)

Bit 7–Bit 0 Address hex 17—Low-byte expansion size

Bit 7-Bit 0 Address hex 18—High-byte expansion size

Valid Sizes:

0200H 512K–I/O adapter
0400H 1024K–I/O adapter (2 adapters)
0600H 1536K–I/O adapter (3 adapters)
through
3C00H 15360K I/O adapter (15M maximum).

Drive C Extended Byte (Hex 19)

Bit 7–Bit 0 Defines the type of first fixed disk drive installed (drive C):

00000000 through 00001111 are reserved.

00010000 to 11111111 define type 16 through 255 as shown in the following table (see BIOS listing at label FD_TBL).

Drive D Extended Byte (Hex 1A)

Bit 7–Bit 0 Defines the type of second fixed disk drive installed (drive D):

00000000 through 00001111 are reserved.

00010000 to 11111111 define type 16 through 255 as shown in the following table (see BIOS listing at label FD_TBL).

The following figure shows the BIOS fixed disk parameters for fixed disk drive types 16 through 22.

Note: Types 23 through 255 are reserved.

Type	Cylinders	Heads	Write Pre-Comp	Landing Zone
16	612	4	All Cyl	663
17	977	5	300	977
18	977	7	None	977
19	1024	7	512	1023
20	733	5	300	732
21	733	7	300	732
22	733	7	300	733
23	Reserved			
.	.			
.	.			
255	Reserved			

BIOS Fixed Disk Parameters (Extended)

Hex addresses 1B through 2D are reserved.

Checksum (Hex 2E and 2F)

Bit 7–Bit 0 Address hex 2E—High byte of checksum

Bit 7–Bit 0 Address hex 2F—Low byte of checksum

Note: Checksum is calculated on addresses hex 10-2D.

Low and High Expansion Memory Bytes (Hex 30 and 31)

Bit 7–Bit 0 Address hex 30—Low-byte expansion size

Bit 7–Bit 0 Address hex 31—High-byte expansion size

Valid Sizes:

0200H	512K–I/O adapter
0400H	1024K–I/O adapter
0600H	1536K–I/O adapter
	through
3C00H	15360K I/O adapter (15M maximum).

Note: This word reflects the total expansion memory above the 1M address space as determined at power-on time. This expansion memory size can be determined through system interrupt 15 (see the BIOS listing). The base memory at power-on time is determined through the system memory-size-determine interrupt (hex 12).

Date Century Byte (Hex 32)

Bit 7–Bit 0 BCD value for the century (BIOS interface to read and set).

Information Flag (Hex 33)

Bit 7 When set, this bit indicates that the top 128K of base memory is installed.

Bit 6 This bit is set to instruct the Setup utility to put out a first user message after initial setup.

Bit 5–Bit 0 Reserved

Hex addresses 34 through 3F are reserved.

I/O Operations

Writing to CMOS RAM involves two steps:

1. OUT to port hex 70 with the CMOS address that will be written to.

2. OUT to port hex 71 with the data to be written.

Reading CMOS RAM also requires two steps:

1. OUT to port hex 70 with the CMOS address that is to be read from.

2. IN from port hex 71, and the data read is returned in the AL register.

Specifications

System Unit

Size

- Length: 540 millimeters (21.3 inches)
- Depth: 439 millimeters (17.3 inches)
- Height: 162 millimeters (6.8 inches)

Weight

- 20.0 kilograms (44 pounds)

Power Cables

- Length: 1.8 meters (6 feet)

Environment

- Air Temperature
  - System On: 15.6 to 32.2 degrees C (60 to 90 degrees F)
  - System Off: 10 to 43 degrees C (50 to 110 degrees F)
- Wet Bulb Temperature
  - System On: 22.8 degrees C (73 degrees F)
  - System Off: 26.7 degrees C (80 degrees F)

- Humidity
  - System On: 8% to 80%
  - System Off: 20% to 80%
- Altitude
  - Maximum altitude: 2133.6 meters (7000 feet)

Heat Output

- 1229 British Thermal Units (BTU) per hour

Noise Level

- Meets Class 3; 59 decibels average-noise rating (without printer)

Electrical

- Power: 450 VA
- Range 1
  - Nominal: 115 Vac
  - Minimum: 100 Vac
  - Maximum: 125 Vac
- Range 2
  - Nominal: 230 Vac
  - Minimum: 200 Vac
  - Maximum: 240 Vac

Connectors

The system board has the following additional connectors:

- Two power-supply connectors (PS8 and PS9)
- Speaker connector (J19)
- Power LED and key lock connector (J20)
- Battery connector (J21)
- Keyboard connector (J22)

The pin assignments for the power-supply connectors, PS8 and PS9, are as follows. The pins are numbered 1 through 6 from the rear of the system.

Connector	Pin	Assignments
PS8	1	Power Good
	2	+5 Vdc
	3	+12 Vdc
	4	-12 Vdc
	5	Ground
	6	Ground
PS9	1	Ground
	2	Ground
	3	-5 Vdc
	4	+5 Vdc
	5	+5 Vdc
	6	+5 Vdc

Power Supply Connectors (PS8, PS9)

The speaker connector, J19, is a 4-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the front of the system. The pin assignments are as follows:

Pin	Function
1	Data out
2	Key
3	Ground
4	+5 Vdc

Speaker Connector (J19)

The power LED and key lock connector, J20, is a 5-pin Berg strip. The pins are numbered 1 through 5 from the front of the system. The pin assignments are as follows:

Pin	Assignments
1	LED Power
2	Key
3	Ground
4	Keyboard Inhibit
5	Ground

Power LED and Key Lock Connector (J20)

The battery connector, J21, is a 4-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the right of the system. The pin assignments are as follows:

Pin	Assignments
1	Ground
2	Not Used
3	Key
4	6 Vdc

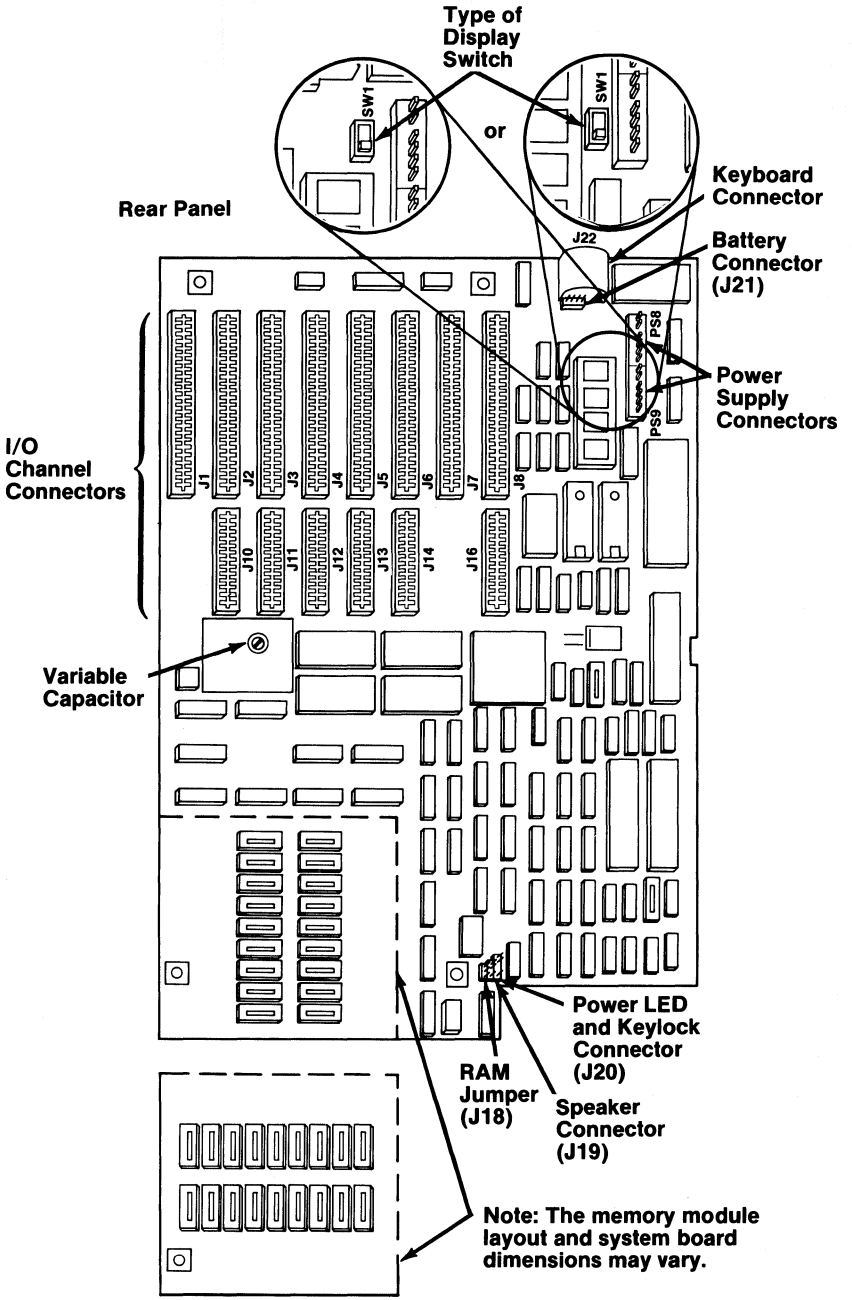
Battery Connector (J21)

The keyboard connector, J22, is a 5-pin, 90-degree Printed Circuit Board (PCB) mounting, DIN connector. For pin numbering, see the "Keyboard" Section. The pin assignments are as follows:

Pin	Assignments
1	Keyboard Clock
2	Keyboard Data
3	Reserved
4	Ground
5	+5 Vdc

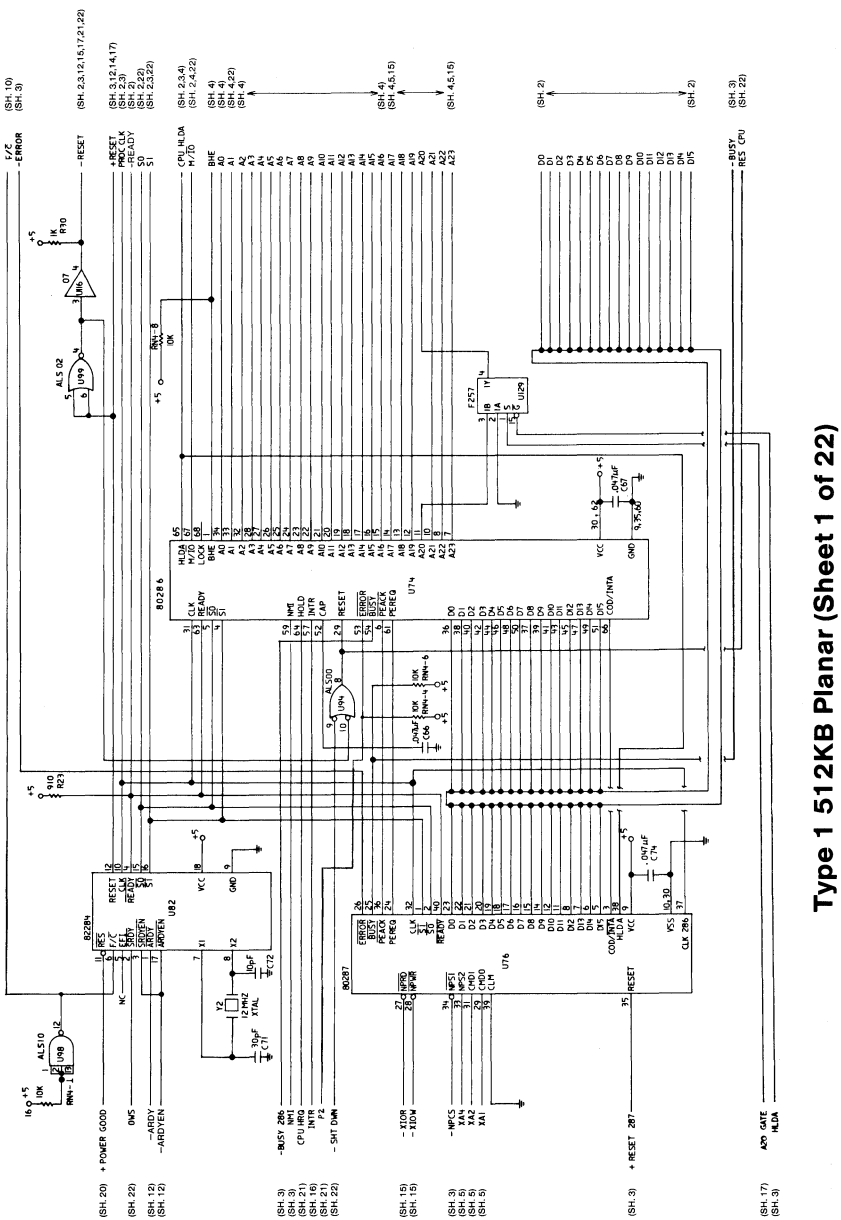
Keyboard Connector (J22)

The following figure shows the layout of the system board.

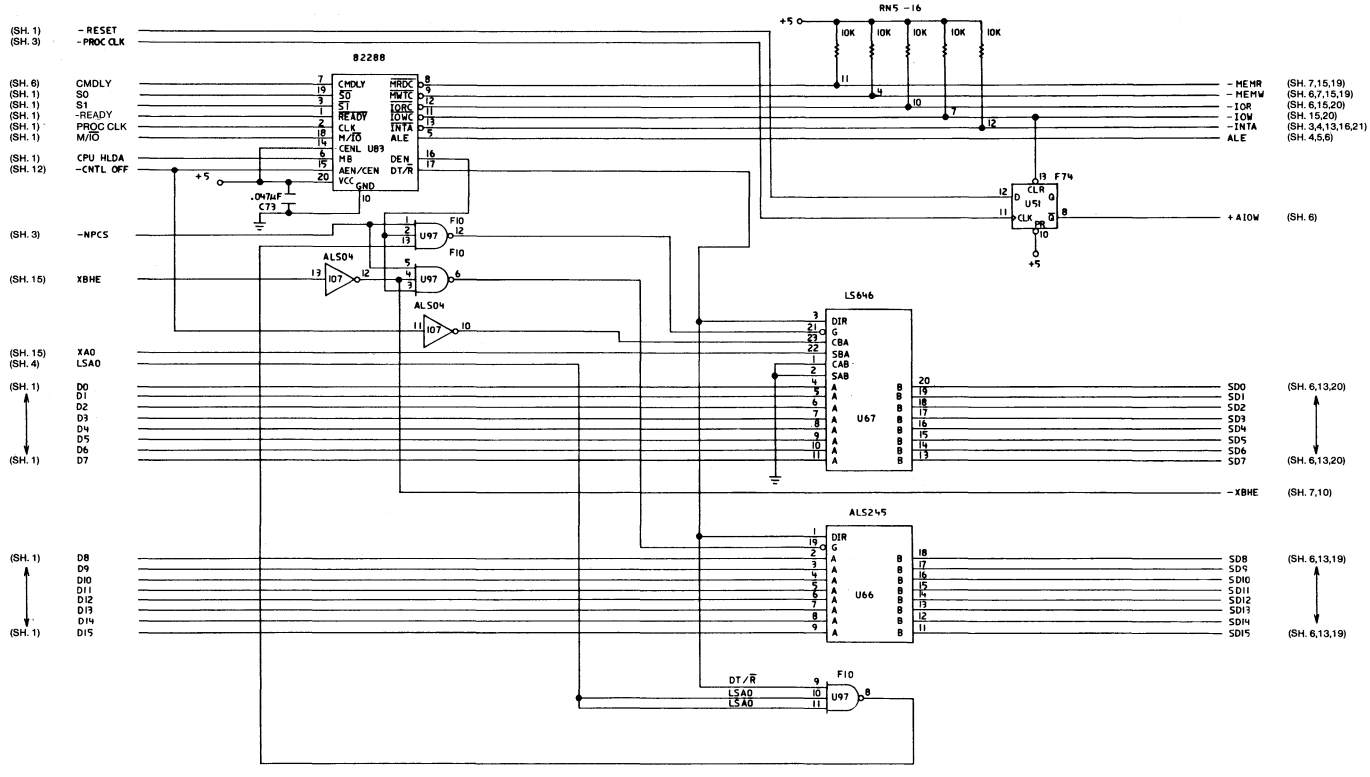


Notes:

Logic Diagrams - Type 1



Type 1 512KB Planar (Sheet 1 of 22)



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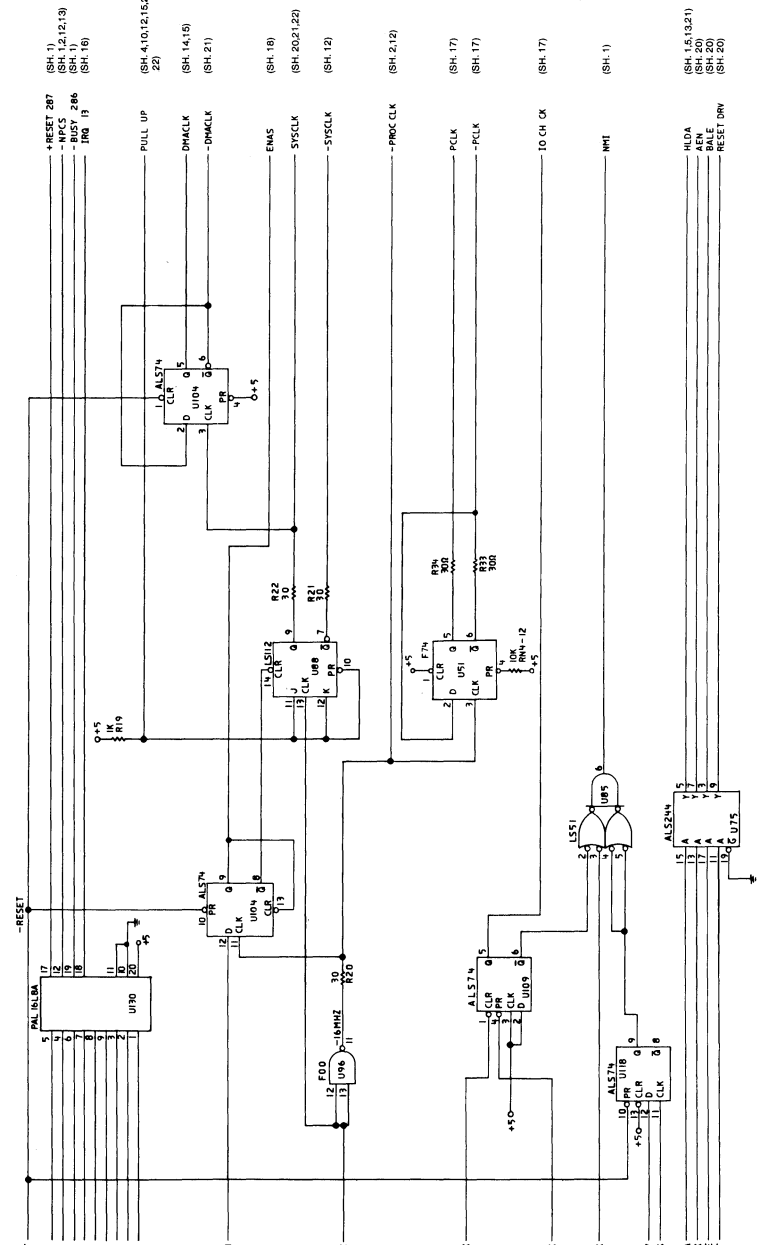

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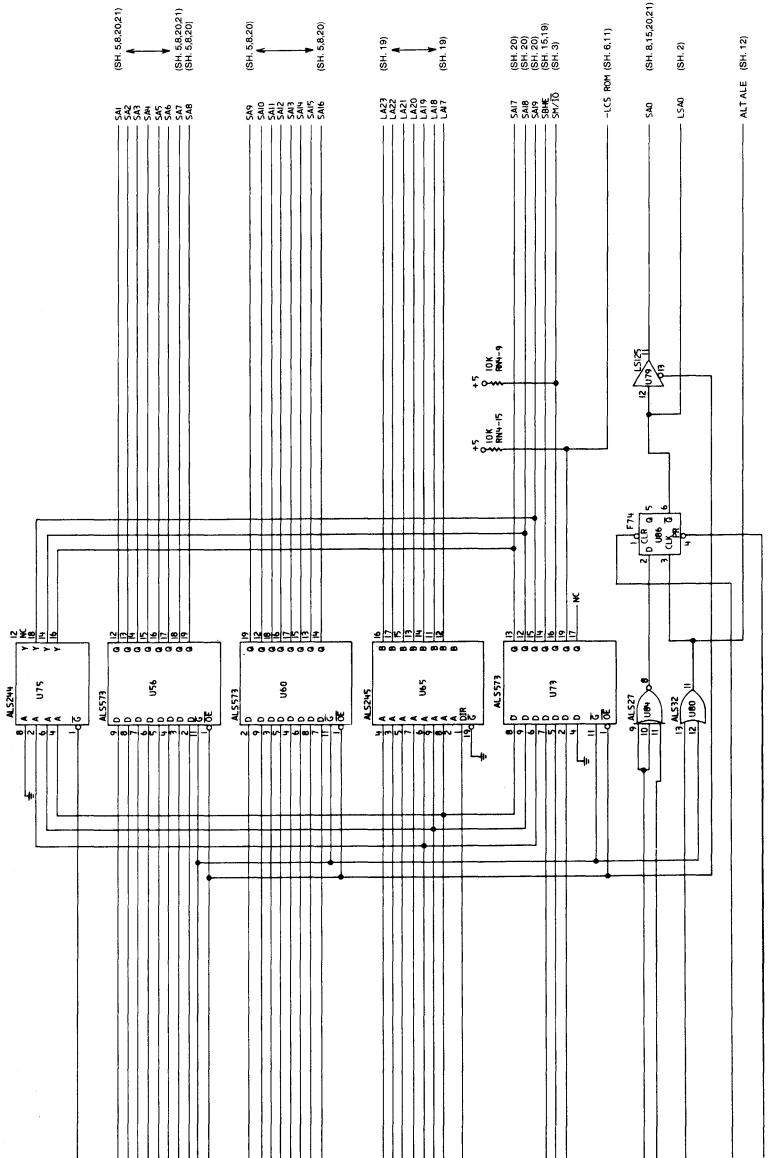

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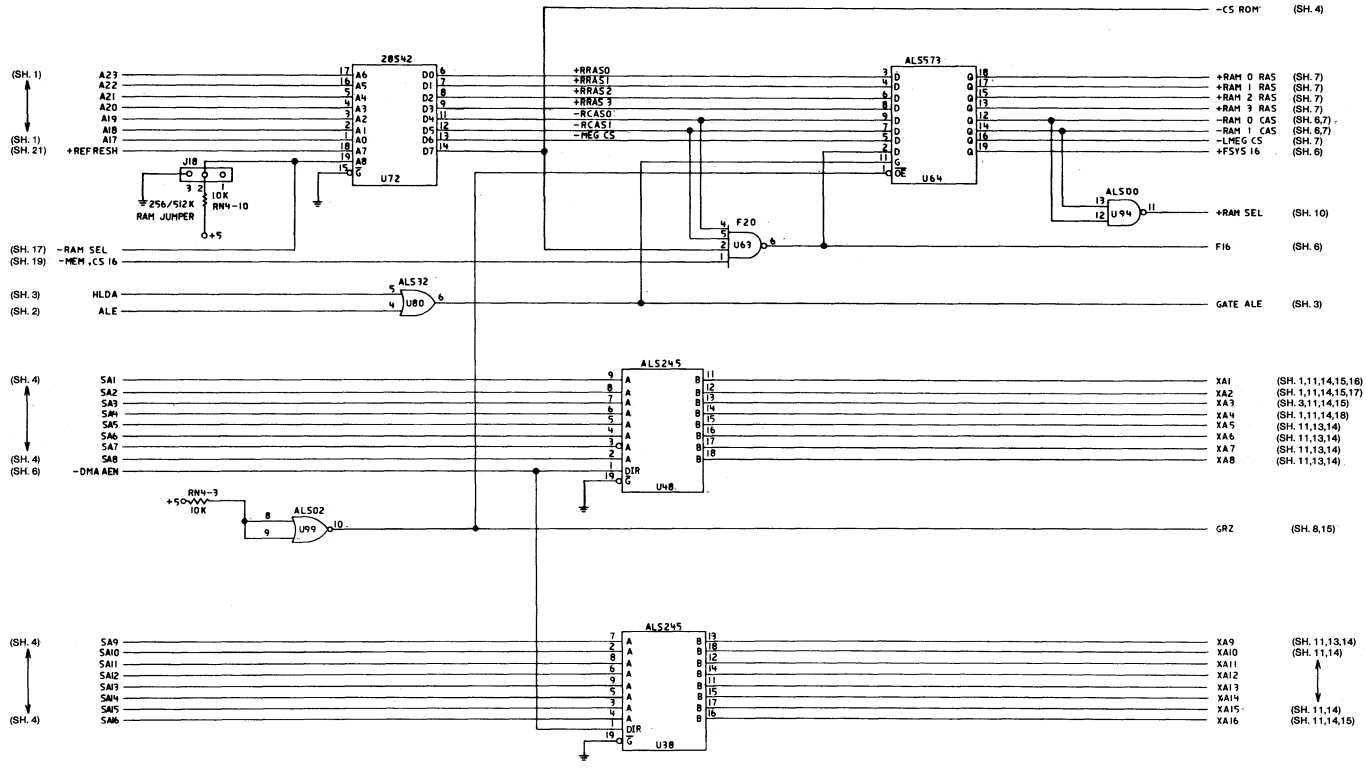

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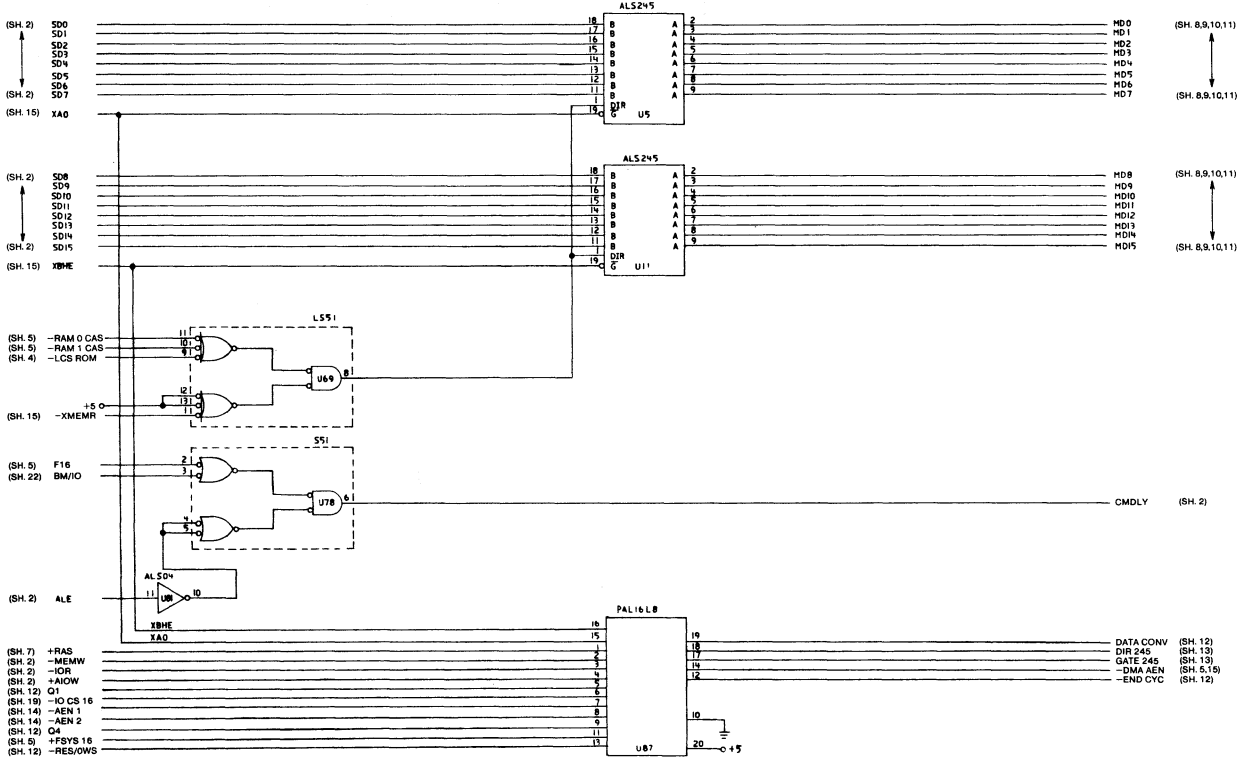

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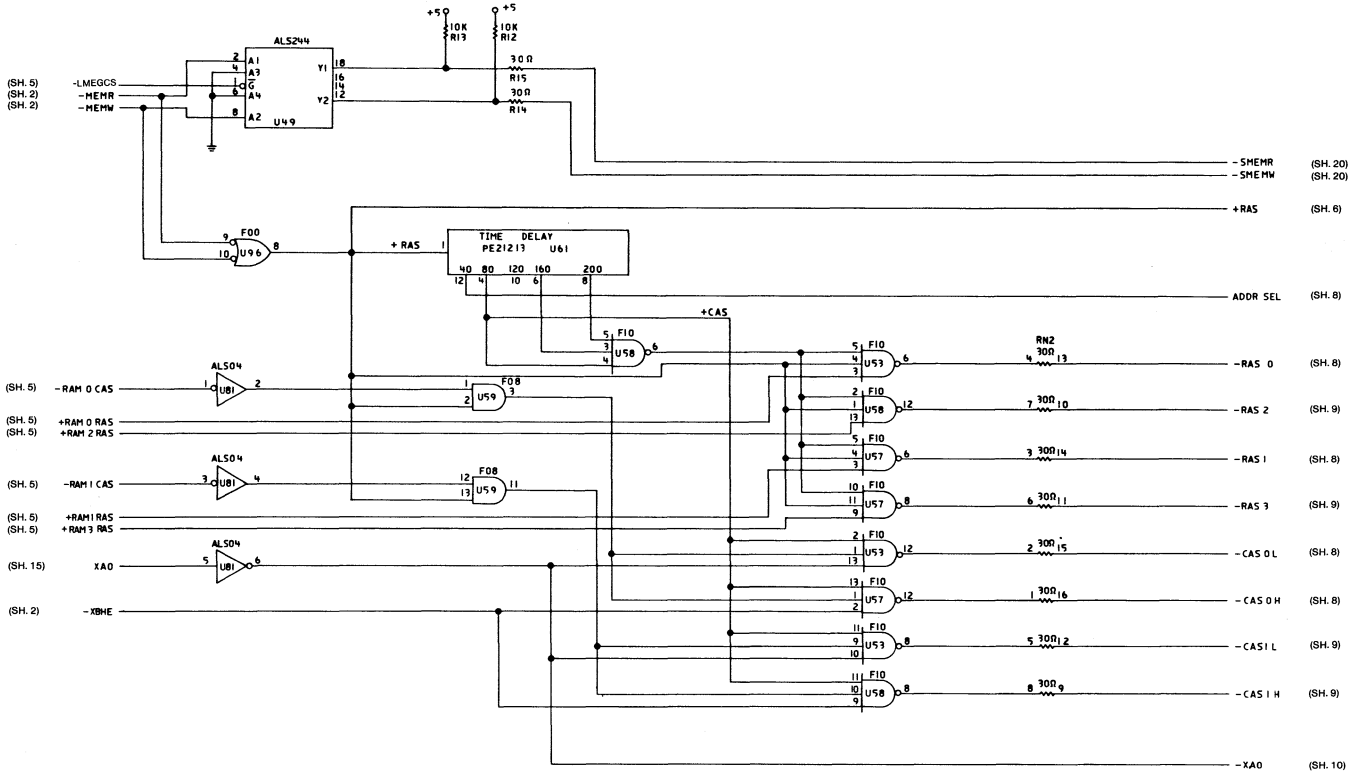

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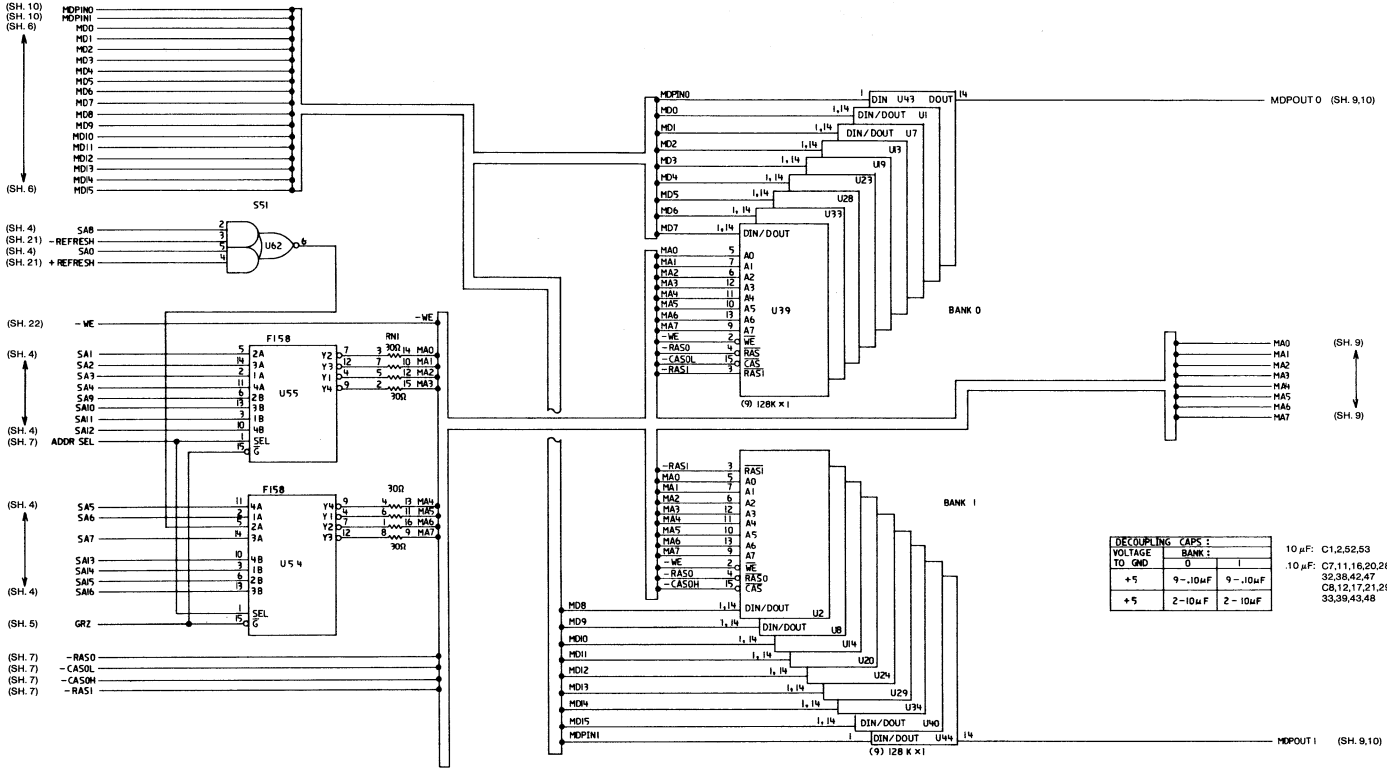

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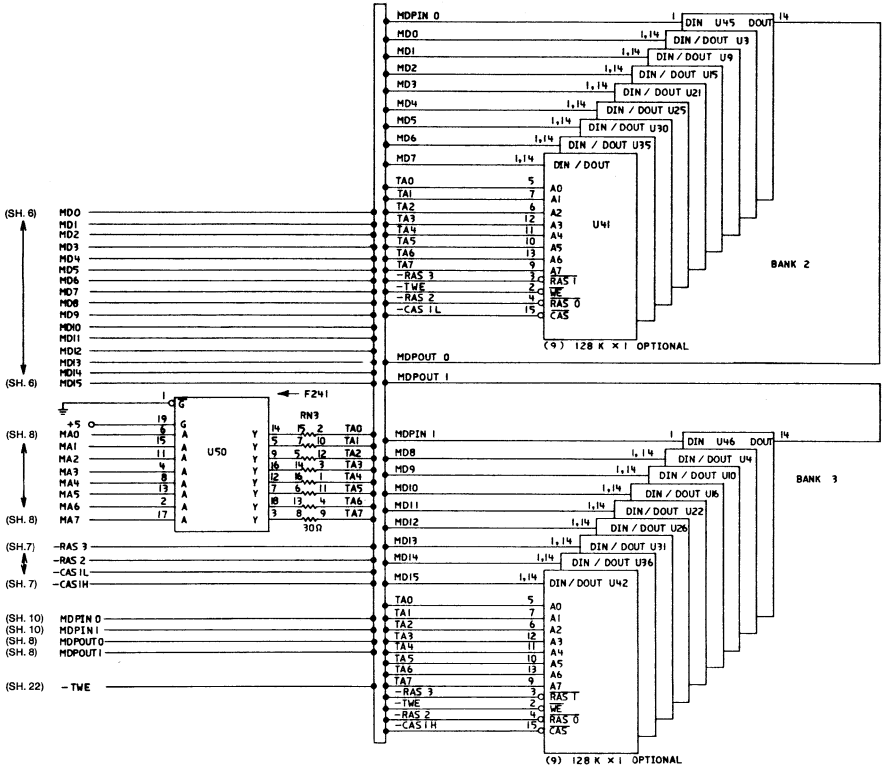

DECOUPLING CAP:		
VOLTAGE TO GND	BANK 2	BANK 3
+ 5	9 - .10uF	9 - .10uF
+ 5	2 - 10uF	2 - 10uF

10μF: C3,4,54,55

.10μF: C9,13,18,22,30, 34,40,44,49 C10,14,19,23,31, 35,41,45,50

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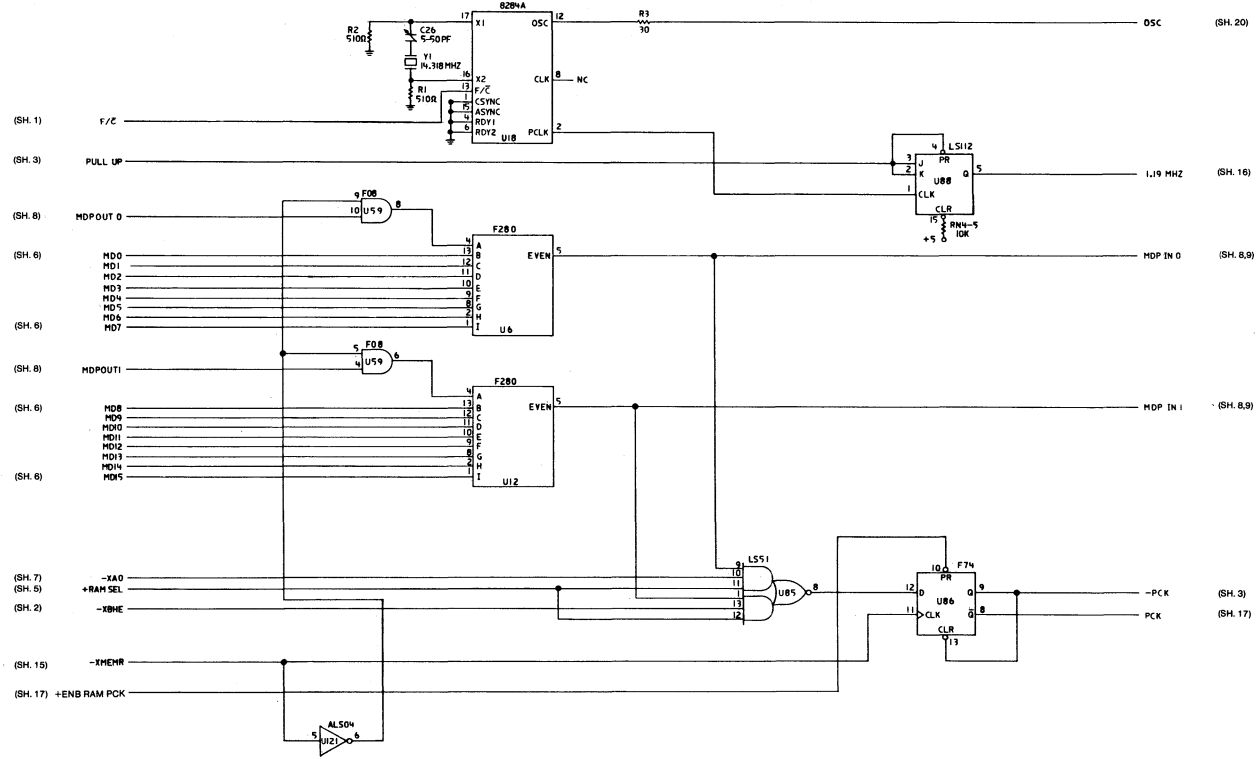

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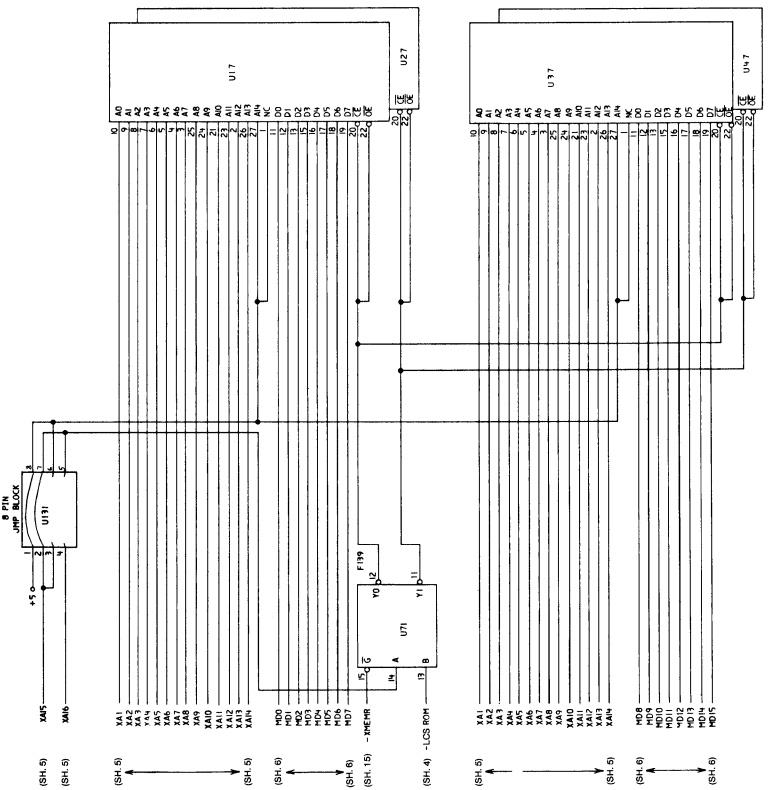

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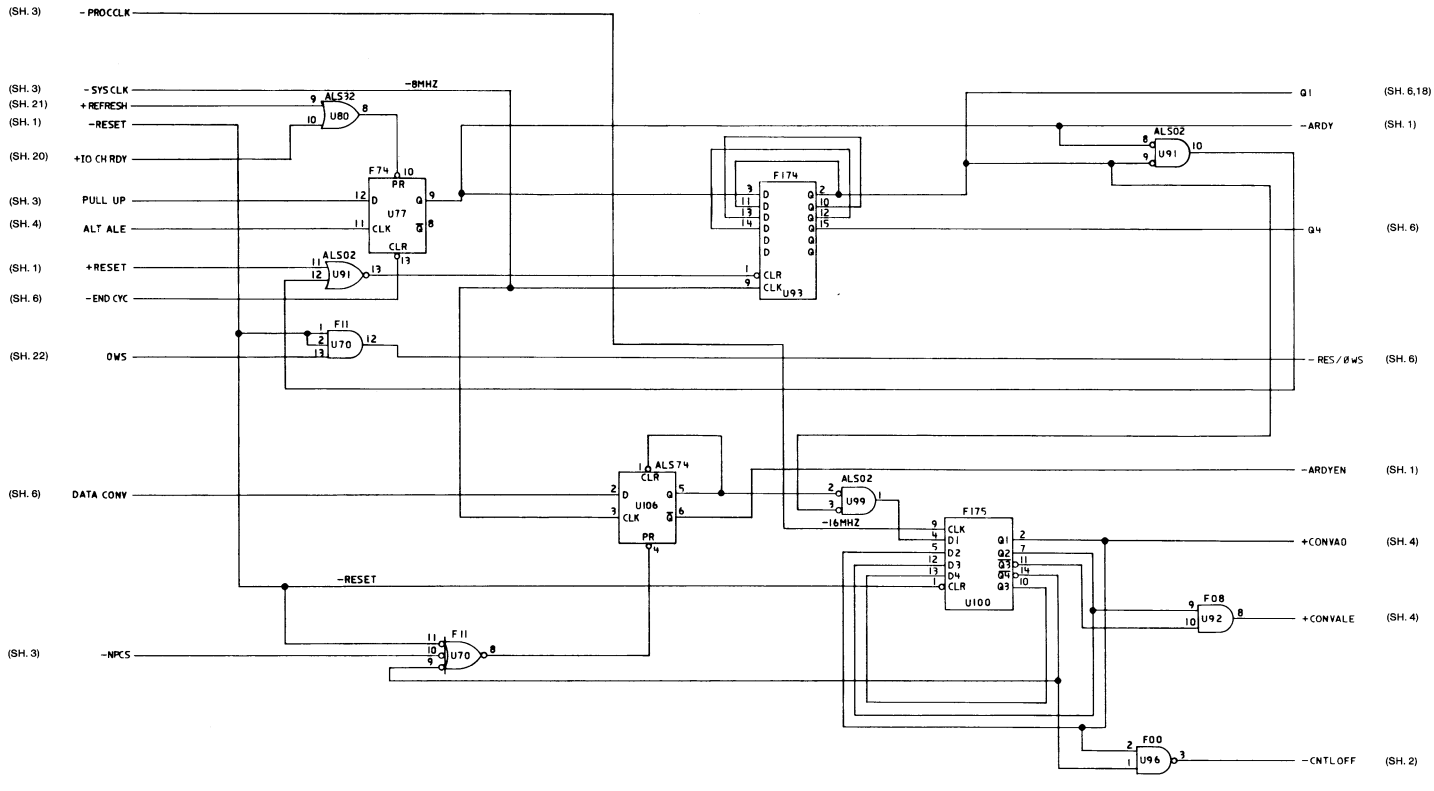

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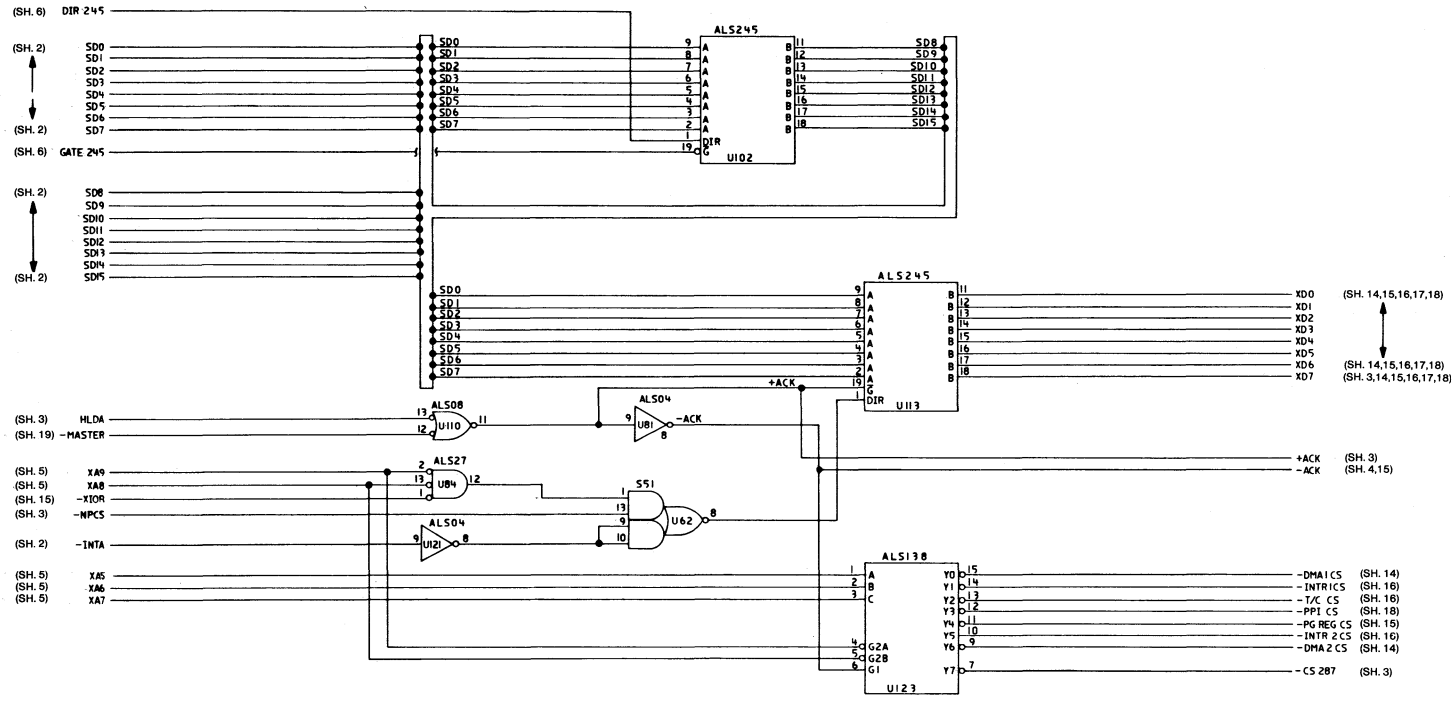
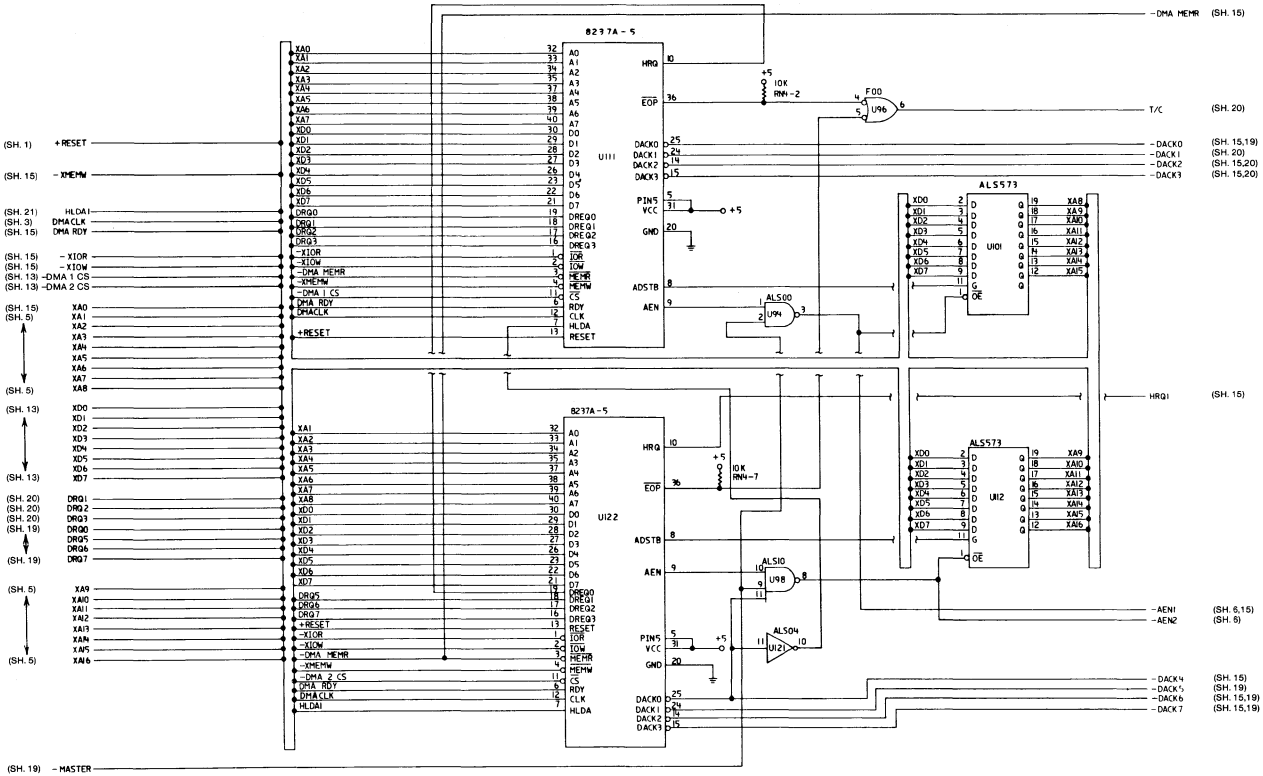
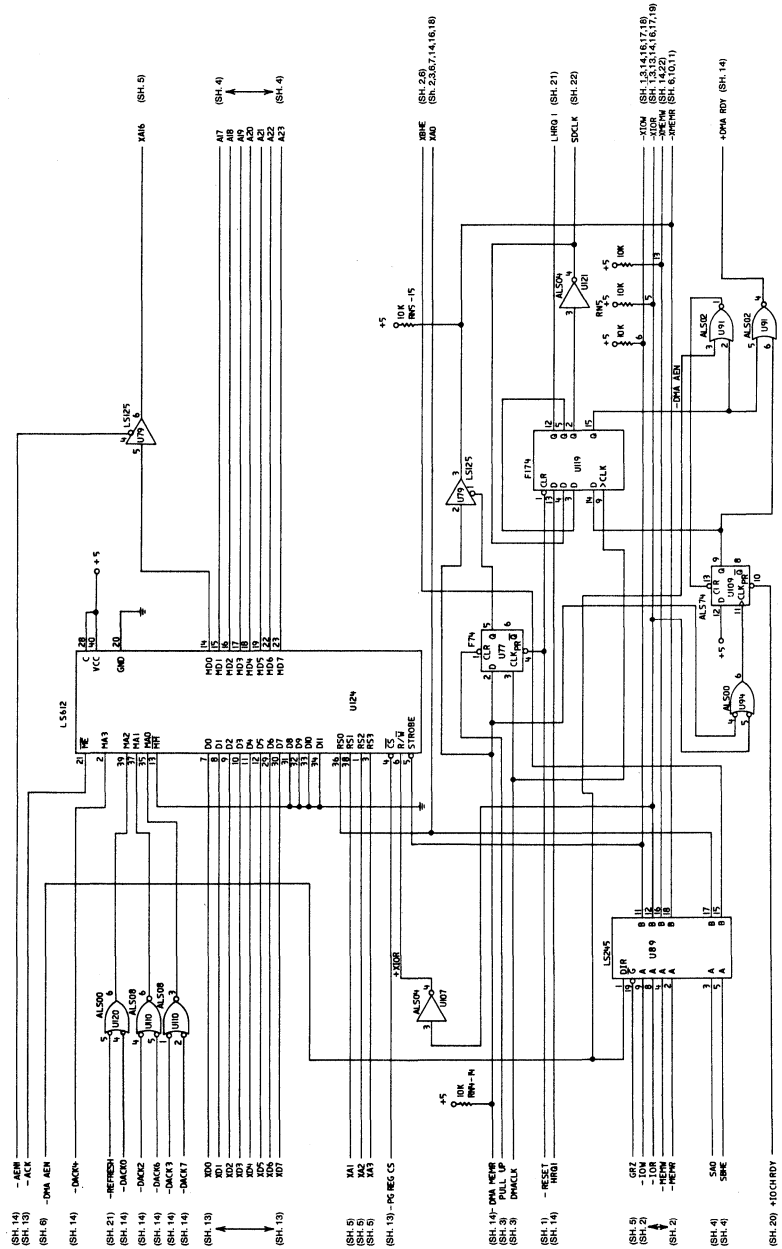


Type 1 512KB Planar (Sheet 13 of 22)



Type 1 512KB Planar (Sheet 14 of 22)



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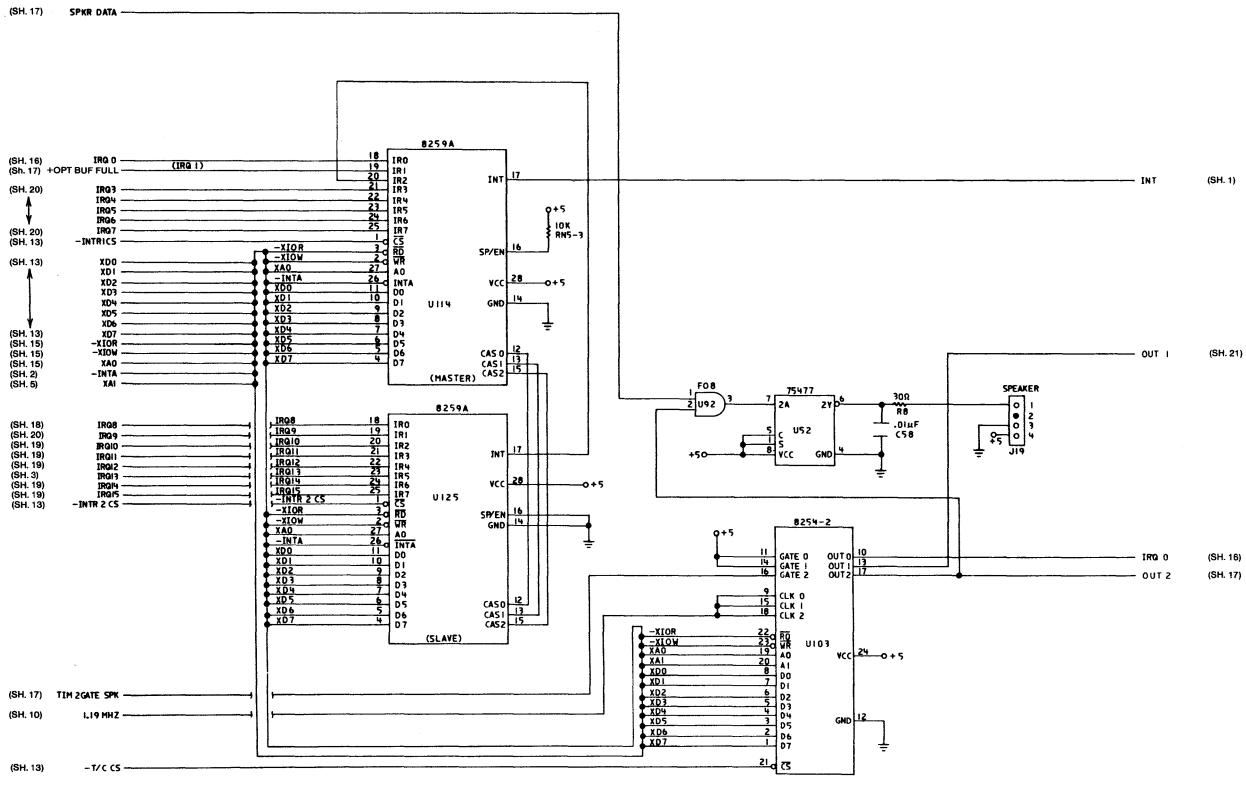

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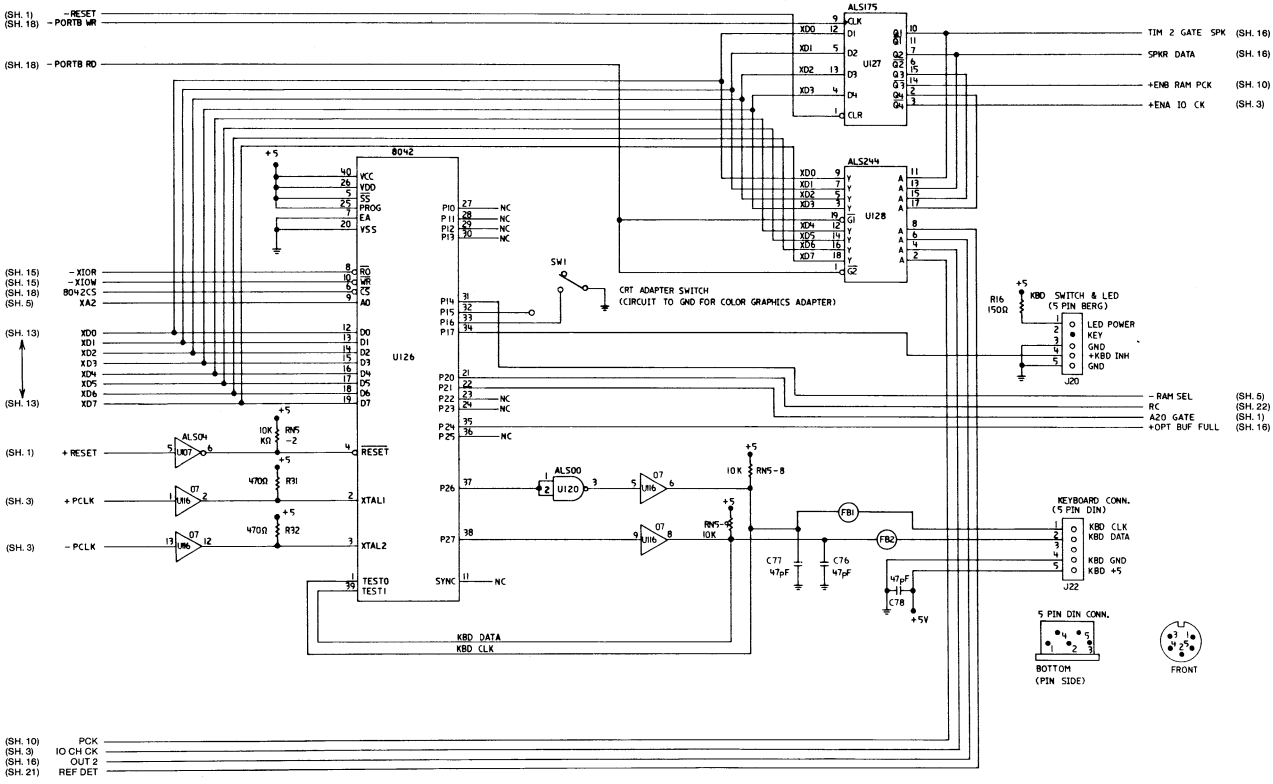

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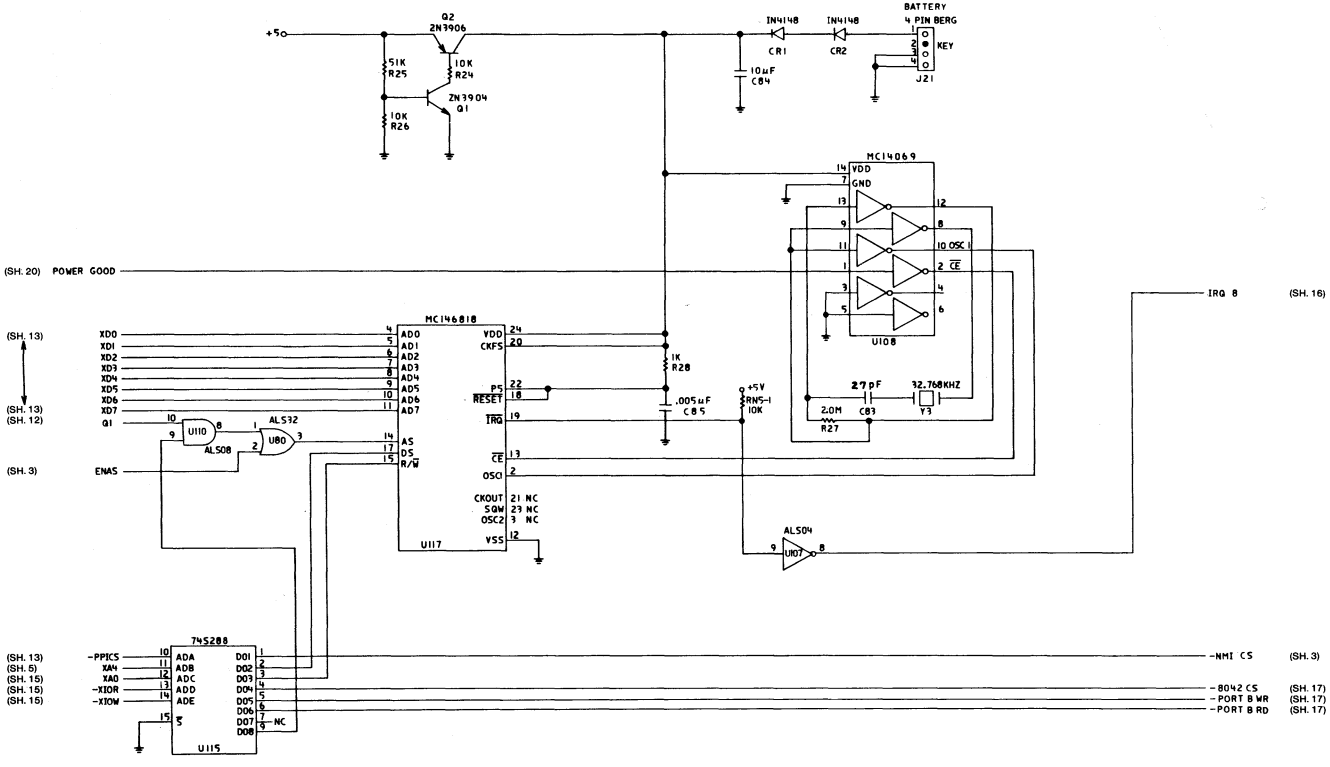

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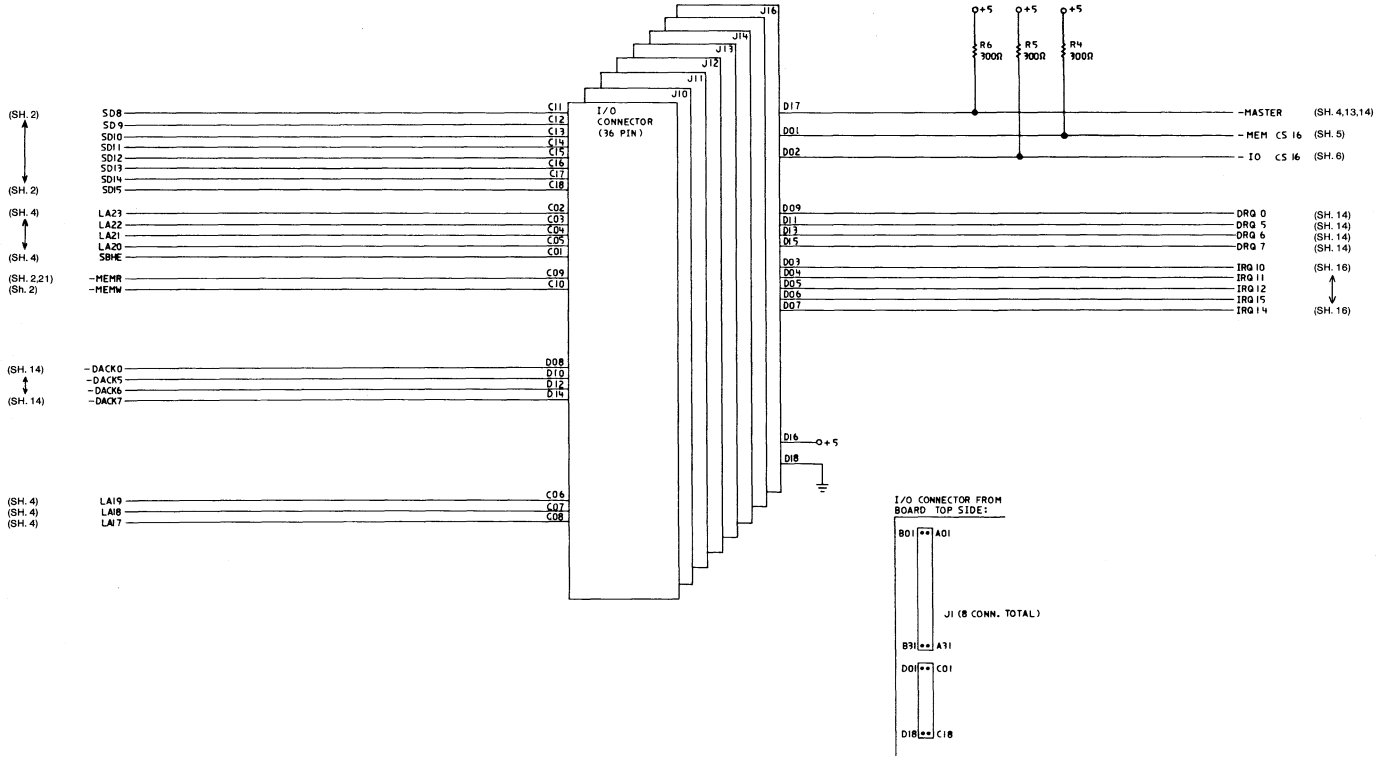

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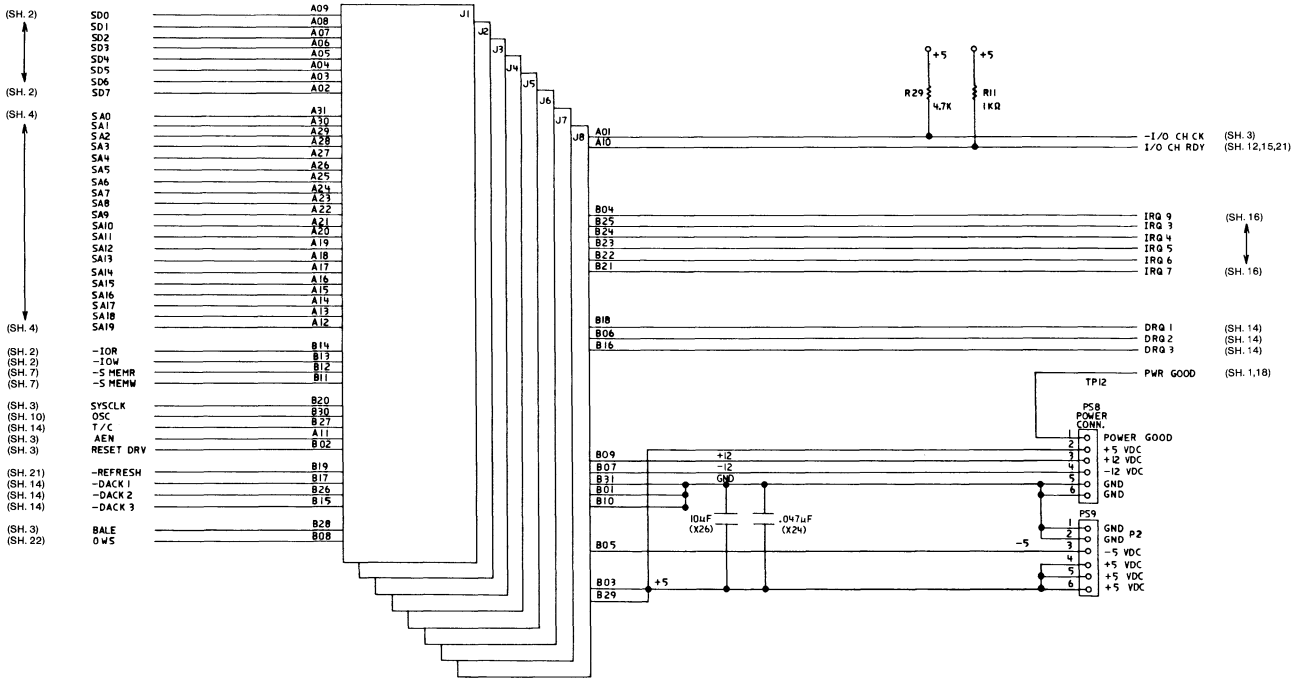

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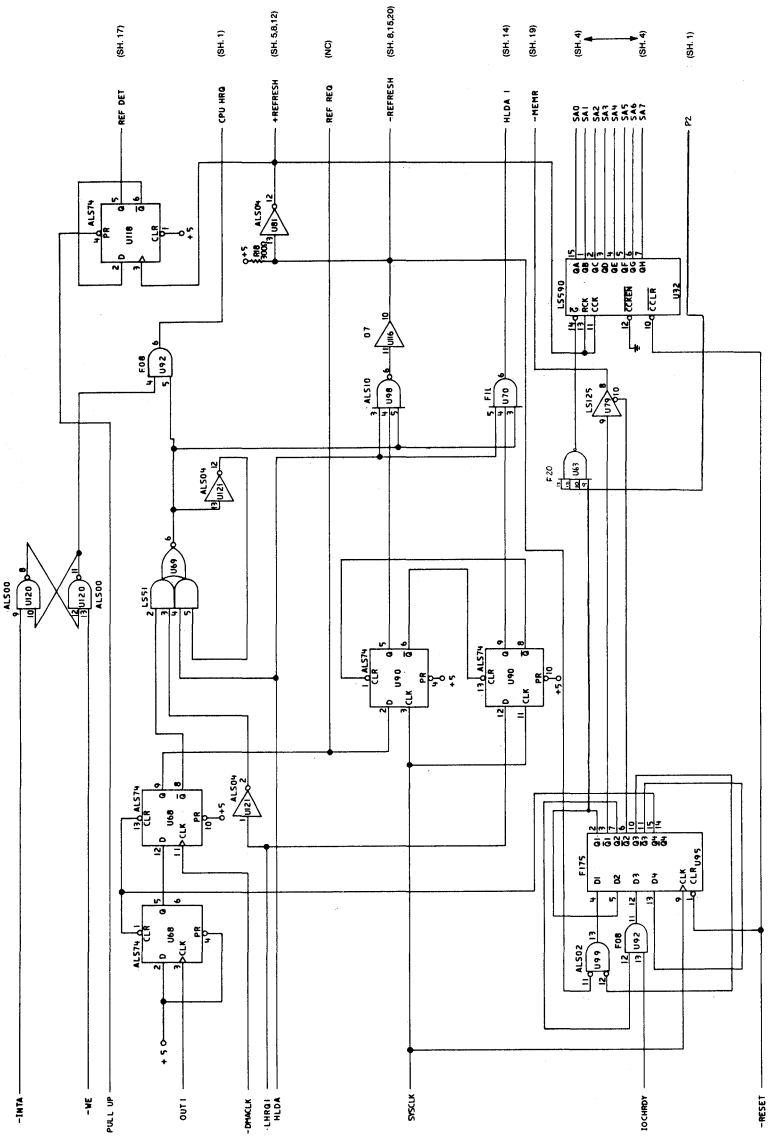
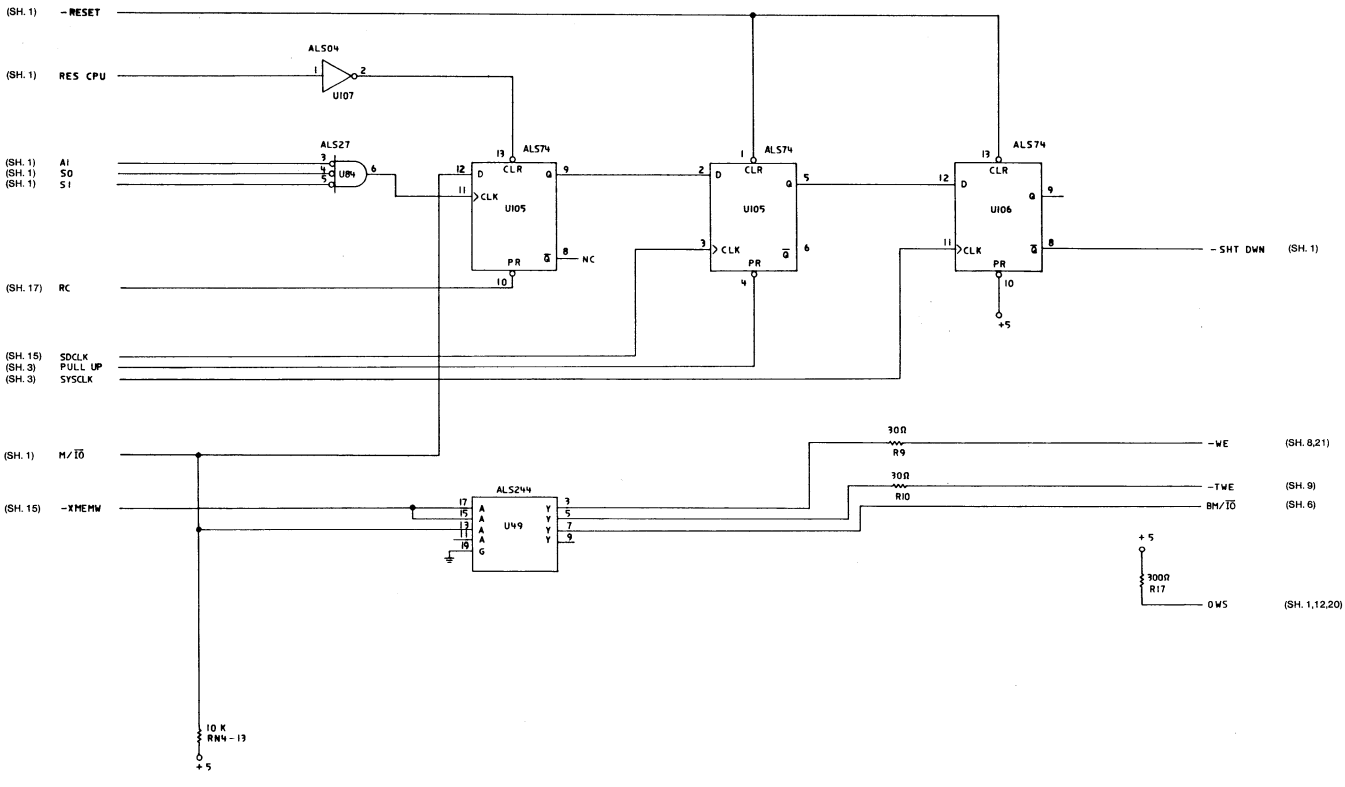
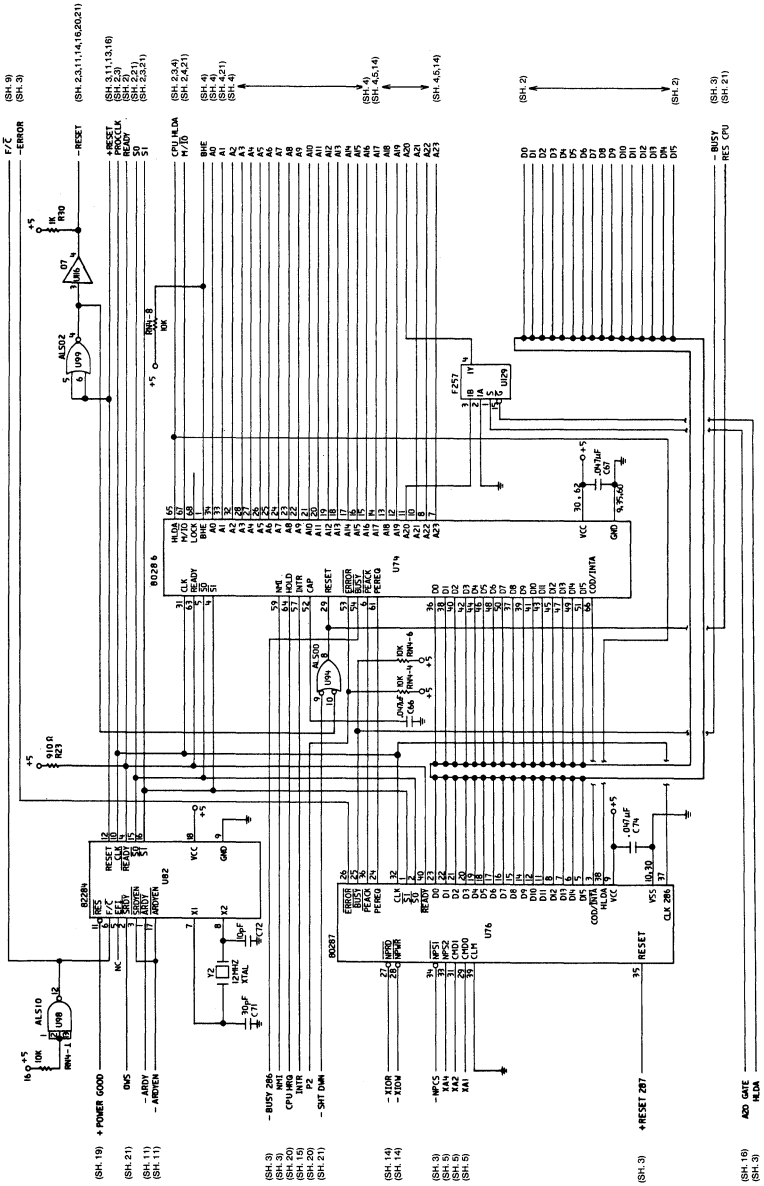


Type 1 512KB Planar (Sheet 21 of 22)



Type 1 512KB Planar (Sheet 22 of 22)

Logic Diagrams - Type 2



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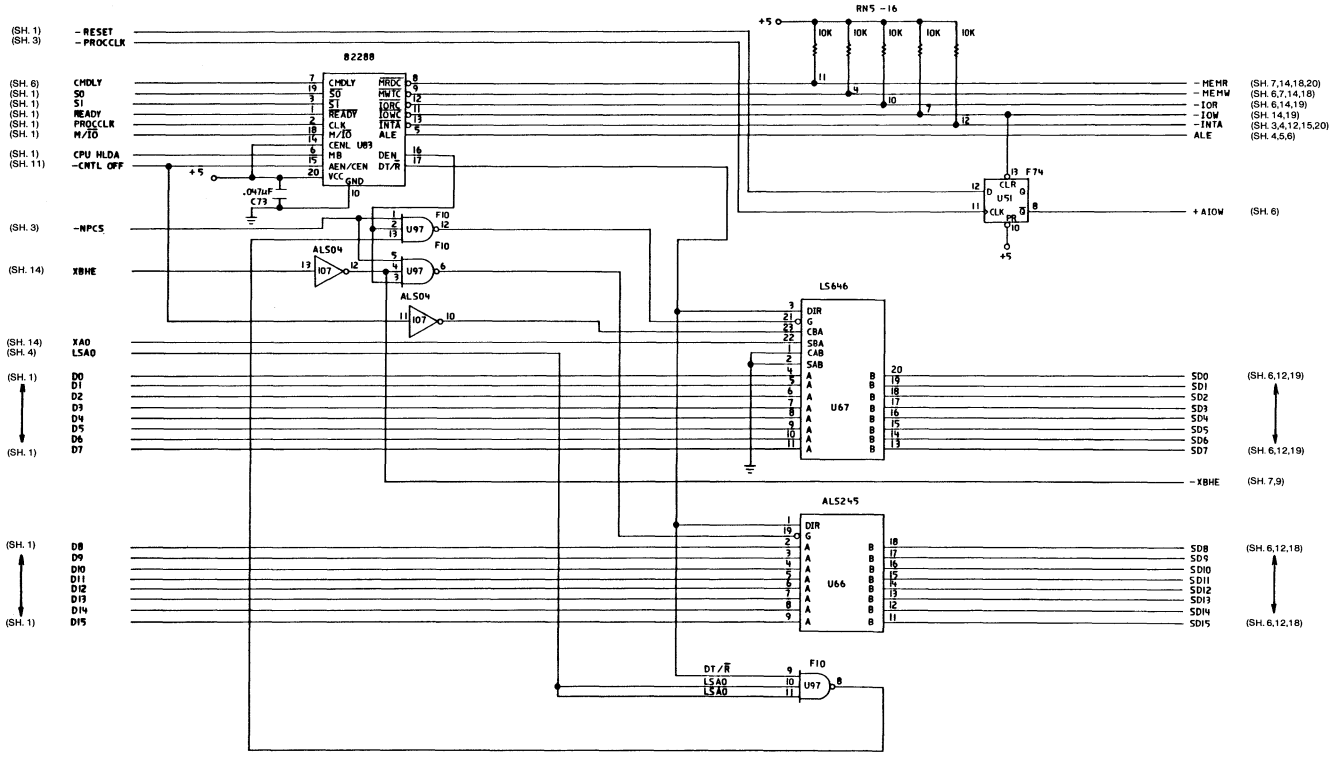

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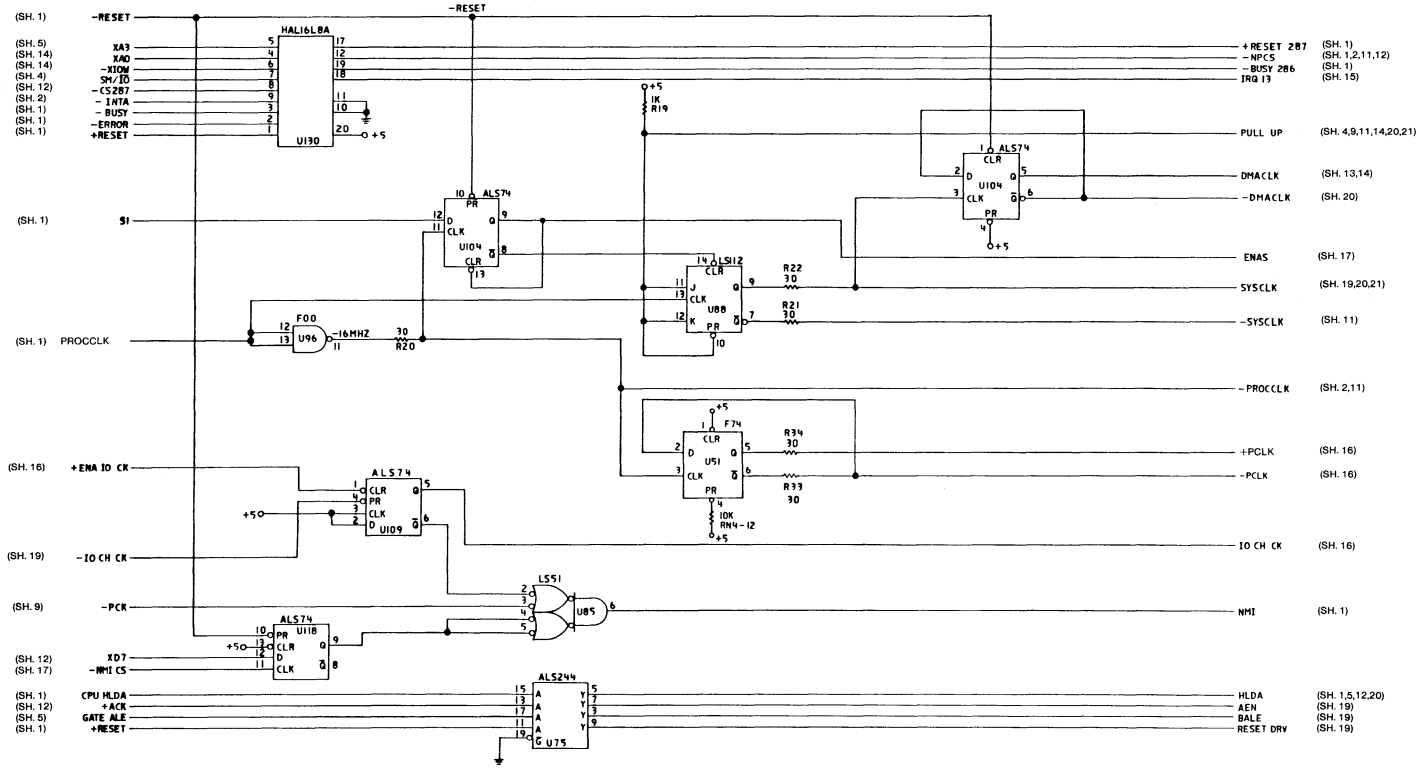

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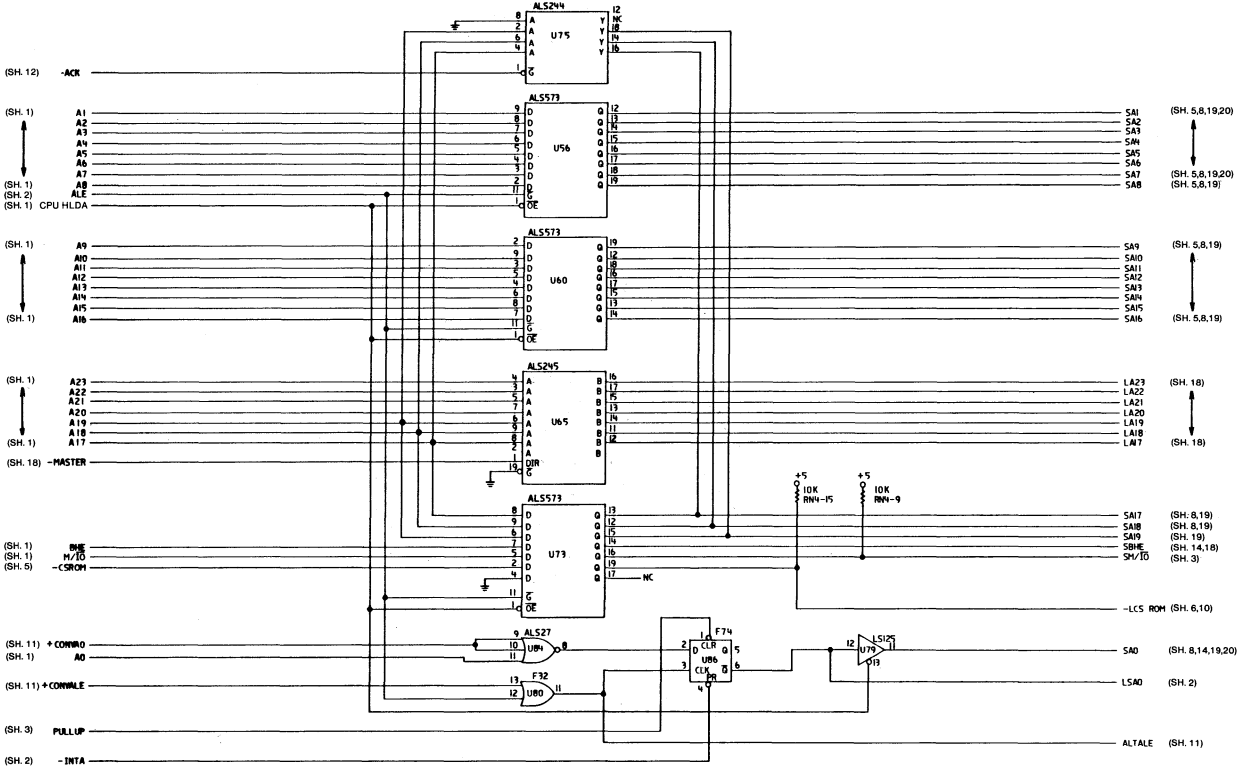

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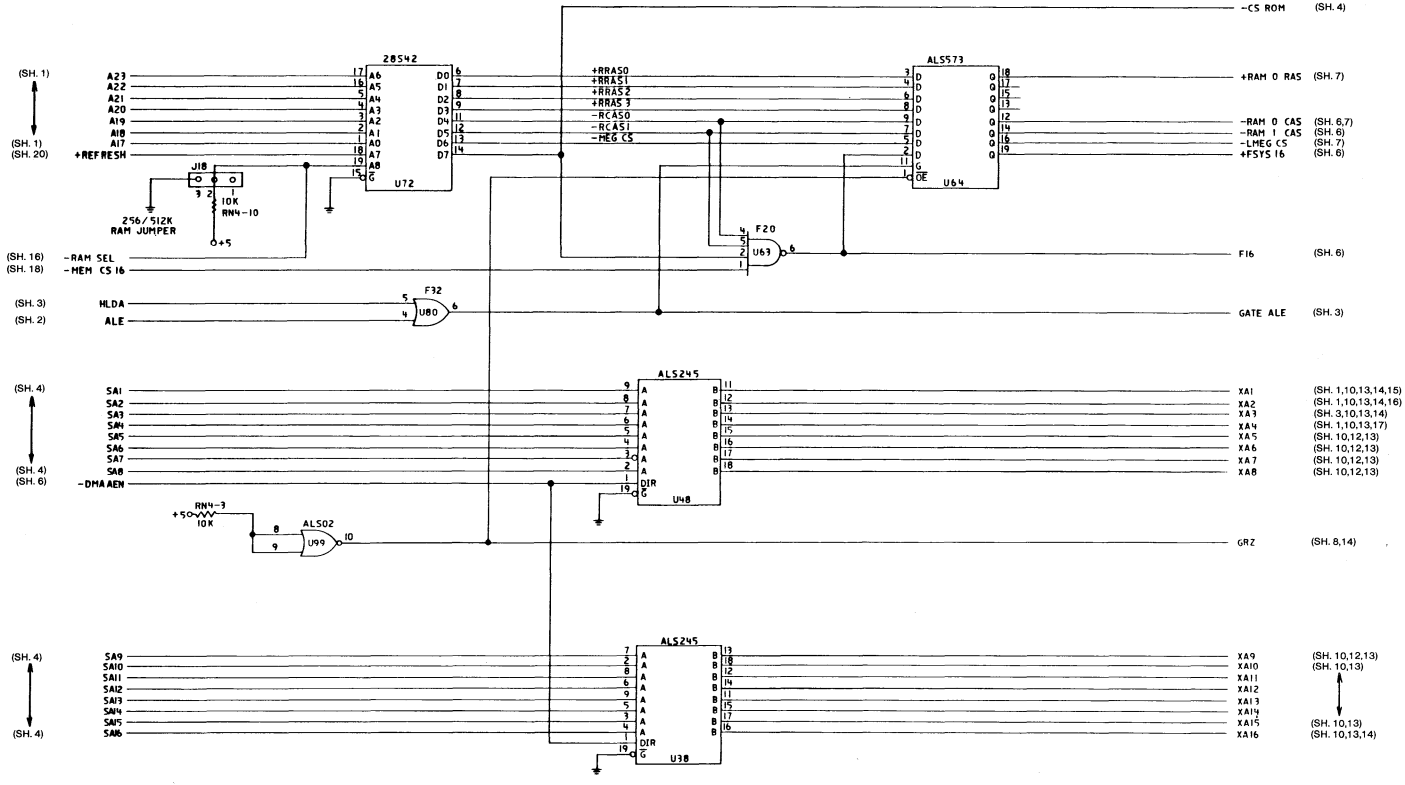

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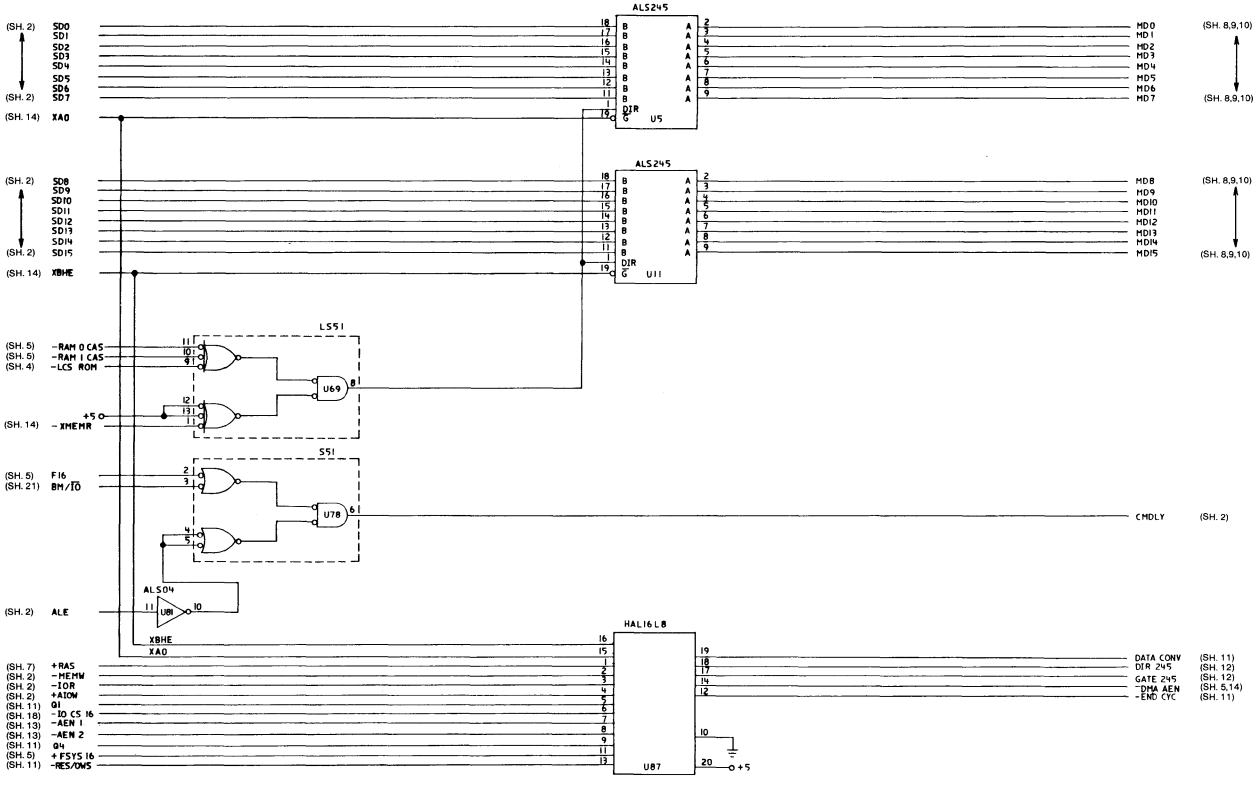
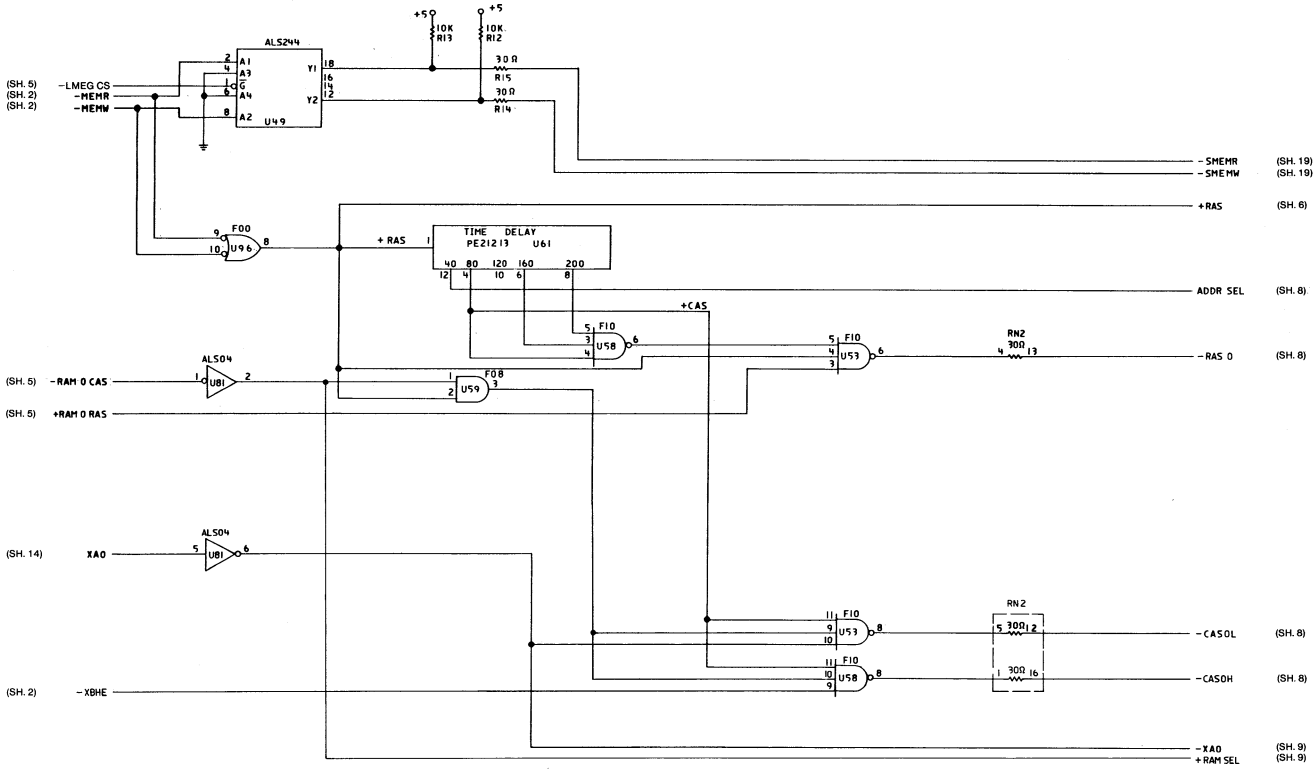
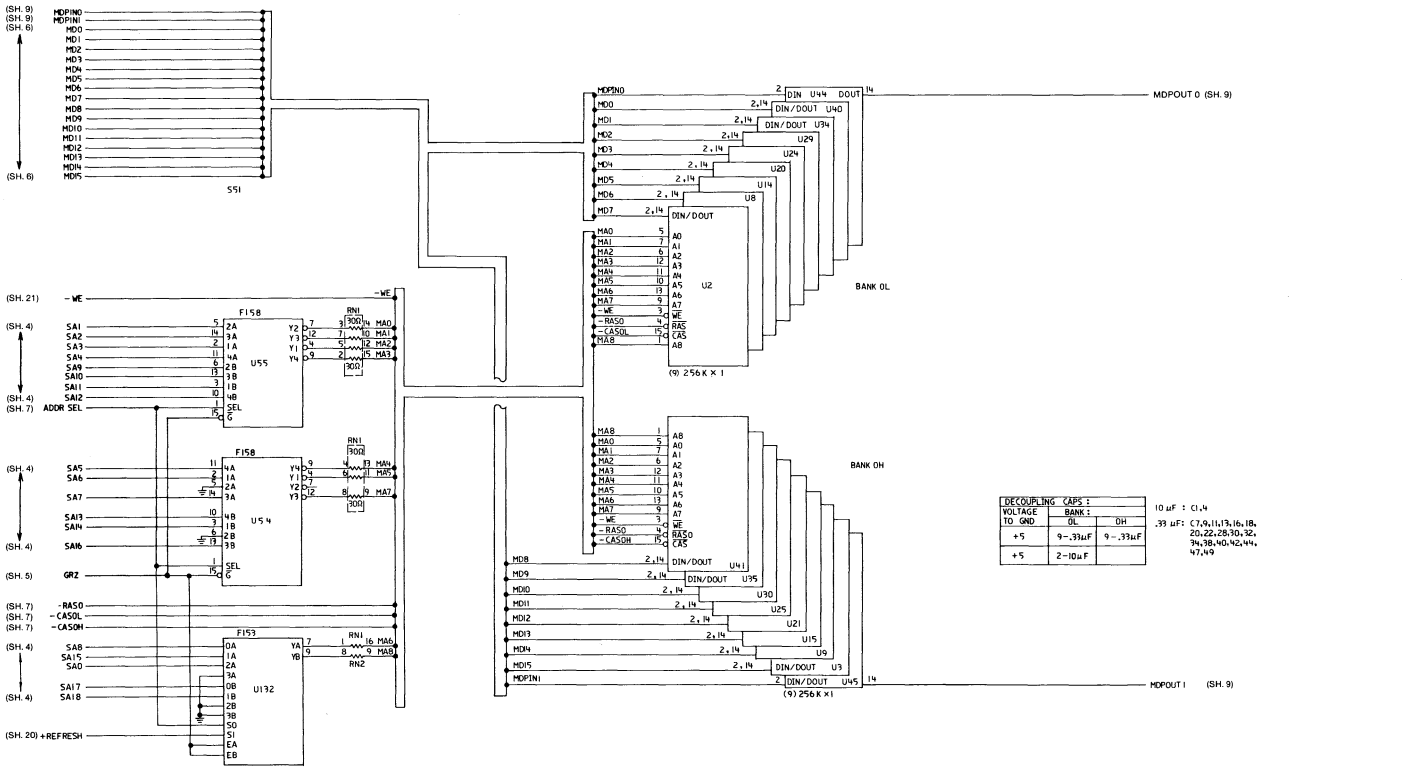


Type 2 512KB Planar (Sheet 6 of 21)



Type 2 512KB Planar (Sheet 7 of 21)



DECOUPLING CAPS :		
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+5	2-10μF	

10 μF : C1,4
.33 μF: C7,9,11,13,16,18, 20,22,28,30,32, 34,38,40,42,44, 47,49

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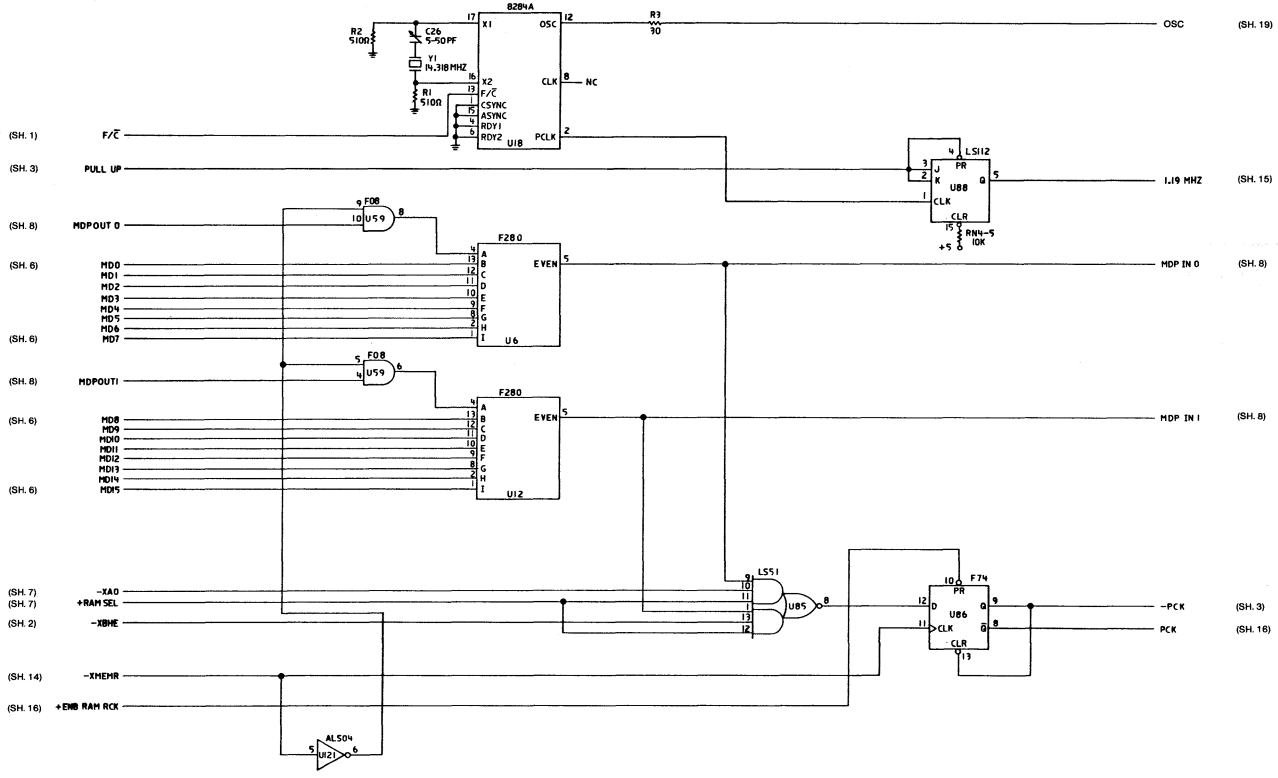

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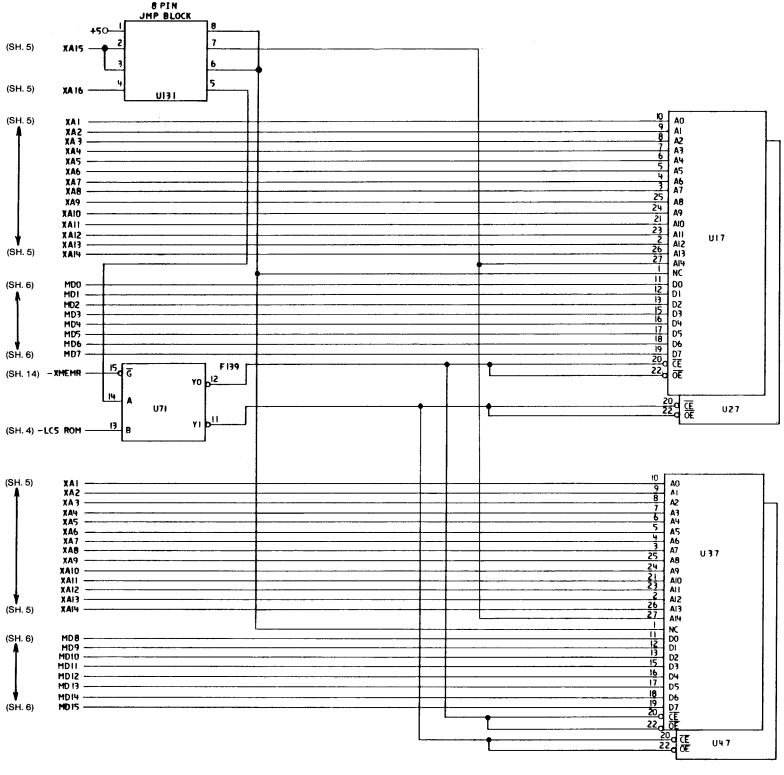

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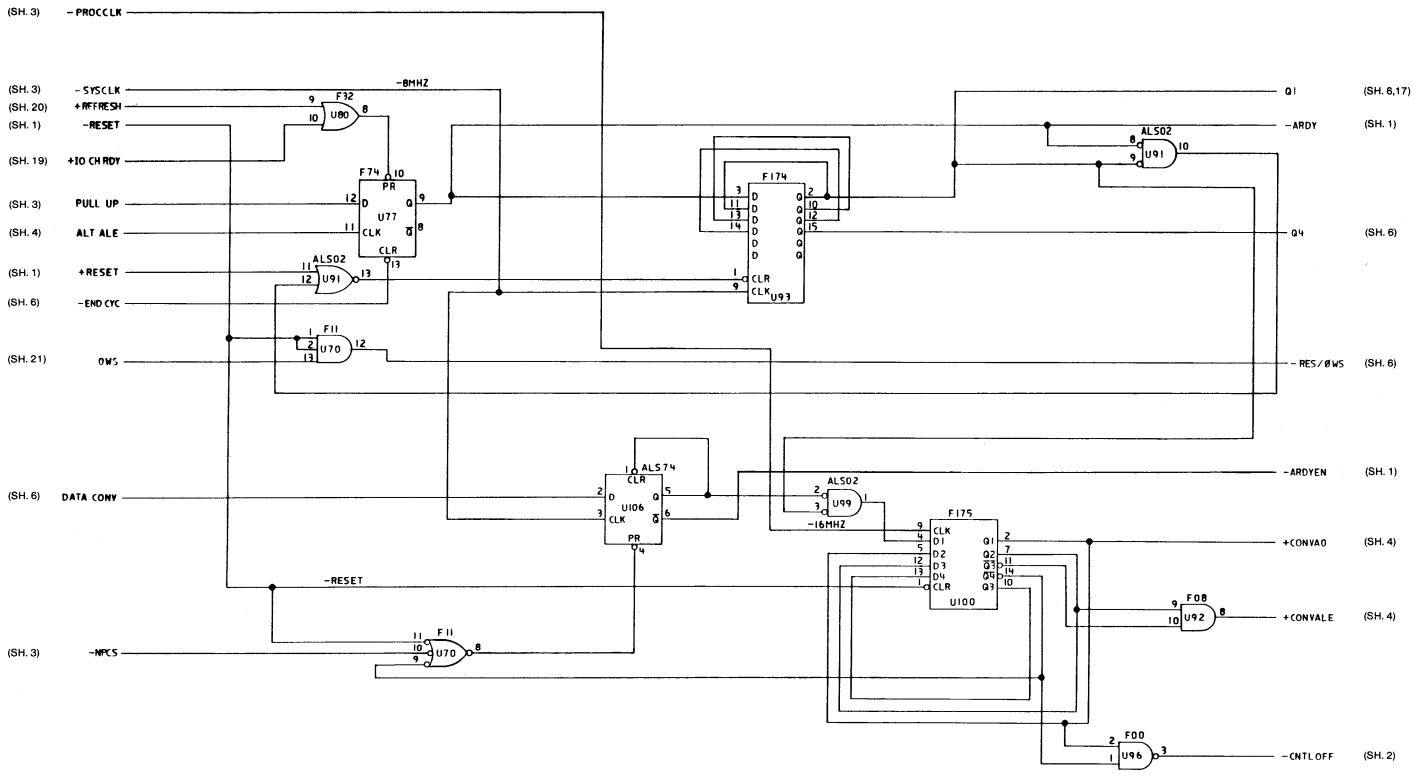
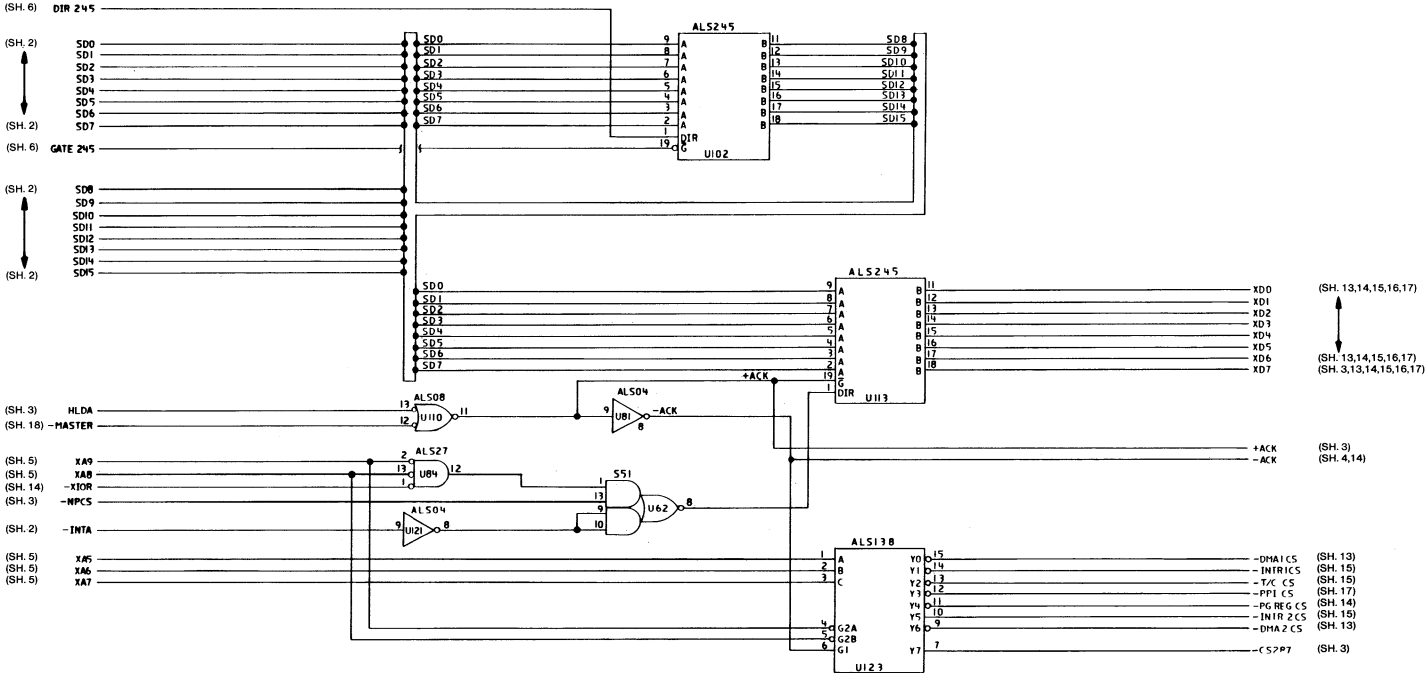
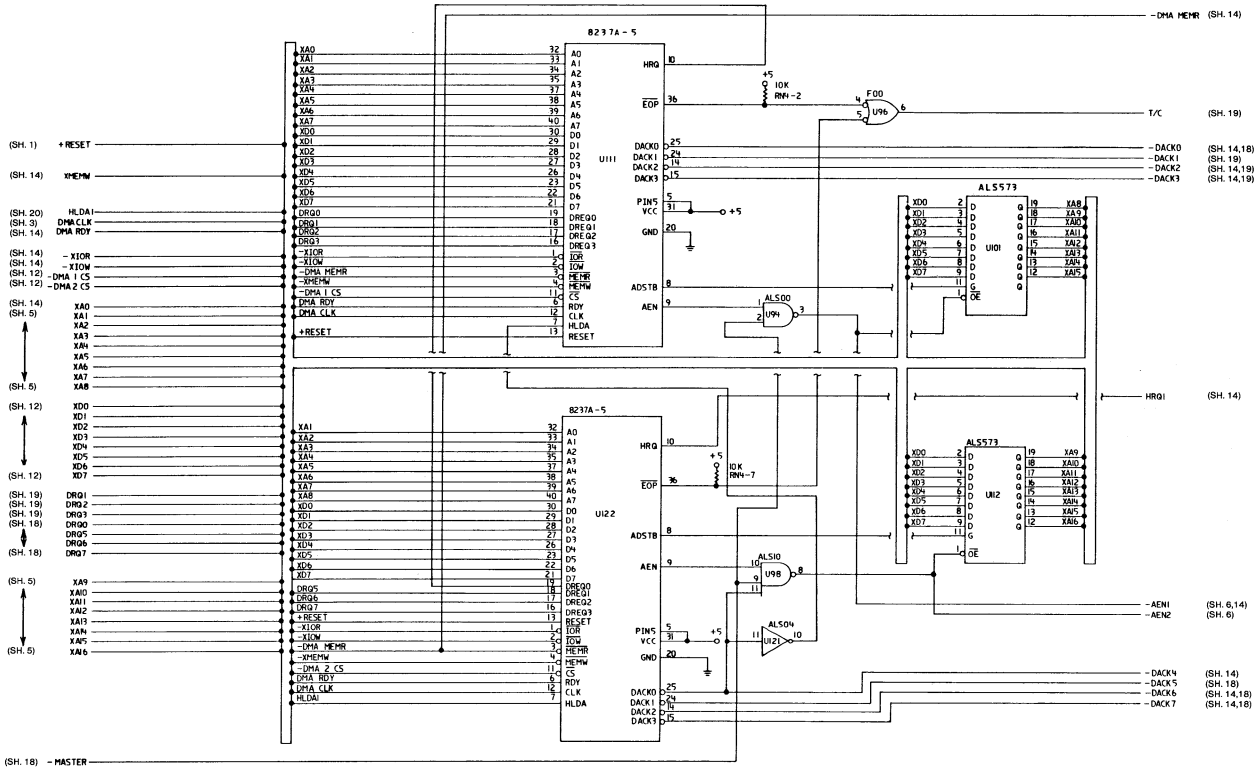


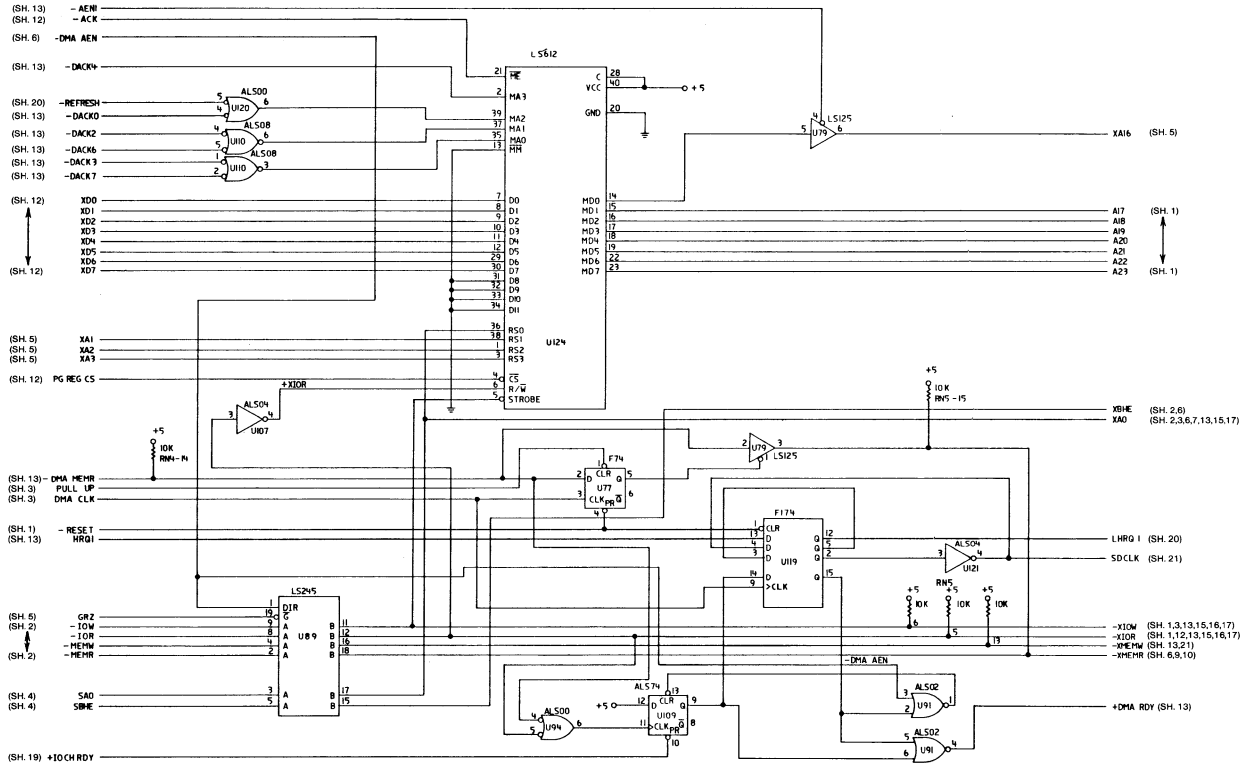
Type 2 512KB Planar (Sheet 11 of 21)



Type 2 512KB Planar (Sheet 12 of 21)



Type 2 512KB Planar (Sheet 13 of 21)



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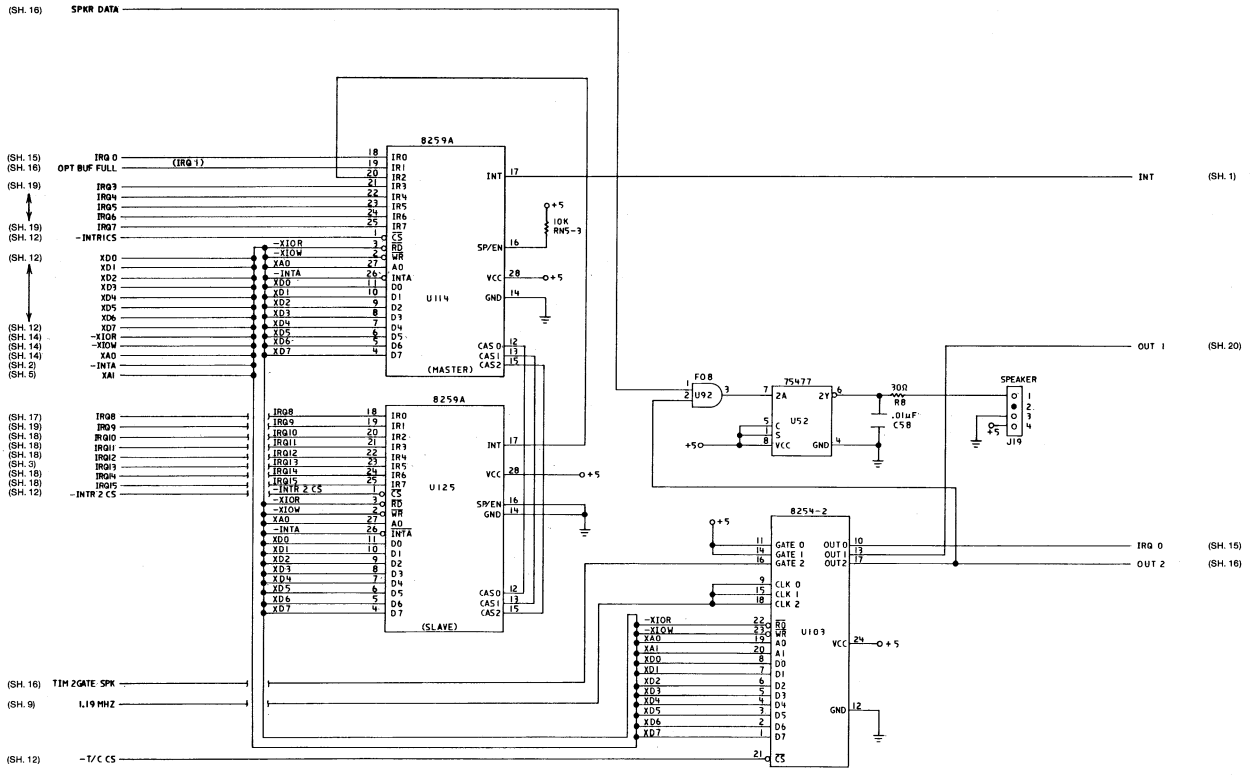

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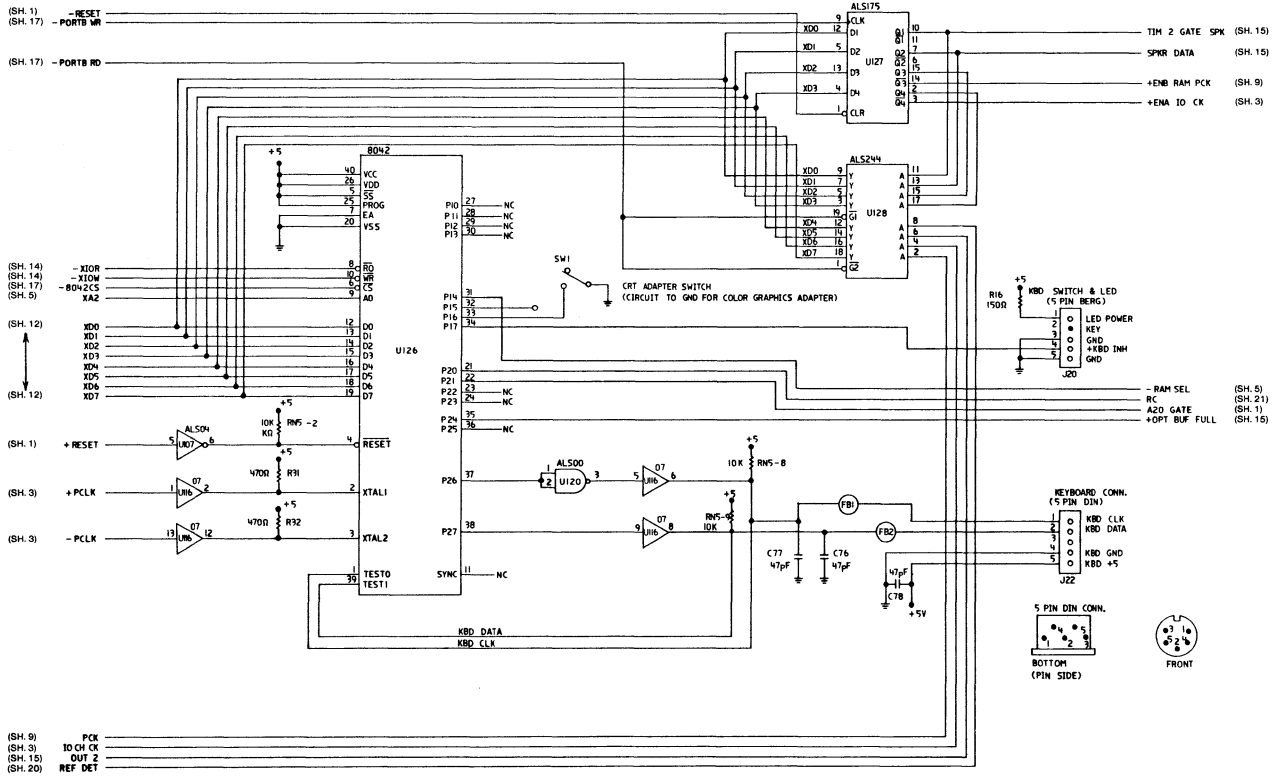

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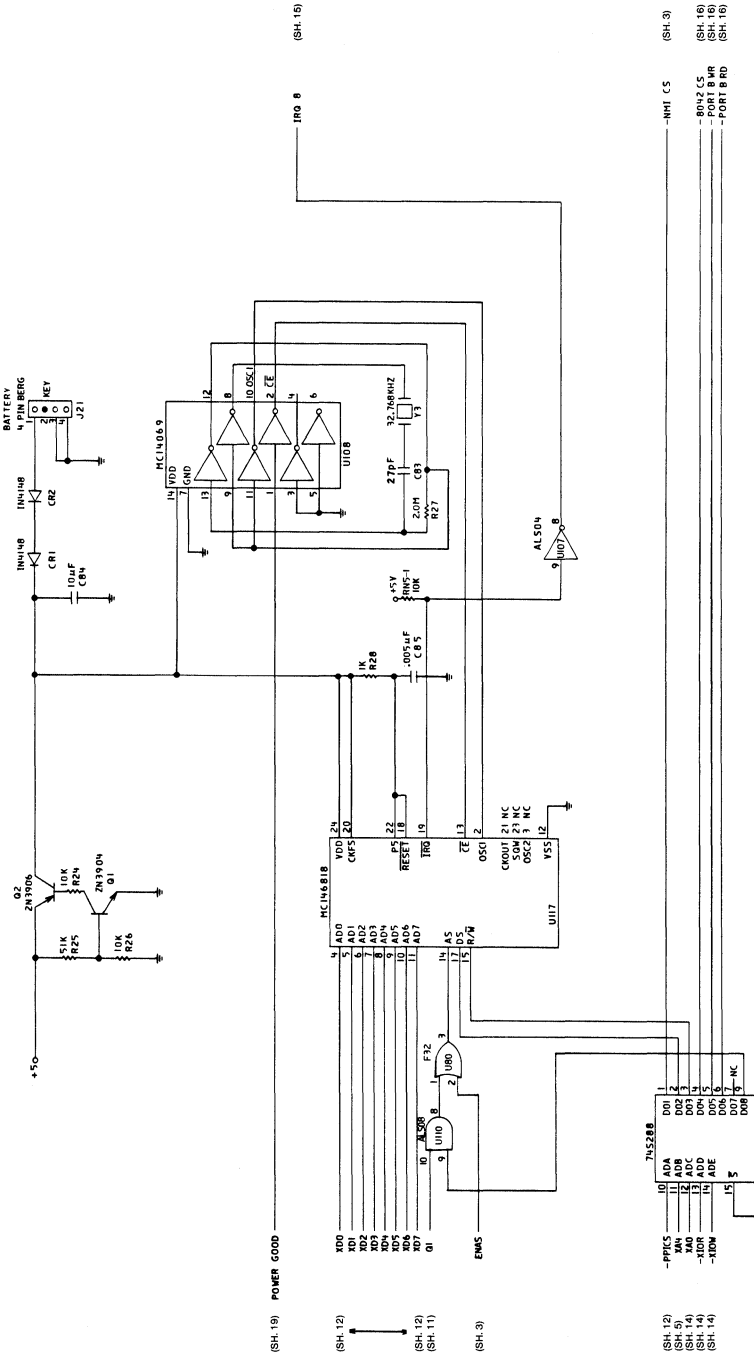

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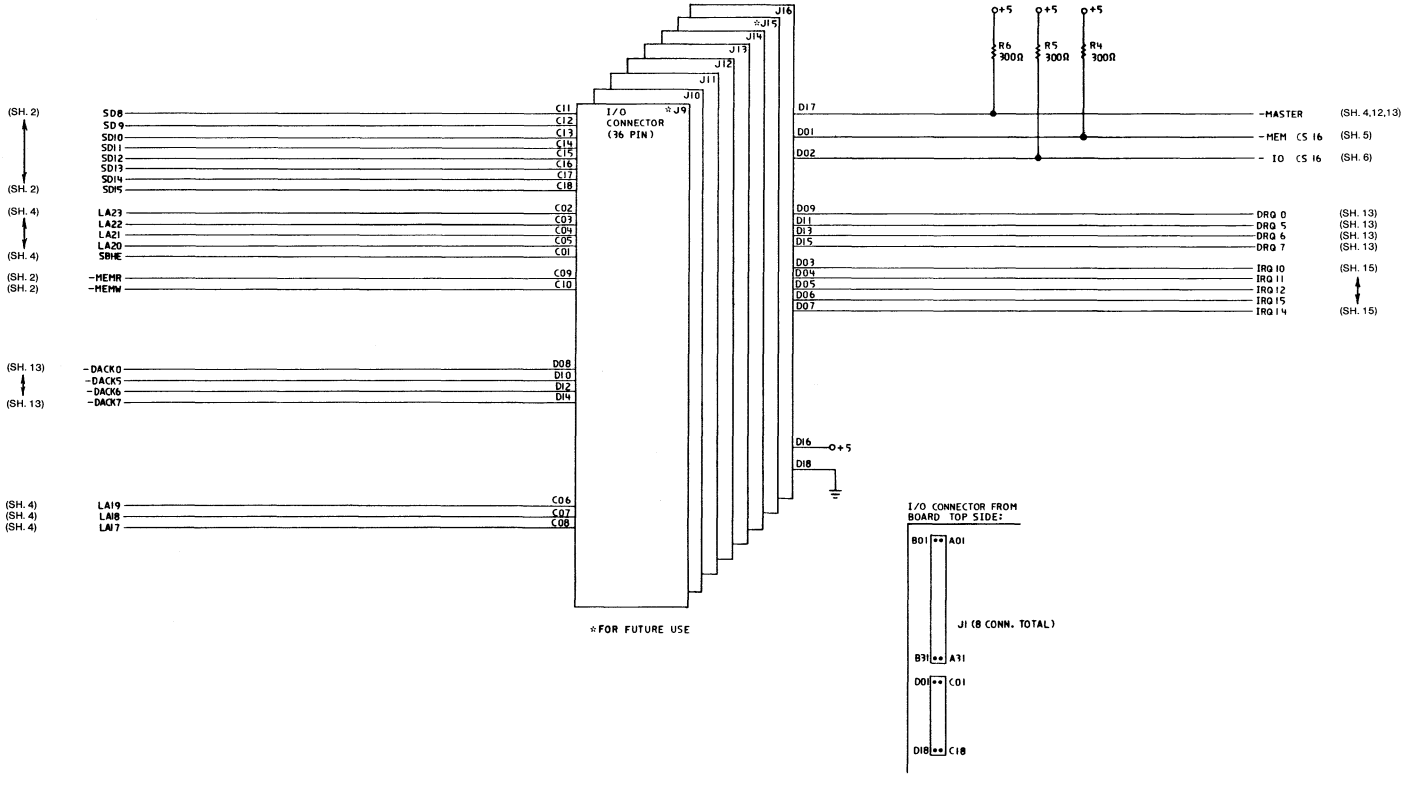

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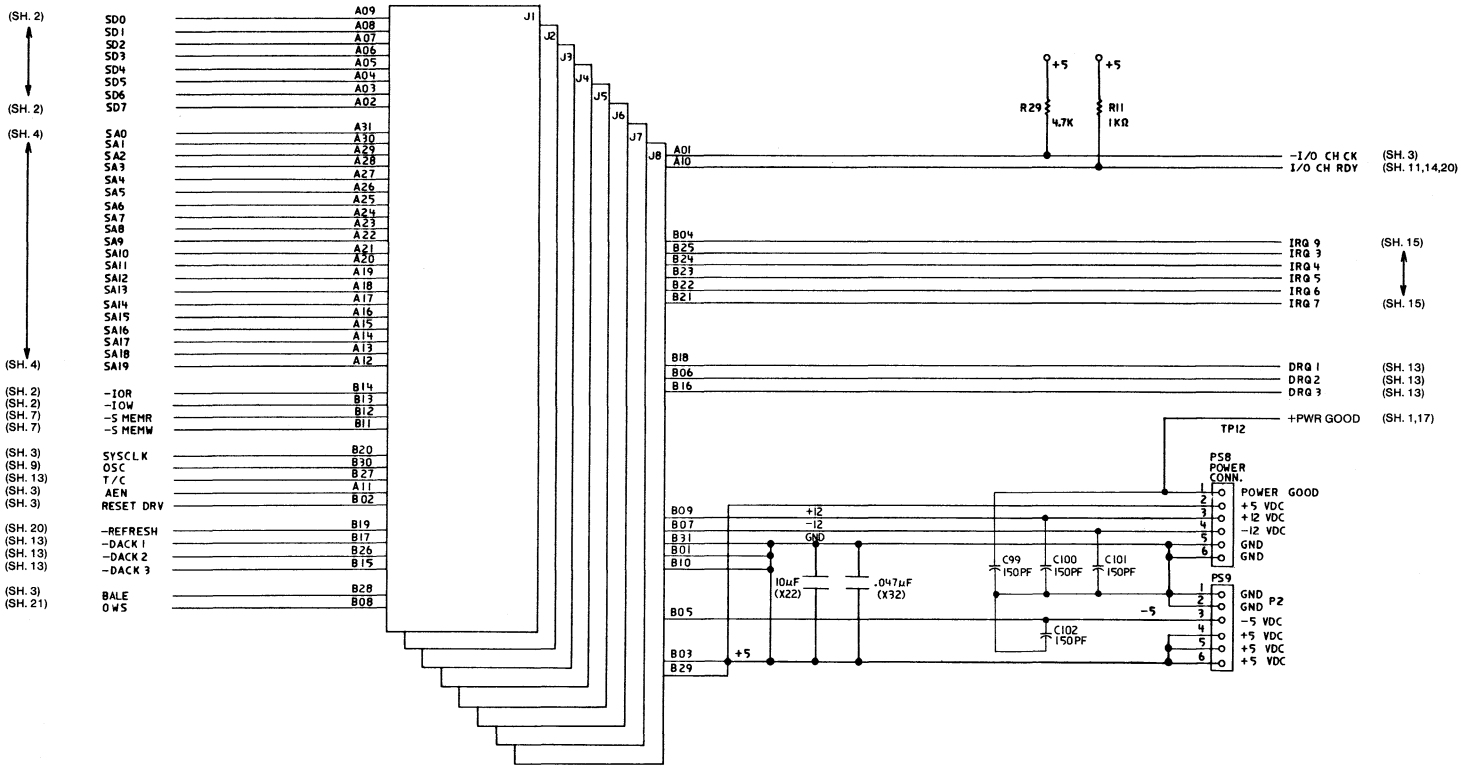

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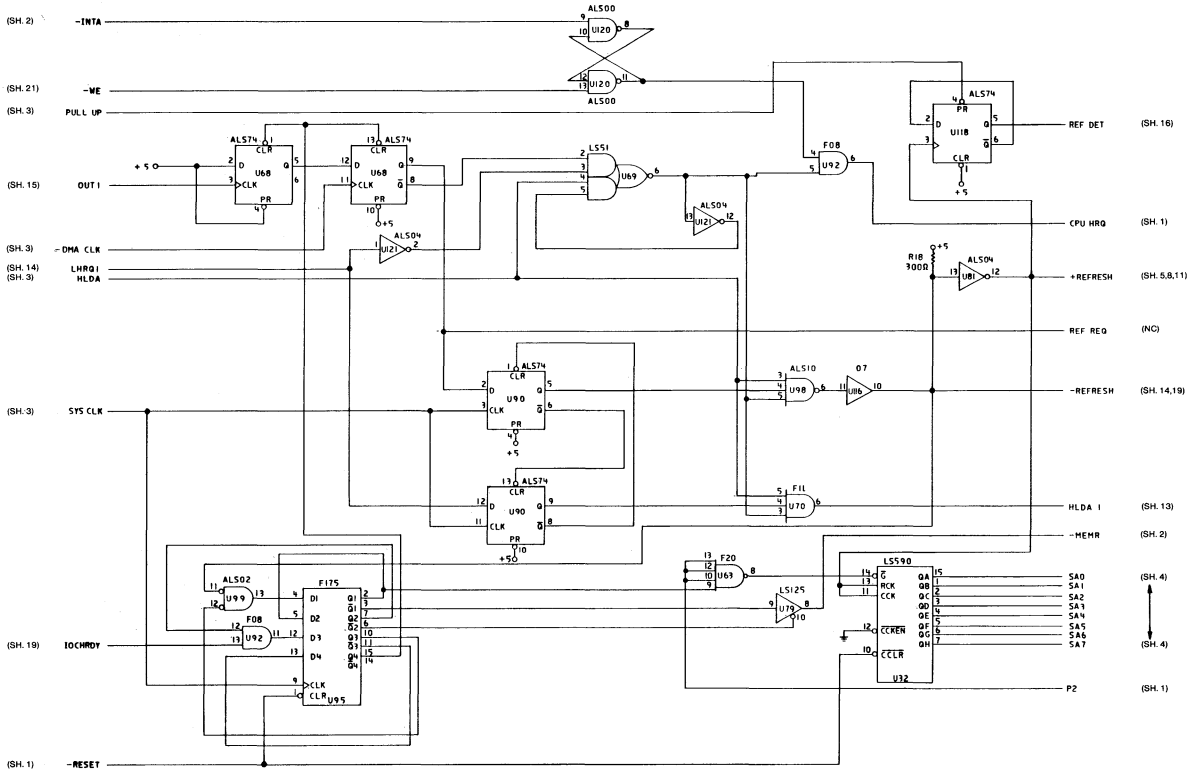
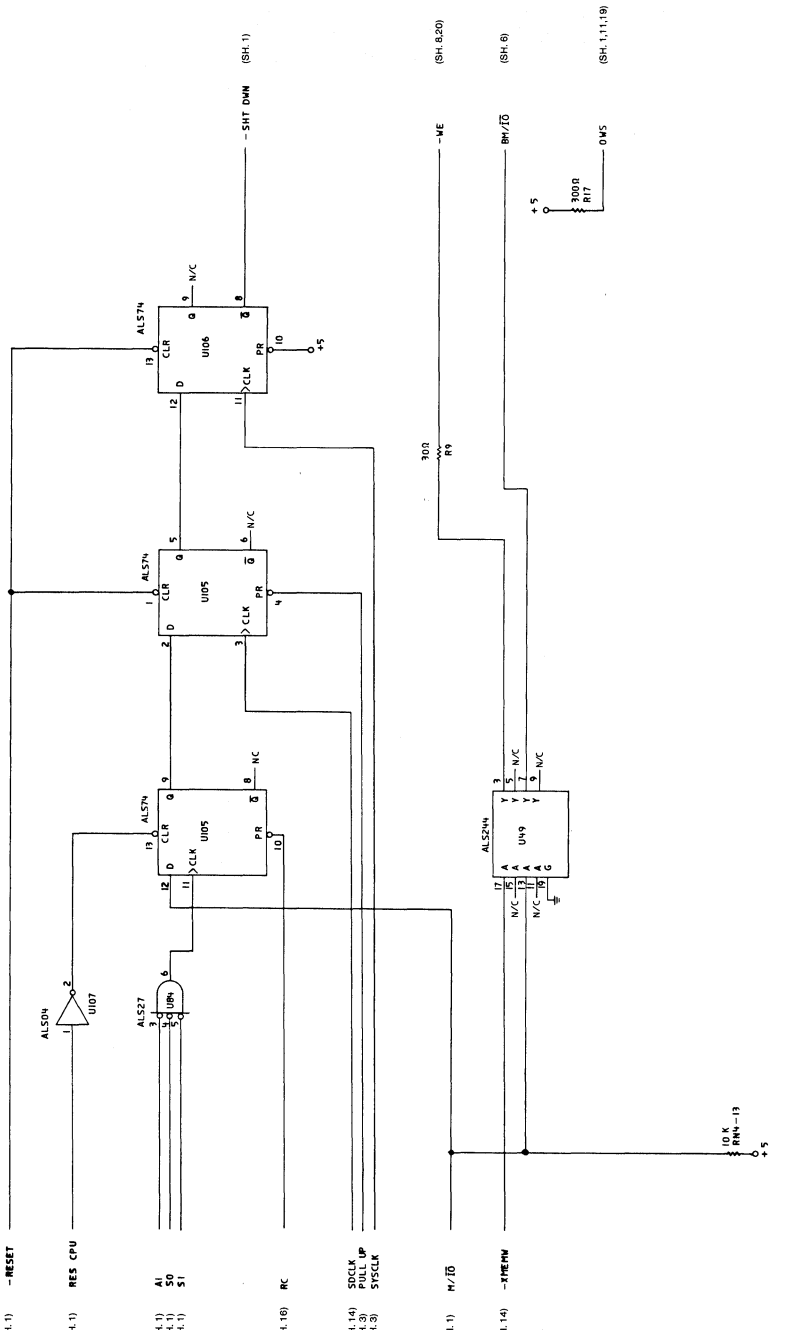


Type 2 512KB Planar (Sheet 20 of 21)



Type 2 512KB Planar (Sheet 21 of 21)

SECTION 2. COPROCESSOR

Contents

Notes:

Description

The IBM Personal Computer AT Math Coprocessor enables the IBM Personal Computer AT to perform high-speed arithmetic, logarithmic functions, and trigonometric operations.

The coprocessor works in parallel with the microprocessor. The parallel operation decreases operating time by allowing the coprocessor to do mathematical calculations while the microprocessor continues to do other functions.

The coprocessor works with seven numeric data types, which are divided into the following three classes:

- Binary integers (3 types)
- Decimal integers (1 type)
- Real numbers (3 types)

Programming Interface

The coprocessor offers extended data types, registers, and instructions to the microprocessor.

The coprocessor has eight 80–bit registers, which provides the equivalent capacity of forty 16–bit registers. This register space allows constants and temporary results to be held in registers during calculations, thus reducing memory access and improving speed as well as bus availability. The register space can be used as a stack or as a fixed register set. When used as a stack, only the top two stack elements are operated on.

The following figure shows representations of large and small numbers in each data type.

Data Type	Bits	Significant Digits (Decimal)	Approximate Range (Decimal)
Word Integer	16	4	$-32{,}768 \leq x \leq +32{,}767$
Short Integer	32	9	$-2 \times 10^{9} \leq x \leq +2 \times 10^{9}$
Long Integer	64	19	$-9 \times 10^{18} \leq x \leq +9 \times 10^{18}$
Packed Decimal	80	18	$-9..99 \leq x \leq +9..99$ (18 digits)
Short Real *	32	6-7	$8.43 \times 10^{-37} \leq x \leq 3.37 \times 10^{38}$
Long Real *	64	15-16	$4.19 \times 10^{-307} \leq x \leq 1.67 \times 10^{308}$
Temporary Real	80	19	$3.4 \times 10^{-4932} \leq x \leq 1.2 \times 10^{4932}$

Data Types

* The Short Real and Long Real data types correspond to the single and double precision data types.

Hardware Interface

The coprocessor uses the same clock generator as the microprocessor. It works at one-third the frequency of the system microprocessor (2.66 MHz). The coprocessor is wired so that it functions as an I/O device through I/O port addresses hex 00F8, 00FA, and 00FC. The microprocessor sends OP codes and operands through these I/O ports. The microprocessor also receives and stores results through the same I/O ports. The coprocessor's 'busy' signal informs the microprocessor that it is executing; the microprocessor's Wait instruction forces the microprocessor to wait until the coprocessor is finished executing.

The coprocessor detects six different exception conditions that can occur during instruction execution. If the appropriate exception mask within the coprocessor is not set, the coprocessor sets its error signal. This error signal generates a hardware interrupt (interrupt 13) and causes the 'busy' signal to the coprocessor to be held in the busy state. The 'busy' signal may

be cleared by an 8-bit I/O Write command to address hex F0 with D0 through D7 equal to 0.

The power-on self-test code in the system ROM enables IRQ 13 and sets up its vector to point to a routine in ROM. The ROM routine clears the 'busy' signal's latch and then transfers control to the address pointed to by the NMI interrupt vector. This allows code written for any IBM Personal Computer to work on an IBM Personal Computer AT. The NMI interrupt handler should read the coprocessor's status to determine if the NMI was caused by the coprocessor. If the interrupt was not generated by the coprocessor, control should be passed to the original NMI interrupt handler.

The coprocessor has two operating modes similar to the two modes of the microprocessor. When reset by a power-on reset, system reset, or an I/O write operation to port hex 00F1, the coprocessor is in the real address mode. This mode is compatible with the 8087 Math Coprocessor used in other IBM Personal Computers. The coprocessor can be placed in the protected mode by executing the SETPM ESC instruction. It can be placed back in the real mode by an I/O write operation to port hex 00F1, with D7 through D0 equal to 0.

The coprocessor instruction extensions to the microprocessor can be found in Section 6 of this manual.

Detailed information for the internal functions of the Intel 80287 Coprocessor can be found in books listed in the bibliography.

Notes:

SECTION 3. POWER SUPPLY

Contents

Notes:

The system power supply is contained *inside* of the system unit and provides power for the system board, the adapters, the diskette drives, the fixed disk drives, the keyboard, and the IBM Monochrome Display.

Inputs

The power supply can operate at a frequency of either 60 ±3 Hz or 50 ±3 Hz and it can operate at 110 Vac, 5 A or 220/240 Vac, 2.5 A. The voltage is selected with the switch above the power-cord plug at the rear of the power supply. The following figure shows the input requirements.

Range	Voltage (Vac)	Current (Amperes)
115 Vac	Minimum 100 Maximum 125	Maximum 5
230 Vac	Minimum 200 Maximum 240	Maximum 3.0

Input Requirements

Note: The maximum in-rush current is 100 A.

Outputs

The power supply provides +5, -5, +12, and -12 Vdc. The following figure shows the load current and regulation tolerance for these voltages. The power supply also supplies either 115 Vac or 230 Vac for the IBM Monochrome Display.

Nominal Output	Load Current (A) Min	Max	Regulation Tolerance
+5 Vdc	7.0	19.8	+5% to -4%
-5 Vdc	0.0	0.3	+10% to -8%
+12 Vdc	2.5	7.3	+5% to -4%
-12 Vdc	0.0	0.3	+10% to -9%

DC Load Requirements

DC Output Protection

If any output becomes overloaded, the power supply will switch off within 20 milliseconds. An overcurrent condition will not damage the power supply.

Output Voltage Sequencing

Under normal conditions, the output voltage levels track within 300 milliseconds of each other when power is applied to, or removed from the power supply, provided at least minimum loading is present.

No-Load Operation

No damage or hazardous conditions occur when primary power is applied with no load on any output level. In such cases, the power supply may switch off, and a power-on reset will be required. The power supply requires a minimum load for proper operation.

Power-Good Signal

The power supply provides a 'power-good' signal to indicate proper operation of the power supply.

When the supply is switched off for a minimum of one second and then switched on, the 'power-good' signal is generated, assuming there are no problems. This signal is a logical AND of the dc output-voltage sense signal and the ac input-voltage sense signal. The 'power-good' signal is also a TTL-compatible high level for normal operation, or a low level for fault conditions. The ac fail signal causes 'power-good' to go to a low level at least one millisecond before any output voltage falls below the regulation limits. The operating point used as a reference for measuring the one millisecond is normal operation at minimum line voltage and maximum load.

Load Resistor

If no fixed disk drive is connected to the power supply, the load resistor must be connected to P10. The load resistor is a 5 ohm, 50 watt resistor.

The dc output-voltage sense signal holds the 'power-good' signal at a low level when power is switched on until all output voltages have reached their minimum sense levels. The 'power-good' signal has a turn-on delay of at least 100 milliseconds but not longer than 500 milliseconds and can drive six standard TTL loads.

The following figure shows the minimum sense levels for the output voltages.

Level (Vdc)	Minimum (Vdc)
+5	+4.5
-5	-3.75
+12	+10.8
-12	-10.4

Sense Level

Connectors

The following figure shows the pin assignments for the power-supply output connectors.

Load Point	Voltage (Vdc)	Max. Current (A)
PS8-1	Power Good	See Note
PS8-2	+5	3.8
PS8-3	+12	0.7
PS8-4	-12	0.3
PS8-5	Ground	0.0
PS8-6	Ground	0.0
PS9-1	Ground	0.0
PS9-2	Ground	0.0
PS9-3	-5	0.3
PS9-4	+5	3.8
PS9-5	+5	3.8
PS9-6	+5	3.8
P10-1	+12	2.8
P10-2	Ground	0.0
P10-3	Ground	0.0
P10-4	+5	1.8
P11-1	+12	2.8
P11-2	Ground	0.0
P11-3	Ground	0.0
P11-4	+5	1.8
P12-1	+12	1.0
P12-2	Ground	0.0
P12-3	Ground	0.0
P12-4	+5	0.6

DC Load Distribution

Note: For more details, see "Power-Good Signal".

Notes:

SECTION 4. KEYBOARD

Contents

Description

The keyboard is a low-profile, 84-key, detachable unit. A bidirectional serial interface in the keyboard is used to carry signals between the keyboard and system unit.

Cabling

The keyboard cable connects to the system board through a 5-pin DIN connector. The following figure lists the connector pins and their signals.

DIN Connector Pins	Signal Name
1	+KBD CLK
2	+KBD DATA
3	Reserved
4	Ground
5	+5.0 Vdc

Sequencing Key Code Scanning

The keyboard is able to detect all keys that are pressed, and their scan codes will be sent to the interface in correct sequence, regardless of the number of keys held down. Keystrokes entered while the interface is inhibited (when the key lock is on) will be lost. Keystrokes are stored only when the keyboard is not serviced by the system.

Keyboard Buffer

The keyboard has a 16-character first-in-first-out (FIFO) buffer where data is stored until the interface is ready to receive it.

A buffer-overrun condition will occur if more than sixteen codes are placed in the buffer before the first keyed data is sent. The seventeenth code will be replaced with the overrun code, hex 00. (The 17th position is reserved for overrun codes). If more keys are pressed before the system allows a keyboard output, the data will be lost. When the keyboard is allowed to send data, the

characters in the buffer will be sent as in normal operation, and new data entered will be detected and sent.

Keys

All keys are classified as *make/break*, which means when a key is pressed, the keyboard sends a make code for that key to the keyboard controller. When the key is released, its break code is sent (the break code for a key is its make code preceded by hex F0).

All keys are *typematic*. When a key is pressed and held down, the keyboard continues to send the make code for that key until the key is released. The rate at which the make code is sent is known as the *typematic rate* (The typematic rate is described under "Set Typematic Rate/Delay"). When two or more keys are held down, only the last key pressed repeats at the typematic rate. Typematic operation stops when the last key pressed is released, even if other keys are still held down. When a key is pressed and held down while the interface is inhibited, only the first make code is stored in the buffer. This prevents buffer overflow as a result of typematic action.

Power-On Routine

Power-On Reset

The keyboard logic generates a POR when power is applied to the keyboard. The POR lasts a minimum of 300 milliseconds and a maximum of 9 seconds.

> **Note:** The keyboard may issue a false return during the first 200 milliseconds after the +5 Vdc is established at the 90% level. Therefore, the keyboard interface is disabled for this period.

Basic Assurance Test

Immediately following the POR, the keyboard executes a basic assurance test (BAT). This test consists of a checksum of all read-only memory (ROM), and a stuck-bit and addressing test of all random-access memory (RAM) in the keyboard's microprocessor. The mode indicators—three light emitting diodes (LEDs) on the upper right-hand corner of the keyboard—are turned on then off, and must be observed to ensure they are operational.

Execution of the BAT will take from 600 to 900 milliseconds. (This is in addition to the time required for the POR.)

The BAT can also be started by a Reset command.

After the BAT, and when the interface is enabled ('clock' and 'data' lines are set high), the keyboard sends a completion code to the interface—either hex AA for satisfactory completion or hex FC (or any other code) for a failure. If the system issues a Resend command, the keyboard sends the BAT completion code again. Otherwise, the keyboard sets the keys to typematic and make/break.

Commands from the System

The commands described below may be sent to the keyboard at any time. The keyboard will respond within 20 milliseconds.

> **Note:** The following commands are those sent by the system. They have a different meaning when issued by the keyboard.

Reset (Hex FF)

The system issues a Reset command to start a program reset and a keyboard internal self-test. The keyboard acknowledges the command with an 'acknowledge' signal (ACK) and ensures the

system accepts the ACK before executing the command. The system signals acceptance of the ACK by raising the clock and data for a minimum of 500 microseconds. The keyboard is disabled from the time it receives the Reset command until the ACK is accepted or until another command overrides the previous one. Following acceptance of the ACK, the keyboard begins the reset operation, which is similar to a power-on reset. The keyboard clears the output buffer and sets up default values for typematic and delay rates.

Resend (Hex FE)

The system can send this command when it detects an error in any transmission from the keyboard. It can be sent only after a keyboard transmission and before the system enables the interface to allow the next keyboard output. Upon receipt of Resend, the keyboard sends the previous output again unless the previous output was Resend. In this case, the keyboard will resend the last byte before the Resend command.

No-Operation (NOP) (Hex FD through F7)

These commands are reserved and are effectively no-operation or NOP. The system does not use these codes. If sent, the keyboard will acknowledge the command and continue in its prior scanning state. No other operation will occur.

Set Default (Hex F6)

The Set Default command resets all conditions to the power-on default state. The keyboard responds with ACK, clears its output buffer, sets default conditions, and continues scanning (only if the keyboard was previously enabled).

Default Disable (Hex F5)

This command is similar to Set Default, except the keyboard stops scanning and awaits further instructions.

Enable (Hex F4)

Upon receipt of this command, the keyboard responds with ACK, clears its output buffer, and starts scanning.

Set Typematic Rate/Delay (Hex F3)

The system issues this command, followed by a parameter, to change the typematic rate and delay. The typematic rate and delay parameters are determined by the value of the byte following the command. Bits 6 and 5 serve as the delay parameter and bits 4, 3, 2, 1, and 0 (the least-significant bit) are the rate parameter. Bit 7, the most-significant bit, is always 0. The delay is equal to 1 plus the binary value of bits 6 and 5 multiplied by 250 milliseconds ±20%. The period (interval from one typematic output to the next) is determined by the following equation:

Period = (8 + A) X (2^B) X 0.00417 seconds, where A = binary value of bits 2, 1, and 0 and B = binary value of bits 4 and 3.

The typematic rate (make code per second) is 1/period. The period is determined by the first equation above. The following table results.

Bit 4 - 0	Typematic Rate ± 20%	Bit 4 - 0	Typematic Rate ± 20%
00000	30.0	10000	7.5
00001	26.7	10001	6.7
00010	24.0	10010	6.0
00011	21.8	10011	5.5
00100	20.0	10100	5.0
00101	18.5	10101	4.6
00110	17.1	10110	4.3
00111	16.0	10111	4.0
01000	15.0	11000	3.7
01001	13.3	11001	3.3
01010	12.0	11010	3.0
01011	10.9	11011	2.7
01100	10.0	11100	2.5
01101	9.2	11101	2.3
01110	8.0	11110	2.1
01111	8.0	11111	2.0

The keyboard responds to the Set Typematic Rate Delay command with an ACK, stops scanning, and waits for the rate parameter. The keyboard responds to the rate parameter with another ACK, sets the rate and delay, and continues scanning (if the keyboard was previously enabled). If a command is received instead of the rate parameter, the set-typematic-rate function ends with no change to the existing rate, and the new command is processed. However, the keyboard will not resume scanning unless instructed to do so by an Enable command.

The default rate for the system keyboard is as follows:

The typematic rate = 10 characters per second ±20% and the delay = 500 ms ±20%.

No-Operation (NOP) (Hex F2 through EF)

These commands are reserved and are effectively no-operation (NOP). The system does not use these codes. If sent, the keyboard acknowledges the command and continues in its prior scanning state. No other operation will occur.

Echo (Hex EE)

Echo is a diagnostic aide. When the keyboard receives this command, it issues a hex EE response and continues scanning if the keyboard was previously enabled.

Set/Reset Mode Indicators (Hex ED)

Three mode indicators on the keyboard are accessible to the system. The keyboard activates or deactivates these indicators when it receives a valid command from the system. They can be activated or deactivated in any combination.

The system remembers the previous state of an indicator so that its setting does not change when a command sequence is issued to change the state of another indicator.

A Set/Reset Mode Indicators command consists of two bytes. The first is the command byte and has the following bit setup:

11101101 – hex ED

The second byte is an option byte. It has a list of the indicators to be acted upon. The bit assignments for this option byte are as follows:

Bit	Indicator
0	Scroll Lock Indicator
1	Num Lock Indicator
2	Caps Lock Indicator
3-7	Reserved (must be 0's)

Note: Bit 7 is the most-significant bit; bit 0 is the least-significant.

The keyboard will respond to the Set/Reset Mode Indicators command with an ACK, discontinue scanning, and wait for the option byte. The keyboard will respond to the option byte with an ACK, set the indicators, and continue scanning if the keyboard was previously enabled. If another command is received in place of the option byte, execution of the function of the Set/Reset Mode Indicators command is stopped with no change to the indicator states, and the new command is processed. Then scanning is resumed.

Commands to the System

The commands described here are those sent by the keyboard. They have a different meaning when issued by the system.

Resend (Hex FE)

The keyboard issues a Resend command following receipt of an invalid input, or any input with incorrect parity. If the system sends nothing to the keyboard, no response is required.

ACK (Hex FA)

The keyboard issues an ACK response to any valid input other than an Echo or Resend command. If the keyboard is interrupted while sending ACK, it will discard ACK and accept and respond to the new command.

Overrun (Hex 00)

An overrun character is placed in position 17 of the keyboard buffer, overlaying the last code if the buffer becomes full. The code is sent to the system as an overrun when it reaches the top of the buffer.

Diagnostic Failure (Hex FD)

The keyboard periodically tests the sense amplifier and sends a diagnostic failure code if it detects any problems. If a failure occurs during BAT, the keyboard stops scanning and waits for a system command or power-down to restart. If a failure is reported after scanning is enabled, scanning continues.

Break Code Prefix (Hex F0)

This code is sent as the first byte of a 2-byte sequence to indicate the release of a key.

BAT Completion Code (Hex AA)

Following satisfactory completion of the BAT, the keyboard sends hex AA. Hex FC (or any other code) means the keyboard microprocessor check failed.

ECHO Response (Hex EE)

This is sent in response to an Echo command from the system.

Keyboard Scan-Code Outputs

Each key is assigned a unique 8-bit, make scan code, which is sent when the key is pressed. Each key also sends a break code when the key is released. The break code consists of two bytes, the first of which is the break code prefix, hex F0; the second byte is the same as the make scan code for that key.

The typematic scan code for a key is the same as the key's make code. Refer to "Keyboard Layouts" beginning on page 4-15 to determine the character associated with each key number.

The following figure lists the positions of the keys and their make scan codes.

Key Number	Make Code	Key Number	Make Code	Key Number	Make Code
1	0E	31	1C	67	0B
2	16	32	1B	68	0A
3	1E	33	23	69	09
4	26	34	2B	70	05
5	25	35	34	71	04
6	2E	36	33	72	03
7	36	37	3B	73	83
8	3D	38	42	74	01
9	3E	39	4B	90	76
10	46	40	4C	91	6C
11	45	41	52	92	6B
12	4E	43	5A	93	69
13	55	44	12	95	77
14	5D	46	1A	96	75
15	66	47	22	97	73
16	0D	48	21	98	72
17	15	49	2A	99	70
18	1D	50	32	100	7E
19	24	51	31	101	7D
20	2D	52	3A	102	74
21	2C	53	3C	103	7A
22	35	54	49	104	71
23	3C	55	4A	105	84
24	43	57	59	106	7C
25	44	58	11	107	7B
26	4D	61	29	108	79
27	54	64	58		
28	5B	65	06		
30	14	66	0C		

Note: Break codes consists of two bytes; the first is hex F0, the second is the make scan code for that key.

Clock and Data Signals

The keyboard and system communicate over the 'clock' and 'data' lines. The source of each of these lines is an open-collector device on the keyboard that allows either the keyboard or the system to force a line to a negative level. When no communication is occurring, both the 'clock' and 'data' lines are at a positive level.

Data transmissions to and from the keyboard consist of 11-bit data streams that are sent serially over the 'data' line. The following figure shows the structure of the data stream.

Bit	Function
1	Start bit (always 1)
2	Data bit 0 (least-significant)
3	Data bit 1
4	Data bit 2
5	Data bit 3
6	Data bit 4
7	Data bit 5
8	Data bit 6
9	Data bit 7 (most-significant)
10	Parity bit (always odd)
11	Stop bit (always 1)

The parity bit is either 1 or 0, and the eight data bits plus the parity bit always equals an odd number.

When the system sends data to the keyboard, it forces the 'data' line to a negative level and allows the 'clock' line to go to a positive level.

When the keyboard sends data to, or receives data from the system, it generates the 'clock' signal to time the data. The system can prevent the keyboard from sending data by forcing the 'clock' line to a negative level; the 'data' line may go high or low during this time.

During the BAT, the keyboard allows the 'clock' and 'data' lines to go to a positive level.

Keyboard Data Output

When the keyboard is ready to send data, it first checks for a keyboard-inhibit or system request-to-send status on the 'clock' and 'data' lines. If the 'clock' line is low (inhibit status), data is stored in the keyboard buffer. If the 'clock' line is high and 'data' is low (request-to-send), data is stored in the keyboard buffer, and the keyboard receives system data.

If 'clock' and 'data' are both high, the keyboard sends the 0 start bit, 8 data bits, the parity bit and the stop bit. Data will be valid after the rising edge and before the falling edge of the 'clock' line. During transmission, the keyboard checks the 'clock' line for a positive level at least every 60 milliseconds. If the system lowers the 'clock' line from a positive level after the keyboard starts sending data, a condition known as *line contention* occurs, and the keyboard stops sending data. If line contention occurs before the rising edge of the tenth clock (parity bit), the keyboard buffer returns the 'data' and 'clock' lines to a positive level. If contention does not occur by the tenth clock, the keyboard completes the transmission.

Following a transmission, the system can inhibit the keyboard until the system processes the input or until it requests that a response be sent.

Keyboard Data Input

When the system is ready to send data to the keyboard, it first checks if the keyboard is sending data. If the keyboard is sending but has not reached the tenth clock, the system can override the keyboard output by forcing the 'clock' line to a negative level. If the keyboard transmission is beyond the tenth clock, the system must receive the transmission.

If the keyboard is not sending, or if the system elects to override the keyboard's output, the system forces the 'clock' line to a negative level for more than 60 microseconds while preparing to send. When the system is ready to send the start bit ('data' line will be low), it allows the 'clock' line to go to a positive level.

The keyboard checks the state of the 'clock' line at intervals of no less than 60 milliseconds. If a request-to-send is detected, the keyboard counts 11 bits. After the tenth bit, the keyboard forces the 'data' line low and counts one more (the stop bit). This action signals the system that the keyboard has received its data. Upon receipt of this signal, the system returns to a ready state, in which it can accept keyboard output, or goes to the inhibited state until it is ready.

Each system command or data transmission to the keyboard requires a response from the keyboard before the system can send its next output. The keyboard will respond within 20 milliseconds unless the system prevents keyboard output. If the keyboard response is invalid or has a parity error, the system sends the command or data again. A Resend command **should** not be sent in this case.

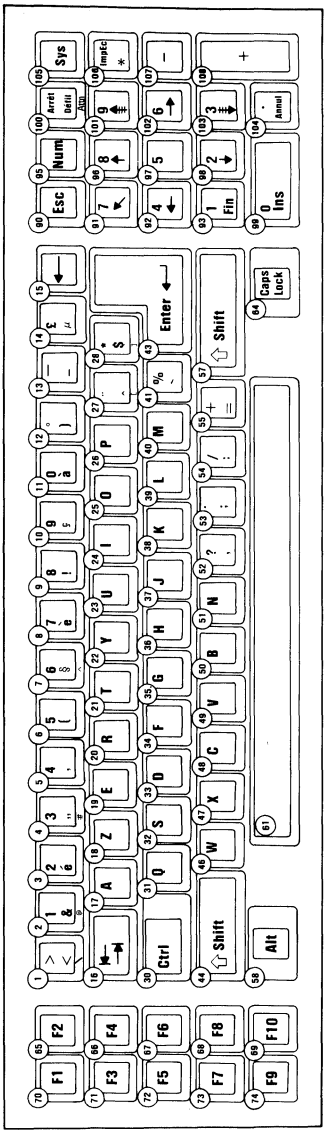
Keyboard Layouts

The keyboard has six different layouts:

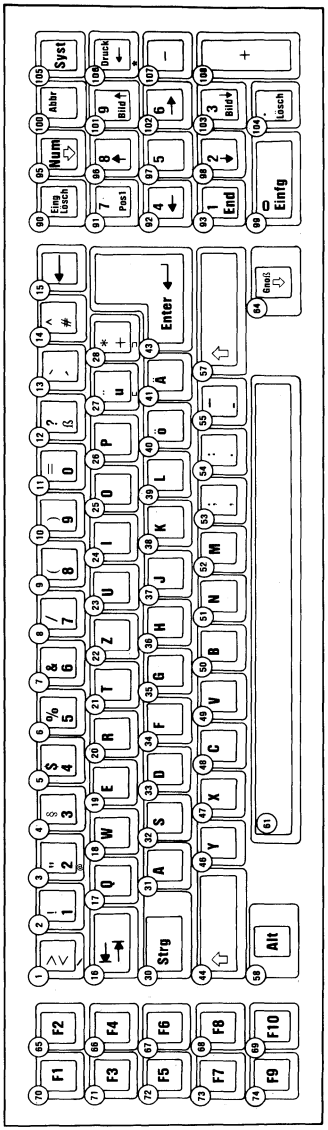
- French
- German
- Italian
- Spanish
- U.K. English
- U.S. English

The following pages show the six keyboard layouts.

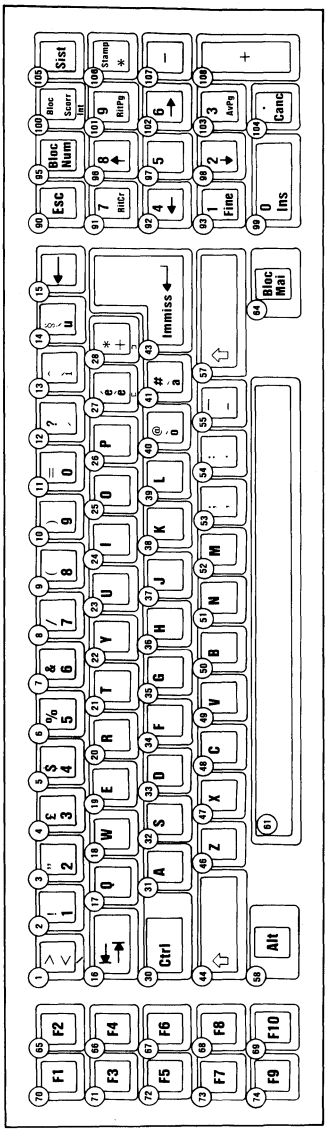
French Keyboard



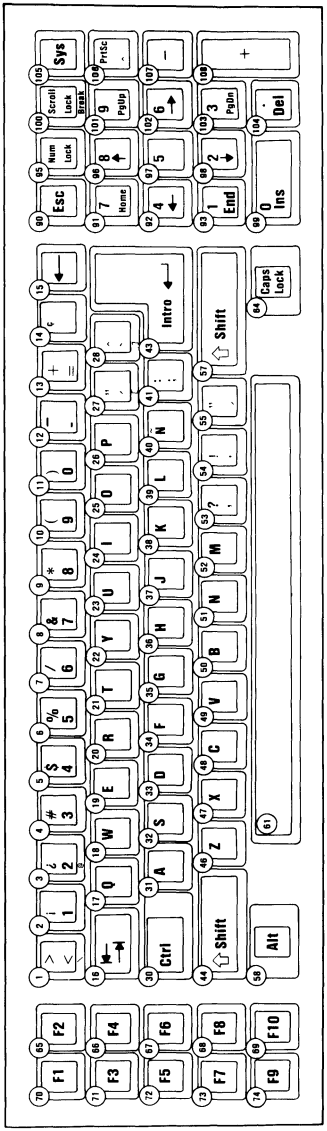
German Keyboard



Italian Keyboard

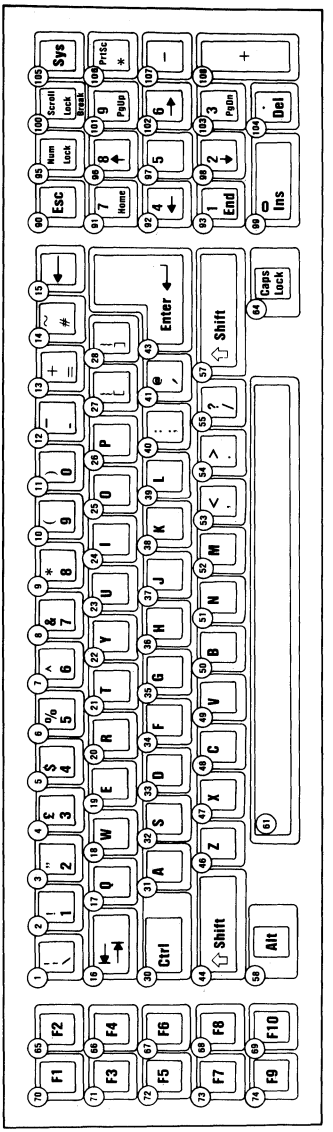


Spanish Keyboard

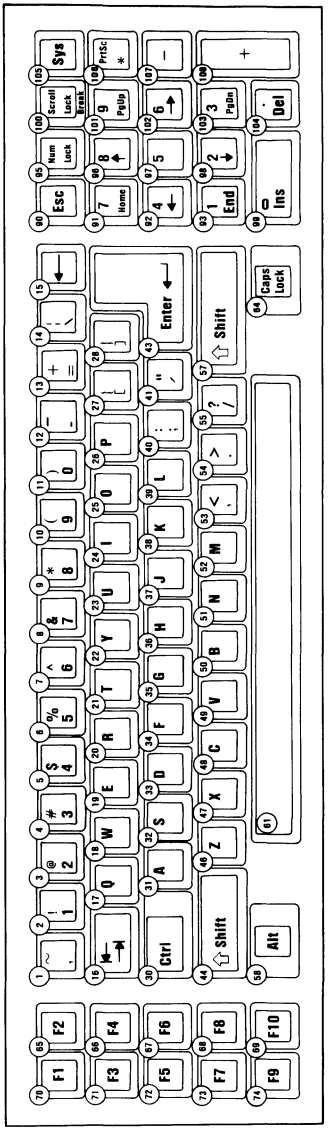


SECTION 4

U.K. English Keyboard



U.S. English Keyboard



Specifications

Size

- Length: 540 millimeters (21.6 inches)
- Depth: 100 millimeters (4 inches)
- Height: 225 millimeters (9 inches)

Weight

- 2.8 kilograms (6.2 pounds)

Enhancement Logic Card Assembly

Notes:

SECTION 5. SYSTEM BIOS

Contents

Notes:

The basic input/output system (BIOS) resides in ROM on the system board and provides level control for the major I/O devices in the system and provides system services, such as time-of-day and memory size determination. Additional ROM modules may be placed on option adapters to provide device-level control for that option adapter. BIOS routines enable the assembly language programmer to perform block (disk or diskette) or character-level I/O operations without concern for device address and characteristics.

If the sockets labeled U17 and U37 on the system board are empty, additional ROM modules may be installed in these sockets. During POST, a test is made for valid code at this location, starting at address hex E0000 and ending at hex EFFFF. More information about these sockets may be found under "Additional System Board ROM Modules" on page 5-13 .

The goal of the BIOS is to provide an operational interface to the system and relieve the programmer of concern about the characteristics of hardware devices. The BIOS interface isolates the user from the hardware, allowing new devices to be added to the system, yet retaining the BIOS level interface to the device. In this manner, hardware modifications and enhancements are not apparent to user programs.

The IBM Personal Computer *MACRO Assembler* manual and the IBM Personal Computer *Disk Operating System (DOS)* manual provide useful programming information related to this section. A complete listing of the BIOS is given later in this section.

System BIOS Usage

Access to the BIOS is through program interrupts of the microprocessor in the real mode. Each BIOS entry point is available through its own interrupt. For example, to determine the amount of base RAM available in the system with the microprocessor in the real mode, INT 12H invokes the BIOS routine for determining the memory size and returns the value to the caller.

Parameter Passing

All parameters passed to and from the BIOS routines go through the 80286 registers. The prolog of each BIOS function indicates the registers used on the call and return. For the memory size example, no parameters are passed. The memory size, in 1K increments, is returned in the AX register.

If a BIOS function has several possible operations, the AH register is used at input to indicate the desired operation. For example, to set the time of day, the following code is required:

```
MOV   AH,1              ; function is to set time-of-day
MOV   CX,HIGH_COUNT     ; establish the current time
MOV   DX,LOW_COUNT
INT   1AH               ; set the time
```

To read the time of day:

```
MOV   AH,0              ; function is to read time-of-day
INT   1AH               ; read the timer
```

The BIOS routines save all registers except for AX and the flags. Other registers are modified on return only if they are returning a value to the caller. The exact register usage can be seen in the prolog of each BIOS function.

The following figure shows the interrupts with their addresses and functions.

Int	Address	Name	BIOS Entry
0	0-3	Divide by Zero	D11
1	4-7	Single Step	D11
2	8-B	Nonmaskable	NMI INT
3	C-F	Breakpoint	D11
4	10-13	Overflow	D11
5	14-17	Print Screen	PRINT_SCREEN
6	18-1B	Reserved	D11
7	1C-1F	Reserved	D11
8	20-23	Time of Day	TIMER_INT
9	24-27	Keyboard	KB_INT
A	28-2B	Reserved	D11
B	2C-2F	Communications	D11
C	30-33	Communications	D11
D	34-37	Alternate Printer	D11
E	38-3B	Diskette	DISK_INT
F	3C-3F	Printer	D11
10	40-43	Video	VIDEO_IO
11	44-47	Equipment Check	EQUIPMENT
12	48-4B	Memory	MEMORY_SIZE_ DETERMINE
13	4C-4F	Diskette/Disk	DISKETTE_IO
14	50-53	Communications	RS232_IO
15	54-57	Cassette	CASSETTE IO/System Extensions
16	58-5B	Keyboard	KEYBOARD_IO
17	5C-5F	Printer	PRINTER_IO
18	60-63	Resident Basic	F600:0000
19	64-67	Bootstrap	BOOTSTRAP
1A	68-6B	Time of Day	TIME_OF_DAY
1B	6C-6F	Keyboard Break	DUMMY_RETURN
1C	70-73	Timer Tick	DUMMY_RETURN
1D	74-77	Video Initialization	VIDEO_PARMS
1E	78-7B	Diskette Parameters	DISK_BASE
1F	7C-7F	Video Graphics Chars	0

80286-2 Program Interrupt Listing (Real Mode Only)

Note: For BIOS index, see the BIOS Quick Reference on page 5-24 .

The following figure shows hardware, BASIC, and DOS reserved interrupts.

Interrupt	Address	Function
20	80-83	DOS program terminate
21	84-87	DOS function call
22	88-8B	DOS terminate address
23	8C-8F	DOS Ctrl Break exit address
24	90-93	DOS fatal error vector
25	94-97	DOS absolute disk read
26	98-9B	DOS absolute disk write
27	9C-9F	DOS terminate, fix in storage
28-3F	A0-FF	Reserved for DOS
40-5F	100-17F	Reserved for BIOS
60-67	180-19F	Reserved for user program interrupts
68-6F	1A0-1BF	Not used
70	1C0-1C3	IRQ 8 Realtime clock INT (BIOS entry RTC_INT)
71	1C4-1C7	IRQ 9 (BIOS entry RE_DIRECT)
72	1C8-1CB	IRQ 10 (BIOS entry D11)
73	1CC-1CF	IRQ 11 (BIOS entry D11)
74	1D0-1D3	IRQ 12 (BIOS entry D11)
75	1D4-1D7	IRQ 13 BIOS Redirect to NMI interrupt (BIOS entry INT_287)
76	1D8-1DB	IRQ 14 (BIOS entry D11)
77	1DC-1DF	IRQ 15 (BIOS entry D11)
78-7F	1E0-1FF	Not used
80-85	200-217	Reserved for BASIC
86-F0	218-3C3	Used by BASIC interpreter while BASIC is running
F1-FF	3C4-3FF	Not used

Hardware, Basic, and DOS Interrupts

Vectors with Special Meanings

Interrupt 15—Cassette I/O: This vector points to the following functions:

- Device open
- Device closed
- Program termination
- Event wait
- Joystick support

- System Request key pressed
- Wait
- Move block
- Extended memory size determination
- Processor to protected mode

Additional information about these functions may be found in the BIOS listing.

Interrupt 1B—Keyboard Break Address: This vector points to the code that is executed when the Ctrl and Break keys are pressed. The vector is invoked while responding to a keyboard interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction so that nothing will occur when the Ctrl and Break keys are pressed unless the application program sets a different value.

This routine may retain control with the following considerations:

- The Break may have occurred during interrupt processing, so that one or more End of Interrupt commands must be sent to the 8259 controller.
- All I/O devices should be reset in case an operation was underway at the same time.

Interrupt 1C—Timer Tick: This vector points to the code that will be executed at every system-clock tick. This vector is invoked while responding to the timer interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction, so that nothing will occur unless the application modifies the pointer. The application must save and restore all registers that will be modified.

Interrupt 1D—Video Parameters: This vector points to a data region containing the parameters required for the initialization of the 6845 on the video adapter. Notice that there are four

separate tables, and all four must be reproduced if all modes of operation are to be supported. The power-on routines initialize this vector to point to the parameters contained in the ROM video routines.

Interrupt 1E—Diskette Parameters: This vector points to a data region containing the parameters required for the diskette drive. The power-on routines initialize this vector to point to the parameters contained in the ROM diskette routine. These default parameters represent the specified values for any IBM drives attached to the system. Changing this parameter block may be necessary to reflect the specifications of other drives attached.

Interrupt 1F—Graphics Character Extensions: When operating in graphics modes 320 x 200 or 640 x 200, the read/write character interface will form a character from the ASCII code point, using a set of dot patterns. ROM contains the dot patterns for the first 128 code points. For access to the second 128 code points, this vector must be established to point at a table of up to 1K, where each code point is represented by 8 bytes of graphic information. At power-on time, this vector is initialized to 000:0, and the user must change this vector if the additional code points are required.

Interrupt 40—Reserved: When a Fixed Disk and Diskette Drive Adapter is installed, the BIOS routines use interrupt 40 to revector the diskette pointer.

Interrupt 41 and 46—Fixed Disk Parameters: These vectors point to the parameters for the fixed disk drives, 41 for the first drive and 46 for the second. The power-on routines initialize the vectors to point to the appropriate parameters in the ROM disk routine if CMOS is valid. The drive type codes in CMOS are used to select which parameter set the vector points to. Changing this parameter hook may be necessary to reflect the specifications of other fixed drives attached.

Other Read/Write Memory Usage

The IBM BIOS routines use 256 bytes of memory from absolute hex 400 to hex 4FF. Locations hex 400 to 407 contain the base

addresses of any RS-232C adapters installed in the system. Locations hex 408 to 40F contain the base addresses of any printer adapters.

Memory locations hex 300 to hex 3FF are used as a stack area during the power-on initialization and bootstrap, when control is passed to it from power-on. If the user desires the stack to be in a different area, that area must be set by the application.

The following figure shows the reserved memory locations.

Address	Mode	Function
400-4A1	ROM BIOS	See BIOS listing
4A2-4EF		Reserved
4F0-4FF		Reserved as intra-application communication area for any application
500-5FF		Reserved for DOS and BASIC
500	DOS	Print screen status flag store 0=Print screen not active or successful print screen operation 1=Print screen in progress 255=Error encountered during print screen operation
504	DOS	Single drive mode status byte
510-511	BASIC	BASIC's segment address store
512-515	BASIC	Clock interrupt vector segment:offset store
516-519	BASIC	Break key interrupt vector segment:offset store
51A-51D	BASIC	Disk error interrupt vector segment:offset store

Reserved Memory Locations

The following is the BASIC workspace for DEF SEG (default workspace).

Offset	Length	
2E	2	Line number of current line being executed
347	2	Line number of last error
30	2	Offset into segment of start of program text
358	2	Offset into segment of start of variables (end of program text 1-1)
6A	1	Keyboard buffer contents 0=No characters in buffer 1=Characters in buffer
4E	1	Character color in graphics mode*

Basic Workspace Variables

*Set to 1, 2, or 3 to get text in colors 1-3. Do not set to 0. The default is 3.

Example
100 PRINT PEEK (&H2E) + 256 x PEEK (&H2F)

L	H
Hex 64	Hex 00

The following is a BIOS memory map.

Starting Address	
00000	BIOS interrupt vectors
001E0	Available interrupt vectors
00400	BIOS data area
00500	User read/write memory
E0000	Read only memory
F0000	BIOS program area

BIOS Memory Map

BIOS Programming Hints

The BIOS code is invoked through program interrupts. The programmer should not "hard code" BIOS addresses into applications. The internal workings and absolute addresses within BIOS are subject to change without notice.

If an error is reported by the disk or diskette code, reset the drive adapter and retry the operation. A specified number of retries should be required for diskette reads to ensure the problem is not due to motor startup.

When altering I/O-port bit values, the programmer should change only those bits necessary to the current task. Upon completion, the original environment should be restored. Failure to adhere to this practice may cause incompatibility with present and future applications.

Additional information for BIOS programming can be found in Section 9 of this manual.

Move Block BIOS

The Move Block BIOS was designed to make use of the memory above the 1M address boundary while operating with IBM DOS. The Block Move is done with the Intel 80286 Microprocessor operating in the protected mode.

Because the interrupts are disabled in the protected mode, Move Block BIOS may demonstrate a data overrun or lost interrupt situation in certain environments.

Communication devices, while receiving data, are sensitive to these interrupt routines; therefore, the timing of communication and the Block Move should be considered. The following table shows the interrupt servicing requirements for communication devices.

Baud Rate	11 Bit (ms)	9 bit (ms)
300	33.33	30.00
1200	8.33	7.50
2400	4.16	7.50
4800	2.08	1.87
9600	1.04	0.93
Times are approximate		

Communication Interrupt Intervals

The following table shows the time required to complete a Block Move.

Block Size	Buffer Addresses	Time in ms
Normal 512 Byte	Both even	0.98
	Even and odd	1.04
	Both odd	1.13
Maximum 64K	Both Even	37.0
	Even and odd	55.0
	Both odd	72.0
Time is approximate		

Move Block BIOS Timing

Following are some ways to avoid data overrun errors and loss of interrupts:

- Do not use the Block Move while communicating, or
- Restrict the block size to 512 bytes or less while communicating, or
- Use even address buffers for both the source and the destination to keep the time for a Block Move to a minumum.

Adapters with System-Accessible ROM Modules

The ROM BIOS provides a way to integrate adapters with on-board ROM code into the system. During POST, interrupt vectors are established for the BIOS calls. After the default vectors are in place, a scan for additional ROM modules occurs. At this point, a ROM routine on an adapter may gain control and establish or intercept interrupt vectors to hook themselves into the system.

The absolute addresses hex C8000 through E0000 are scanned in 2K blocks in search of a valid adapter ROM. A valid ROM is defined as follows:

Byte 0 Hex 55

Byte 1 Hex AA

Byte 2 A length indicator representing the number of 512-byte blocks in the ROM

Byte 3 Entry by a CALL FAR

A checksum is also done to test the integrity of the ROM module. Each byte in the defined ROM module is summed modulo hex 100. This sum must be 0 for the module to be valid.

When the POST identifies a valid ROM, it does a CALL FAR to byte 3 of the ROM, which should be executable code. The adapter can now perform its power-on initialization tasks. The

adapter's ROM should then return control to the BIOS routines by executing a RETURN FAR.

Additional System Board ROM Modules

The POST provides a way to integrate the code for additional ROM modules into the system. These modules are placed in the sockets marked U17 and U37. A test for additional ROM modules on the system board occurs. At this point, the additional ROM, if valid, will gain control.

The absolute addresses, E0000 through EFFFF, are scanned in 64K blocks for a valid checksum. Valid ROM is defined as follows:

Byte 0 Hex 55

Byte 1 Hex AA

Byte 2 Not used

Byte 3 Entry by a CALL FAR

A checksum is done to test the integrity of the ROM modules. Each byte in the ROM modules is summed modulo hex 100. This sum must be 0 for the modules to be valid. This checksum is located at address EFFFF.

When the POST identifies a valid ROM at this segment, it does a CALL FAR to byte 3 of the ROM, which should be executable code.

Keyboard Encoding and Usage

The keyboard routine, provided by IBM in the ROM BIOS, is responsible for converting the keyboard scan codes into what will be termed *Extended ASCII*. The extended ASCII codes returned by the ROM routine are mapped to the U.S. English keyboard

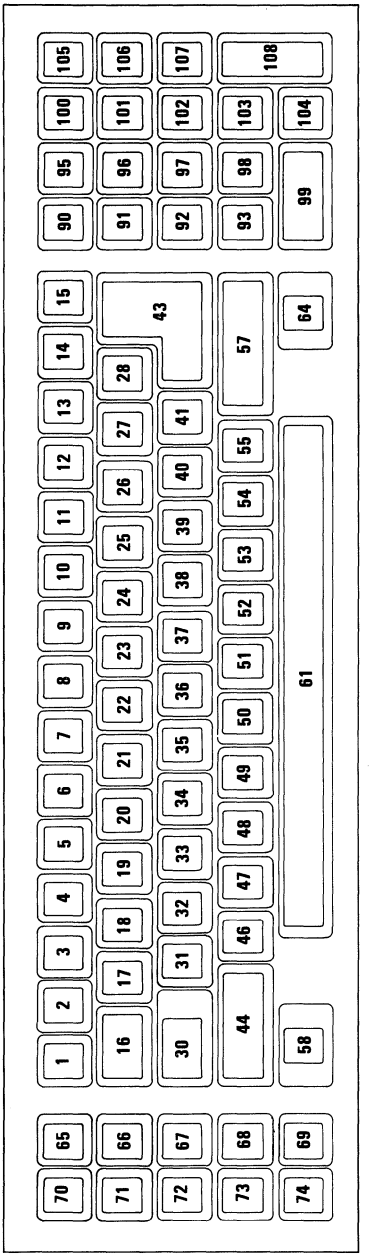
layout. Some operating systems may make provisions for alternate keyboard layouts by providing an interrupt replacer, which resides in the read/write memory. This section discusses only the ROM routine.

Extended ASCII encompasses 1-byte character codes, with possible values of 0 to 255, an extended code for certain extended keyboard functions, and functions handled within the keyboard routine or through interrupts.

Character Codes

The character codes described later are passed through the BIOS keyboard routine to the system or application program. A "-1" means the combination is suppressed in the keyboard routine. The codes are returned in the AL register. See "Characters, Keystrokes, and Color" later in this manual for the exact codes.

The following figure shows the keyboard layout and key positions.



Key	Base Case	Uppercase	Ctrl	Alt
1	'	~	-1	-1
2	1	!	-1	(*)
3	2	@	Nul(000) (*)	(*)
4	3	#	-1	(*)
5	4	$	-1	(*)
6	5	%	-1	(*)
7	6	^	RS(030)	(*)
8	7	&	-1	(*)
9	8	*	-1	(*)
10	9	(	-1	(*)
11	0	)	-1	(*)
12	-	_	US(031)	(*)
13	=	+	-1	(*)
14	\	|	FS(028)	-1
15	Backspace (008)	Backspace (008)	Del(127)	-1
16	→| (009)	|← (*)	-1	-1
17	q	Q	DC1(017)	(*)
18	w	W	ETB(023)	(*)
19	e	E	ENQ(005)	(*)
20	r	R	DC2(018)	(*)
21	t	T	DC4(020)	(*)
22	y	Y	EM(025)	(*)
23	u	U	NAK(021)	(*)
24	i	I	HT(009)	(*)
25	o	O	SI(015)	(*)
26	p	P	DLE(016)	(*)
27	[	{	Esc(027)	(*)
28	]	}	GS(029)	-1
30 Ctrl	-1	-1	-1	-1
31	a	A	SOH(001)	(*)
32	s	S	DC3(019)	(*)
33	d	D	EOT(004)	(*)
34	f	F	ACK(006)	(*)
35	g	G	BEL(007)	(*)
36	h	H	BS(008)	(*)
37	j	J	LF(010)	(*)
38	k	K	VT(011)	(*)
39	l	L	FF(012)	(*)
40	; ,	: "	-1	-1
41	`	~	-1	-1
43	CR	CR	LF(010)	-1
44 Shift (Left)	-1	-1	-1	-1
46	z	Z	SUB(026)	(*)
47	x	X	CAN(024)	(*)
48	c	C	ETX(003)	(*)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 1 of 2)

Key	Base Case	Uppercase	Ctrl	Alt
49	v	V	SYN(022)	(*)
50	b	B	STX(002)	(*)
51	n	N	SO(014)	(*)
52	m	M	CR(013)	(*)
53	,	<	-1	-1
54	.	>	-1	-1
55	/	?	-1	-1
57 Shift (Right)	-1	-1	-1	-1
58 Alt	-1	-1	-1	-1
61	Space	Space	Space	Space
64 Caps Lock	-1	-1	-1	-1
90	Esc	Esc	Esc	-1
95 Num Lock	-1	-1 (*)	Pause (**)	-1
100 Scroll Lock	-1	-1	Break (**)	-1
107	-	-	(*)	(*)
108	Enter	Enter	-1	-1
112	Null (*)	Null (*)	Null (*)	Null(*)
113	Null (*)	Null (*)	Null (*)	Null(*)
114	Null (*)	Null (*)	Null (*)	Null(*)
115	Null (*)	Null (*)	Null (*)	Null(*)
116	Null (*)	Null (*)	Null (*)	Null(*)
117	Null (*)	Null (*)	Null (*)	Null(*)
118	Null (*)	Null (*)	Null (*)	Null(*)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 2 of 2)

The following figure lists keys that have meaning only in Num Lock, Shift, or Ctrl states. The Shift key temporarily reverses the current Num Lock state.

Key	Num Lock	Base Case	Alt	Ctrl
91	7	Home (*)	-1	Clear Screen
92	4	← (*)	-1	Reverse Word (*)
93	1	End (*)	-1	Erase to EOL (*)
96	8	↑ (*)	-1	-1
97	5	-1	-1	-1
98	2	↓ (*)	-1	-1
99	0	Ins	-1	-1
101	9	Page Up (*)	-1	Top of Text and Home
102	6	→ (*)	-1	Advance Word (*)
103	3	Page Down (*)	-1	Erase to EOS (*)
104	.	Delete (*,**)	(**)	(**)
105	-	Sys Request	-1	-1
106	+	+ (*)	-1	-1

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Special Character Codes

Extended Functions

For certain functions that cannot be represented by a standard ASCII code, an extended code is used. A character code of 000 (null) is returned in AL. This indicates that the system or application program should examine a second code, which will indicate the actual function. Usually, but not always, this second code is the scan code of the primary key that was pressed. This code is returned in AH.

The following is a list of the extended codes and their functions.

Second Code	Function
3	Nul Character
15	⇤ (Back-tab)
16-25	Alt Q, W, E, R, T, Y, U, I, O, P
30-38	Alt A, S, D, F, G, H, J, K, L
44-50	Alt Z, X, C, V, B, N, M
59-68	F1 to F10 Function Keys (Base Case)
71	Home
72	↑ (Cursor Up)
73	Page Up and Home Cursor
75	← (Cursor Left)
77	→ (Cursor Right)
79	End
80	↓ (Cursor Down)
81	Page Down and Home Cursor
82	Ins (Insert)
83	Del (Delete)
84-93	F11 to F20 (Shift-F1 through Shift-F10)
94-103	F21 to F30 (Ctrl-F1 through Ctrl-F10)
104-113	F31 to F40 (Alt-F1 through Alt-F10)
114	Ctrl PrtSc (Start/Stop Echo to Printer)
115	Ctrl ← (Reverse Word)
116	Ctrl → (Advance Word)
117	Ctrl End (Erase to End of Line-EOL)
118	Ctrl PgDn (Erase to End of Screen-EOS)
119	Ctrl Home (Clear Screen and Home)
120-131	Alt 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, -, = keys 2-13
132	Ctrl PgUp (Top 25 Lines of Text and Cursor Home)

Keyboard Extended Functions

Shift States

Most shift states are handled within the keyboard routine, and are not apparent to the system or application program. In any case, the current status of active shift states is available by calling an entry point in the BIOS keyboard routine. The following keys result in altered shift states:

Shift: This key temporarily shifts keys 1 through 13, 15 through 29, 31 through 41, and 46 through 55, to uppercase (base case if in Caps Lock state). Also, the Shift temporarily reverses the Num Lock or non-Num Lock state of keys 91 through 93, 96, 98, 99, and 101 through 104.

Ctrl: This key temporarily shifts keys 3, 7, 12, 15, 17 through 29, 31 through 39, 43, 46 through 52, 91 through 93, and 101 through 103 to the Ctrl state. The Ctrl key is also used with the Alt and Del keys to cause the system-reset function; with the Scroll Lock key to cause the break function; and with the Num Lock key to cause the pause function. The system-reset, break, and pause functions are described under "Special Handling" later in this section.

Alt: This key temporarily shifts keys 1 through 13, 17 through 26, 31 through 39, and 46 through 52 to the Alt state. The Alt key is also used with the Ctrl and Del keys to cause a system reset.

The Alt key also allows the user to enter any character code from 1 to 255.

> **Note:** Character codes 97-122 will display uppercase with Caps Lock activated.

The user holds down the Alt key and types the decimal value of the characters desired on the numeric keypad (keys 91 through 93, 96 through 99, and 101 through 103). The Alt key is then released. If the number is greater than 255, a modulo-256 value is used. This value is interpreted as a character code and is sent through the keyboard routine to the system or application program. Alt is handled internal to the keyboard routine.

Caps Lock: This key shifts keys 17 through 26, 31 through 39, and 46 through 52 to uppercase. When Caps Lock is pressed again, it reverses the action. Caps Lock is handled internal to the keyboard routine. When Caps Lock is pressed, it changes the Caps Lock Mode indicator. If the indicator was on, it will go off; and if it was off, it will go on.

Scroll Lock: When interpreted by appropriate application programs, this key indicates that the cursor-control keys will cause windowing over the text rather than moving the cursor. When the Scroll Lock key is pressed again, it reverses the action. The keyboard routine simply records the current shift state of the Scroll Lock key. It is the responsibility of the application program to perform the function. When Scroll Lock is pressed, it

changes the Scroll Lock Mode indicator. If the indicator was on, it will go off; and if it was off, it will go on.

Num Lock: This key shifts keys 91 through 93, 96 through 99, and 101 through 104 to uppercase. When Num Lock is pressed again, it reverses the action. Num Lock is handled internal to the keyboard routine. When Num Lock is pressed, it changes the Num Lock Mode indicator. If the indicator was on, it will go off; if it was off, it will go on.

If the keyboard Num Lock Mode indicator and the system get out of synchronization, pressing the key combination of Shift and Num Lock will synchronize them. This key combination changes the Num Lock bit in the keyboard memory, but sends only the scan code for the Shift key to the system.

Shift Key Priorities and Combinations: If combinations of the Alt, Ctrl, and Shift keys are pressed and only one is valid, the priority is as follows: the Alt key is first, the Ctrl key is second, and the Shift key is third. The only valid combination is Alt and Ctrl, which is used in the system-reset function.

Special Handling

System Reset

The combination of the Alt, Ctrl, and Del keys results in the keyboard routine that starts a system reset or restart. System reset is handled by BIOS.

Break

The combination of the Ctrl and Break keys results in the keyboard routine signaling interrupt hex 1B. The extended characters AL=hex 00, and AH=hex 00 are also returned.

Pause

The Pause key (Ctrl and Num Lock) causes the keyboard interrupt routine to loop, waiting for any key except Num Lock to be pressed. This provides a method of temporarily suspending an operation, such as listing or printing, and then resuming the operation. The method is not apparent to either the system or the application program. The key stroke used to resume operation is discarded. Pause is handled internal to the keyboard routine.

Print Screen

The PrtSc key results in an interrupt invoking the print-screen routine. This routine works in the alphanumeric or graphics mode, with unrecognizable characters printing as blanks.

System Request

When the System Request (Sys) key is pressed, a hex 8500 is placed in AX, and an interrupt hex 15 is executed. When the Sys key is released, a hex 8501 is placed in AX, and another interrupt hex 15 is executed. If an application is to use System Request, the following rules must be observed:

Save the previous address.

Overlay interrupt vector hex 15.

Check AH for a value of hex 85:

If yes, process may begin.
If no, go to previous address.

The application program must preserve the value in all registers, except AX, upon return. System Request is handled internal to the keyboard routine.

Other Characteristics

The keyboard routine does its own buffering, and the keyboard buffer is large enough to support entries by a fast typist. However, if a key is pressed when the buffer is full, the key will be ignored and the "alarm" will sound.

The keyboard routine also suppresses the typematic action of the following keys: Ctrl, Shift, Alt, Num Lock, Scroll Lock, Caps Lock, and Ins.

During each interrupt 09H from the keyboard, an interrupt 15H, function (AH)=4FH is generated by the BIOS after the scan code is read from the keyboard adapter. The scan code is passed in the (AL) register with the carry flag set. This is to allow an operating system to intercept each scan code prior to its being handled by the interrupt 09H routine, and have a chance to change or act on the scan code. If the carry flag is changed to 0 on return from interrupt 15H, the scan code will be ignored by the interrupt handler.

Quick Reference

Address		Publics by Name
F000:E729		A1
F000:3A23		ACT_DISP_PAGE
F000:6000		BASIC
F000:19F0		BEEP
F000:1B1A		BLINK_INT
F000:2022		BOOT_STRAP_1
F000:0C96		C21
F000:0396		C8042
F000:4135		CASSETTE_IO_1
F000:1941		CMOS_READ
F000:195B		CMOS_WRITE
F000:1A45		CONFIG_BAD
F000:E6F5		CONF_TBL
F000:FA6E		CRT_CHAR_GEN
F000:E020		D1
F000:1BCA		D11
F000:E030		D2
F000:E040		D2A
F000:1975		DDS
F000:20E3		DISKETTE_IO_1
F000:EFC7		DISK_BASE
F000:2A17		DISK_INT_1
F000:2C2B		DISK_IO
F000:2A82		DISK_SETUP
F000:2A2E		DSKETTE_SETUP
F000:FF53		DUMMY_RETURN
F000:1C18		DUMMY_RETURN_1
F000:E05E		E101
F000:E077		E102
F000:E090		E103
F000:E0A9		E104
F000:E0C2		E105
F000:E0DB		E106
F000:E0F4		E107
F000:E10D		E108
F000:E126		E109
F000:E13F		E161
F000:E168		E162
F000:E191		E163
F000:E1B7		E164
F000:E1DB		E201
F000:E1EE		E202
F000:E209		E203
F000:E224		E301
F000:E239		E302
F000:E2C6		E303
F000:E2EA		E304
F000:E30E		E401
F000:E31E		E501
F000:E32E		E601
F000:E343		E602
F000:40A8		EQUIPMENT_1
F000:19B2		ERR_BEEP
F000:197D		E_MSG
F000:E364		FT780
F000:E379		FT781
F000:E38E		FT782
F000:E3AC		FT790
F000:E3BF		FT791
F000:E3D2		F3A
F000:E25D		F3D
F000:E3DF		F3D1
F000:E401		FD_TBL
F000:4888		FILL
F000:FF5E		FLOPPY
F000:4501		GATE_A20
F000:314F		HD_INT
F000:FF5A		HRD
F000:1C22		INT_287
F000:E8E1		K10
F000:E91B		K11
F000:E955		K12
F000:E95F		K13
F000:E969		K14
F000:E976		K15
F000:3267		K16
F000:E87E		K6
F000:0008	Abs	K6L
F000:E886		K7
F000:E88E		K8
F000:E8C8		K9
F000:1AEF		KBD_RESET
F000:31FE		KB_INT_1
F000:3172		KEYBOARD_IO_1
F000:0010	Abs	M4
F000:F0E4		M5
F000:F0EC		M6
F000:F0F4		M7
F000:409E		MEMORY_SIZE_DET_1
F000:E2C3		NMI_INT
F000:40B2		NMI_INT_1
F000:03A2		OBF_42
F000:0000		POST1
F000:0C96		POST2
F000:1671		POST3
F000:1941		POST4
F000:1C38		POST5
F000:1EB5		POST6

Address		Publics by Value
F000:0000		POST1
F000:0008	Abs	K6L
F000:0010	Abs	M4
F000:0050		START_1
F000:0396		C8042
F000:03A2		OBF_42
F000:0C96		POST2
F000:0C96		C21
F000:1052		SHUT3
F000:10B6		SHUT2
F000:10B9		SHUT7
F000:10DA		SHUT6
F000:1613		SHUT4
F000:1671		POST3
F000:1941		CMOS_READ
F000:1941		POST4
F000:195B		CMOS_WRITE
F000:1975		DDS
F000:197D		E_MSG
F000:19A4		P_MSG
F000:19B2		ERR_BEEP
F000:19F0		BEEP
F000:1A36		WAITF
F000:1A45		CONFIG_BAD
F000:1A59		XPC_BYTE
F000:1A69		PRT_HEX
F000:1A70		PRT_SEG
F000:1A85		PROT_PRT_HEX
F000:1AB1		ROM_CHECKSUM
F000:1ABD		ROM_CHECK
F000:1AEF		KBD_RESET
F000:1B1A		BLINK_INT
F000:1B28		SET_TOD
F000:1BCA		D11
F000:1C18		DUMMY_RETURN_1
F000:1C19		RE_DIRECT
F000:1C22		INT_287
F000:1C31		PROC_SHUTDOWN
F000:1C38		POST5
F000:1D2A		SYSINIT1
F000:1EB5		POST6
F000:1EB5		STGTST_CNT
F000:1FB5		ROM_ERR
F000:1FE1		XMIT_8042
F000:2022		BOOT_STRAP_1
F000:20E3		DISKETTE_IO_1
F000:28C1		SEEK
F000:2A17		DISK_INT_1
F000:2A2E		DSKETTE_SETUP
F000:2A82		DISK_SETUP
F000:2C2B		DISK_IO
F000:314F		HD_INT
F000:3172		KEYBOARD_IO_1
F000:31FE		KB_INT_1
F000:3267		K16
F000:366C		SND_DATA
F000:3716		PRINTER_IO_1
F000:37A0		RS232_IO_1
F000:38B0		VIDEO_IO_1
F000:38EF		SET_MODE
F000:39BF		SET_CTYPE
F000:39E4		SET_CPOS
F000:3A0C		READ_CURSOR
F000:3A23		ACT_DISP_PAGE
F000:3A47		SET_COLOR
F000:3A6D		VIDEO_STATE
F000:3A90		SCROLL_UP
F000:3B2F		SCROLL_DOWN
F000:3B81		READ_AC_CURRENT
F000:3BDB		WRITE_AC_CURRENT
F000:3C0D		WRITE_C_CURRENT
F000:3CBD		READ_DOT
F000:3CCE		WRITE_DOT
F000:3F72		WRITE_TTY
F000:3FF9		READ_LPEN
F000:409E		MEMORY_SIZE_DET_1
F000:40A8		EQUIPMENT_1
F000:40B2		NMI_INT_1
F000:4135		CASSETTE_IO_1
F000:43BF		SHUT9
F000:4501		GATE_A20
F000:45BD		TIME_OF_DAY_1
F000:473F		RTC_INT
F000:47A9		PRINT_SCREEN_1
F000:483F		TIMER_INT_1
F000:4888		FILL
F000:6000		BASIC
F000:E020		D1
F000:E030		D2
F000:E040		D2A
F000:E05E		E101
F000:E077		E102
F000:E090		E103
F000:E0A9		E104
F000:E0C2		E105
F000:E0DB		E106
F000:E0F4		E107
F000:E10D		E108

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F000:3716       PRINTER_IO_1
F000:FF54       PRINT_SCREEN
F000:47A9       PRINT_SCREEN_1
F000:1C31       PROC_SHUTDOWN
F000:1A85       PROT_PRT_HEX
F000:1A69       PRT_HEX
F000:1A70       PRT_SEG
F000:19A4       P_MSG
F000:FFF0       P_O_R
F000:3B81       READ_AC_CURRENT
F000:3A0C       READ_CURSOR
F000:3CBD       READ_DOT
F000:3FF9       READ_LPEN
F000:1C19       RE_DIRECT
F000:1ABD       ROM_CHECK
F000:1AB1       ROM_CHECKSUM
F000:1FB5       ROM_ERR
F000:37A0       RS232_IO_1
F000:473F       RTC_INT
F000:3B2F       SCROLL_DOWN
F000:3A90       SCROLL_UP
F000:28C1       SEEK
F000:FF62       SEEKS_1
F000:3A47       SET_COLOR
F000:39E4       SET_CPOS
F000:39BF       SET_CTYPE
F000:38EF       SET_MODE
F000:1B28       SET_TOD
F000:10B6       SHUT2
F000:1052       SHUT3
F000:1613       SHUT4
F000:10DA       SHUT6
F000:10B9       SHUT7
F000:43BF       SHUT9
F000:FF23       SLAVE_VECTOR_TABLE
F000:366C       SND_DATA
F000:0050       START_1
F000:1EB5       STGTST_CNT
F000:1D2A       SYSINIT1
F000:483F       TIMER_INT_1
F000:45BD       TIME_OF_DAY_1
F000:FF66       TUTOR
F000:FEF3       VECTOR_TABLE
F000:38B0       VIDEO_IO_1
F000:F0A4       VIDEO_PARMS
F000:3A6D       VIDEO_STATE
F000:1A36       WAITF
F000:3BDB       WRITE_AC_CURRENT
F000:3C0D       WRITE_C_CURRENT
F000:3CCE       WRITE_DOT
F000:3F72       WRITE_TTY
F000:1FE1       XMIT_8042
F000:1A59       XPC_BYTE

F000:E126       E109
F000:E13F       E161
F000:E168       E162
F000:E191       E163
F000:E1B7       E164
F000:E1DB       E201
F000:E1EE       E202
F000:E209       E203
F000:E224       E301
F000:E239       E302
F000:E25D       F3D
F000:E2C3       NMI_INT
F000:E2C6       E303
F000:E2EA       E304
F000:E30E       E401
F000:E31E       E501
F000:E32E       E601
F000:E343       E602
F000:E364       F1780
F000:E379       F1781
F000:E38E       F1782
F000:E3AC       F1790
F000:E3BF       F1791
F000:E3D2       F3A
F000:E3DF       F3D1
F000:E401       FD_TBL
F000:E6F5       CONF_TBL
F000:E729       A1
F000:E87E       K6
F000:E886       K7
F000:E88E       K8
F000:E8C8       K9
F000:E8E1       K10
F000:E91B       K11
F000:E955       K12
F000:E95F       K13
F000:E969       K14
F000:E976       K15
F000:EFC7       DISK_BASE
F000:F0A4       VIDEO_PARMS
F000:F0E4       M5
F000:F0EC       M6
F000:F0F4       M7
F000:FA6E       CRT_CHAR_GEN
F000:FEF3       VECTOR_TABLE
F000:FF23       SLAVE_VECTOR_TABLE
F000:FF53       DUMMY_RETURN
F000:FF54       PRINT_SCREEN
F000:FF5A       HRD
F000:FF5E       FLOPPY
F000:FF62       SEEKS_1
F000:FF66       TUTOR
F000:FFF0       P_O_R
```

THE BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH SOFTWARE INTERRUPTS ONLY. ANY ADDRESSES PRESENT IN THESE LISTINGS ARE INCLUDED ONLY FOR COMPLETENESS, NOT FOR REFERENCE. APPLICATIONS WHICH REFERENCE ANY ABSOLUTE ADDRESSES WITHIN THE CODE SEGMENTS OF BIOS VIOLATE THE STRUCTURE AND DESIGN OF BIOS. ADDRESSES WITHIN THE BIOS CODE SEGMENT ARE SUBJECT TO CHANGE AND ROUTINES SHOULD BE ACCESSED THROUGH POINTERS IN THE INTERRUPT VECTORS OR WHEN NECESSARY THROUGH THE POINTERS IN THE BIOS "DATA" SEGMENT.

```
                        PAGE 118,121
                        TITLE TEST1 ---- 06/10/85  POWER ON SELF TEST (POST)
                        .286C
                        ;--------------------------------------------------------------------------------
                        ;                                                                               :
                        ; BIOS I/O INTERFACE                                                            :
                        ;                                                                               :
                        ;       THESE LISTINGS PROVIDE INTERFACE INFORMATION FOR ACCESSING              :
                        ;       THE BIOS ROUTINES.  THE POWER ON SELF TEST IS INCLUDED.                 :
                        ;                                                                               :
                        ;       THE  BIOS  ROUTINES  ARE  MEANT  TO  BE  ACCESSED  THROUGH             :
                        ;       SOFTWARE  INTERRUPTS  ONLY.    ANY  ADDRESSES  PRESENT  IN            :
                        ;       THESE  LISTINGS  ARE  INCLUDED  ONLY  FOR  COMPLETENESS,                :
                        ;       NOT  FOR  REFERENCE.   APPLICATIONS  WHICH  REFERENCE  ANY              :
                        ;       ABSOLUTE  ADDRESSES  WITHIN  THE  CODE  SEGMENTS  OF  BIOS              :
                        ;       VIOLATE  THE  STRUCTURE  AND  DESIGN  OF  BIOS.                         :
                        ;                                                                               :
                        ;--------------------------------------------------------------------------------



                        ;--------------------------------------------------------------------------------
                        ;   MODULE REFERENCE                                                            :
                        ;                                                                               :
                        ;    TEST1.ASM      -->  POST AND MANUFACTURING TEST ROUTINES                   :
                        ;      DSEG.INC     -->   DATA SEGMENTS LOCATIONS                               :
                        ;      POSTEQU.INC  -->   COMMON EQUATES FOR POST AND BIOS                      :
                        ;      SYSDATA.INC  -->   POWER ON SELF TEST EQUATES FOR PROTECTED MODE         :
                        ;                         POST TEST.01 THROUGH TEST.16                          :
                        ;    TEST2.ASM      -->  POST TEST AND INITIALIZATION ROUTINES                  :
                        ;                         POST TEST.17 THROUGH TEST.22                          :
                        ;    TEST3.ASM      -->  POST EXCEPTION INTERRUPT TESTS                         :
                        ;    TEST4.ASM      -->  POST AND BIOS UTILITY ROUTINES                         :
                        ;                          CMOS_READ      - READ CMOS LOCATION ROUTINE        :
                        ;                          CMOS_WRITE     - WRITE CMOS LOCATION ROUTINE       :
                        ;                          DDS            - LOAD (DS:) WITH DATA SEGMENT      :
                        ;                          E_MSG          - POST ERROR MESSAGE HANDLER        :
                        ;                          MFG_HALT       - MANUFACTURING ERROR TRAP          :
                        ;                          P_MSG          - POST STRING DISPLAY ROUTINE       :
                        ;                          ERR_BEEP       - POST ERROR BEEP PROCEDURE         :
                        ;                          BEEP           - SPEAKER BEEP CONTROL ROUTINE      :
                        ;                          WAITF          - FIXED TIME WAIT ROUTINE           :
                        ;                          CONFIG_BAD     - SET BAD_CONFIG IN CMOS_DIAG       :
                        ;                          XPC_BYTE       - DISPLAY HEX BYTE AS 00 - FF       :
                        ;                          PRT_HEX        - DISPLAY CHARACTER                 :
                        ;                          PRT_SEG        - DISPLAY SEGMENT FORMAT ADDRESS    :
                        ;                          PROT_PRT_HEX   - POST PROTECTED MODE DISPLAY       :
                        ;                          ROM_CHECKSUM   - CHECK ROM MODULES FOR CHECKSUM    :
                        ;                          ROM_CHECK      - ROM SCAN AND INITIALIZE           :
                        ;                          KBD_RESET      - POST KEYBOARD RESET ROUTINE       :
                        ;                          BLINK_INT      - MANUFACTURING TOGGLE BIT ROUTINE  :
                        ;                          SET_TOD        - SET TIMER FROM CMOS RTC           :
                        ;                          D11            - DUMMY INTERRUPT HANDLER   ->INT ??H :
                        ;                          RE_DIRECT      - HARDWARE INT  9 REDIRECT (L 2)    :
                        ;                          INT_287        - HARDWARE INT 13 REDIRECT (287)    :
                        ;                          PROC_SHUTDOWN  - 80286 RESET ROUTINE               :
                        ;    TEST5.ASM      -->  EXCEPTION INTERRUPT TEST HANDLERS FOR POST TESTS       :
                        ;                          SYSINIT1       - BUILD PROTECTED MODE POINTERS     :
                        ;                          GDT_BLD        - BUILD THE GDT FOR POST            :
                        ;                          SIDT_BLD       - BUILD THE IDT FOR POST            :
                        ;    TEST6.ASM      -->  POST TESTS AND SYSTEM BOOT STRAP                       :
                        ;                          STGTST_CNT     - SEGMENT STORAGE TEST              :
                        ;                          ROM_ERR        - ROM ERROR DISPLAY ROUTINE         :
                        ;                          XMIT_8042      - KEYBOARD DIAGNOSTIC OUTPUT        :
                        ;                          BOOT_STRAP     - BOOT STRAP LOADER          -INT 19H :
                        ;                                                                              :
                        ;    DSKETTE.ASM    -->  DISKETTE BIOS                                          :
                        ;                          DISKETTE_IO_1  - INT 13H BIOS ENTRY (40H)   -INT 13H :
                        ;                          DISK_INT_1     - HARDWARE INTERRUPT HANDLER -INT 0EH :
                        ;                          DSKETTE_SETUP  - POST SETUP DRIVE TYPES             :
                        ;    DISK.ASM       -->  FIXED DISK BIOS                                        :
                        ;                          DISK_SETUP     - SETUP DISK VECTORS AND TEST        :
                        ;                          DISK_IO        - INT 13H BIOS ENTRY         -INT 13H :
                        ;                          HD_INT         - HARDWARE INTERRUPT HANDLER -INT 76H :
                        ;    KYBD.ASM       -->  KEYBOARD BIOS                                          :
                        ;                          KEYBOARD_IO_1  - INT 16H BIOS ENTRY         -INT 16H :
                        ;                          KB_INT_1       - HARDWARE INTERRUPT         -INT 09H :
                        ;                          SND_DATA       - KEYBOARD TRANSMISSION              :
                        ;    PRT.ASM        -->  PRINTER ADAPTER BIOS                          -INT 17H :
                        ;    RS232.ASM      -->  COMMUNICATIONS BIOS FOR RS232                 -INT 14H :
                        ;    VIDEO1.ASM     -->  VIDEO BIOS                                    -INT 10H :
                        ;    BIOS.ASM       -->  BIOS ROUTINES                                          :
                        ;                          MEMORY_SIZE_DET_1 - REAL MODE SIZE          -INT 12H :
                        ;                          EQUIPMENT_1    - EQUIPMENT DETERMINATION    -INT 11H :
                        ;                          NMI_INT_1      - NMI HANDLER                -INT 02H :
                        ;    BIOS1.ASM      -->  INTERRUPT 15H BIOS ROUTINES                   -INT 15H :
                        ;                          DEV_OPEN       - NULL DEVICE OPEN HANDLER           :
                        ;                          DEV_CLOSE      - NULL DEVICE CLOSE HANDLER          :
                        ;                          PROG_TERM      - NULL PROGRAM TERMINATION           :
                        ;                          EVENT_WAIT     - RTC EVENT WAIT/TIMEOUT ROUTINE     :
                        ;                          JOY_STICK      - JOYSTICK PORT HANDLER              :
                        ;                          SYS_REQ        - NULL SYSTEM REQUEST KEY            :
                        ;                          WAIT           - RTC TIMED WAIT ROUTINE             :
                        ;                          BLOCKMOVE      - EXTENDED MEMORY MOVE INTERFACE     :
                        ;                          GATE_A20       - ADDRESS BIT 20 CONTROL             :
                        ;                          EXT_MEMORY     - EXTENDED MEMORY SIZE DETERMINE     :
                        ;                          SET_VMODE      - SWITCH PROCESSOR TO VIRTUAL MODE   :
                        ;                          DEVICE_BUSY    - NULL DEVICE BUSY HANDLER           :
                        ;                          INT_COMPLETE   - NULL INTERRUPT COMPLETE HANDLER    :
                        ;    BIOS2.ASM      -->  BIOS INTERRUPT ROUTINES                               :
                        ;                          TIME_OF_DAY_1  - TIME OF DAY ROUTINES       -INT 1AH :
                        ;                          RTC_INT        - IRQ LEVEL 8 ALARM HANDLER  -INT 70H :
                        ;                          PRINT_SCREEN1  - PRINT SCREEN ROUTINE       -INT 05H :
                        ;                          TIMER_INT_1    - TIMER1 INTERRUPT HANDLER  ->INT 1CH :
                        ;    ORGS.ASM       -->  COMPATIBILITY MODULE                                  :
                        ;                          POST ERROR MESSAGES                                  :
                        ;                          DISKETTE - DISK - VIDEO DATA TABLES                  :
                        ;                                                                               :
                        ;--------------------------------------------------------------------------------
                        .LIST
```

```
                        PAGE
                        INCLUDE DSEG.INC
                        ;--------------------------------------
                        ;       80286 INTERRUPT LOCATIONS      :
                        ;       REFERENCED BY POST & BIOS      :
                        ;--------------------------------------

0000                    ABS0            SEGMENT AT 0            ; ADDRESS= 0000:0000

0000 ??                 @STG_LOC0       DB      ?               ; START OF INTERRUPT VECTOR TABLE

0008                                    ORG     4*002H
0008 ????????           @NMI_PTR        DD      ?               ; NON-MASKABLE INTERRUPT VECTOR

0014                                    ORG     4*005H
0014 ????????           @INT5_PTR       DD      ?               ; PRINT SCREEN INTERRUPT VECTOR

0020                                    ORG     4*008H
0020 ????????           @INT_PTR        DD      ?               ; HARDWARE INTERRUPT POINTER (8-F)

0040                                    ORG     4*010H
0040 ????????           @VIDEO_INT      DD      ?               ; VIDEO I/O INTERRUPT VECTOR

004C                                    ORG     4*013H
004C ????????           @ORG_VECTOR     DD      ?               ; DISKETTE/DISK INTERRUPT VECTOR

0060                                    ORG     4*018H
0060 ????????           @BASIC_PTR      DD      ?               ; POINTER TO CASSETTE BASIC

0074                                    ORG     4*01DH
0074 ????????           @PARM_PTR       DD      ?               ; POINTER TO VIDEO PARAMETERS

0078                                    ORG     4*01EH
0078 ????????           @DISK_POINTER   DD      ?               ; POINTER TO DISKETTE PARAMETER TABLE

007C                                    ORG     4*01FH
007C ????????           @EXT_PTR        DD      ?               ; POINTER TO GRAPHIC CHARACTERS 128-255

0100                                    ORG     4*040H
0100 ????????           @DISK_VECTOR    DD      ?               ; POINTER TO DISKETTE INTERRUPT CODE

0104                                    ORG     4*041H
0104 ????????           @HF_TBL_VEC     DD      ?               ; POINTER TO FIRST DISK PARAMETER TABLE

0118                                    ORG     4*046H
0118 ????????           @HF1_TBL_VEC    DD      ?               ; POINTER TO SECOND DISK PARAMETER TABLE

01C0                                    ORG     4*070H
01C0 ????????           @SLAVE_INT_PTR  DD      ?               ; POINTER TO SLAVE INTERRUPT HANDLER

01D8                                    ORG     4*076H
01D8 ????????           @HDISK_INT      DD      ?               ; POINTER TO FIXED DISK INTERRUPT CODE

0400                                    ORG     0400H
0400 ????               @TOS            DW      ?               ; STACK -- USED DURING POST ONLY
                                                                ;   USE WILL OVERLAY INTERRUPTS VECTORS

0500                                    ORG     0500H
0500                    @MFG_TEST_RTN   LABEL   FAR             ; LOAD LOCATION FOR MANUFACTURING TESTS

7C00                                    ORG     7C00H
7C00                    @BOOT_LOCN      LABEL   FAR             ; BOOT STRAP CODE LOAD LOCATION

7C00                    ABS0            ENDS
```

```
                        DSEG.INC - DATA SEGMENTS

                        PAGE
                        ;--------------------------------------
                        ;       ROM BIOS DATA AREAS            :
                        ;--------------------------------------

0000                    DATA            SEGMENT AT 40H          ; ADDRESS= 0040:0000

0000 ????               @RS232_BASE     DW      ?               ; BASE ADDRESSES OF RS232 ADAPTERS
0002 ????                               DW      ?               ;  SECOND LOGICAL RS232 ADAPTER
0004 ????                               DW      ?               ;   RESERVED
0006 ????                               DW      ?               ;   RESERVED
0008 ????               @PRINTER_BASE   DW      ?               ; BASE ADDRESSES OF PRINTER ADAPTERS
000A ????                               DW      ?               ;  SECOND LOGICAL PRINTER ADAPTER
000C ????                               DW      ?               ;  THIRD LOGICAL PRINTER ADAPTER
000E ????                               DW      ?               ;   RESERVED
0010 ????               @EQUIP_FLAG     DW      ?               ; INSTALLED HARDWARE FLAGS
0012 ??                 @MFG_TST        DB      ?               ; INITIALIZATION FLAGS
0013 ????               @MEMORY_SIZE    DW      ?               ; BASE MEMORY SIZE IN K BYTES  (X 1024)
0015 ??                 @MFG_ERR_FLAG   DB      ?               ; SCRATCHPAD FOR MANUFACTURING
0016 ??                                 DB      ?               ;  ERROR CODES

                        ;--------------------------------------
                        ;       KEYBOARD DATA AREAS            :
                        ;--------------------------------------

0017 ??                 @KB_FLAG        DB      ?               ; KEYBOARD SHIFT STATE AND STATUS FLAGS
0018 ??                 @KB_FLAG_1      DB      ?               ; SECOND BYTE OF KEYBOARD STATUS
0019 ??                 @ALT_INPUT      DB      ?               ; STORAGE FOR ALTERNATE KEY PAD ENTRY
001A ????               @BUFFER_HEAD    DW      ?               ; POINTER TO HEAD OF KEYBOARD BUFFER
001C ????               @BUFFER_TAIL    DW      ?               ; POINTER TO TAIL OF KEYBOARD BUFFER

                        ;------       HEAD = TAIL    INDICATES THAT THE BUFFER IS EMPTY

001E   10 [             @KB_BUFFER      DW      16 DUP(?)       ; ROOM FOR 15 SCAN CODE ENTRIES
           ????
                ]

                        ;--------------------------------------
                        ;       DISKETTE DATA AREAS            :
                        ;--------------------------------------

003E ??                 @SEEK_STATUS    DB      ?               ; DRIVE RECALIBRATION STATUS
                                                                ; BIT 3-0 = DRIVE 3-0 RECALIBRATION
                                                                ; BEFORE NEXT SEEK IF BIT IS = 0
003F ??                 @MOTOR_STATUS   DB      ?               ; MOTOR STATUS
                                                                ; BIT 3-0 = DRIVE 3-0 CURRENTLY RUNNING
                                                                ; BIT 7 = CURRENT OPERATION IS A WRITE
0040 ??                 @MOTOR_COUNT    DB      ?               ; TIME OUT COUNTER FOR MOTOR(S) TURN OFF
0041 ??                 @DSKETTE_STATUS DB      ?               ; RETURN CODE STATUS BYTE
                                                                ; CMD_BLOCK  IN STACK FOR DISK OPERATION
0042   07 [             @NEC_STATUS     DB      7 DUP(?)        ; STATUS BYTES FROM DISKETTE OPERATION
           ??
                ]

                        ;--------------------------------------
                        ;       VIDEO DISPLAY DATA AREA        :
                        ;--------------------------------------

0049 ??                 @CRT_MODE       DB      ?               ; CURRENT DISPLAY MODE (TYPE)
004A ????               @CRT_COLS       DW      ?               ; NUMBER OF COLUMNS ON SCREEN
004C ????               @CRT_LEN        DW      ?               ; LENGTH OF REGEN BUFFER IN BYTES
004E ????               @CRT_START      DW      ?               ; STARTING ADDRESS IN REGEN BUFFER
0050   08 [             @CURSOR_POSN    DW      8 DUP(?)        ; CURSOR FOR EACH OF UP TO 8 PAGES
           ????
                ]

0060 ????               @CURSOR_MODE    DW      ?               ; CURRENT CURSOR MODE SETTING
0062 ??                 @ACTIVE_PAGE    DB      ?               ; CURRENT PAGE BEING DISPLAYED
0063 ????               @ADDR_6845      DW      ?               ; BASE ADDRESS FOR ACTIVE DISPLAY CARD
0065 ??                 @CRT_MODE_SET   DB      ?               ; CURRENT SETTING OF THE 3X8 REGISTER
0066 ??                 @CRT_PALETTE    DB      ?               ; CURRENT PALETTE SETTING - COLOR CARD

                        ;--------------------------------------
                        ;       POST AND BIOS WORK DATA AREA   :
                        ;--------------------------------------

                                                                ; STACK SAVE, etc.
0067 ????               @IO_ROM_INIT    DW      ?               ; POINTER TO ROM INITIALIZATION ROUTINE
0069 ????               @IO_ROM_SEG     DW      ?               ; POINTER TO I/O ROM SEGMENT
006B ??                 @INTR_FLAG      DB      ?               ; FLAG INDICATING AN INTERRUPT HAPPENED

                        ;--------------------------------------
                        ;       TIMER DATA AREA                :
                        ;--------------------------------------

006C ????               @TIMER_LOW      DW      ?               ; LOW WORD OF TIMER COUNT
006E ????               @TIMER_HIGH     DW      ?               ; HIGH WORD OF TIMER COUNT
0070 ??                 @TIMER_OFL      DB      ?               ; TIMER HAS ROLLED OVER SINCE LAST READ

                        ;--------------------------------------
                        ;       SYSTEM DATA AREA               :
                        ;--------------------------------------

0071 ??                 @BIOS_BREAK     DB      ?               ; BIT 7=1 IF BREAK KEY HAS BEEN PRESSED
0072 ????               @RESET_FLAG     DW      ?               ; WORD=1234H IF KEYBOARD RESET UNDERWAY

                        ;--------------------------------------
                        ;       FIXED DISK DATA AREAS          :
                        ;--------------------------------------

0074 ??                 @DISK_STATUS1   DB      ?               ; FIXED DISK STATUS
0075 ??                 @HF_NUM         DB      ?               ; COUNT OF FIXED DISK DRIVES
0076 ??                 @CONTROL_BYTE   DB      ?               ; HEAD CONTROL BYTE
0077 ??                 @PORT_OFF       DB      ?               ;  RESERVED (PORT OFFSET)
```

```
                        C  PAGE
                        C  ;--------------------------------------
                        C  ;       TIME-OUT VARIABLES            :
                        C  ;--------------------------------------
                        C
0078 ??                 C  @PRINT_TIM_OUT  DB      ?             ; TIME OUT COUNTERS FOR PRINTER RESPONSE
0079 ??                 C                  DB      ?             ;  SECOND LOGICAL PRINTER ADAPTER
007A ??                 C                  DB      ?             ;  THIRD LOGICAL PRINTER ADAPTER
007B ??                 C                  DB      ?             ;    RESERVED
007C ??                 C  @RS232_TIM_OUT  DB      ?             ; TIME OUT COUNTERS FOR RS232 RESPONSE
007D ??                 C                  DB      ?             ;  SECOND LOGICAL RS232 ADAPTER
007E ??                 C                  DB      ?             ;    RESERVED
007F ??                 C                  DB      ?             ;    RESERVED
                        C
                        C  ;--------------------------------------
                        C  ;       ADDITIONAL KEYBOARD DATA AREA :
                        C  ;--------------------------------------
                        C
                        C                                        ; BUFFER LOCATION WITHIN SEGMENT 40H
0080 ????               C  @BUFFER_START   DW      ?             ; OFFSET OF KEYBOARD BUFFER START
0082 ????               C  @BUFFER_END     DW      ?             ; OFFSET OF END OF BUFFER
                        C
                        C  ;--------------------------------------
                        C  ;       EGA/PGA DISPLAY WORK AREA     :
                        C  ;--------------------------------------
                        C
0084 ??                 C  @ROWS           DB      ?             ; ROWS ON THE ACTIVE SCREEN (LESS 1)
0085 ????               C  @POINTS         DW      ?             ; BYTES PER CHARACTER
0087 ??                 C  @INFO           DB      ?             ; MODE OPTIONS
0088 ??                 C  @INFO_3         DB      ?             ; FEATURE BIT SWITCHES
0089 ??                 C                  DB      ?             ; RESERVED FOR DISPLAY ADAPTERS
008A ??                 C                  DB      ?             ; RESERVED FOR DISPLAY ADAPTERS
                        C
                        C  ;--------------------------------------
                        C  ;       ADDITIONAL MEDIA DATA         :
                        C  ;--------------------------------------
                        C
008B ??                 C  @LASTRATE       DB      ?             ; LAST DISKETTE DATA RATE SELECTED
008C ??                 C  @HF_STATUS      DB      ?             ; STATUS REGISTER
008D ??                 C  @HF_ERROR       DB      ?             ; ERROR REGISTER
008E ??                 C  @HF_INT_FLAG    DB      ?             ; FIXED DISK INTERRUPT FLAG
008F ??                 C  @HF_CNTRL       DB      ?             ; COMBO FIXED DISK/DISKETTE CARD BIT 0=1
0090 ??                 C  @DSK_STATE      DB      ?             ; DRIVE 0 MEDIA STATE
0091 ??                 C                  DB      ?             ; DRIVE 1 MEDIA STATE
0092 ??                 C                  DB      ?             ; DRIVE 0 OPERATION START STATE
0093 ??                 C                  DB      ?             ; DRIVE 1 OPERATION START STATE
0094 ??                 C  @DSK_TRK        DB      ?             ; DRIVE 0 PRESENT CYLINDER
0095 ??                 C                  DB      ?             ; DRIVE 1 PRESENT CYLINDER
                        C
                        C  ;--------------------------------------
                        C  ;       ADDITIONAL KEYBOARD FLAGS     :
                        C  ;--------------------------------------
                        C
0096 ??                 C  @KB_FLAG_3      DB      ?             ; KEYBOARD MODE STATE AND TYPE FLAGS
0097 ??                 C  @KB_FLAG_2      DB      ?             ; KEYBOARD LED FLAGS
                        C
                        C  ;--------------------------------------
                        C  ;       REAL TIME CLOCK DATA AREA     :
                        C  ;--------------------------------------
                        C
0098 ????               C  @USER_FLAG      DW      ?             ; OFFSET ADDRESS OF USERS WAIT FLAG
009A ????               C  @USER_FLAG_SEG  DW      ?             ; SEGMENT ADDRESS OF USER WAIT FLAG
009C ????               C  @RTC_LOW        DW      ?             ; LOW WORD OF USER WAIT FLAG
009E ????               C  @RTC_HIGH       DW      ?             ; HIGH WORD OF USER WAIT FLAG
00A0 ??                 C  @RTC_WAIT_FLAG  DB      ?             ; WAIT ACTIVE FLAG (01=BUSY, 80=POSTED)
                        C                                        ;                  (00=POST ACKNOWLEDGED)
                        C  ;--------------------------------------
                        C  ;       AREA FOR NETWORK ADAPTER      :
                        C  ;--------------------------------------
                        C
00A1   07 [             C  @NET            DB      7 DUP(?)      ; RESERVED FOR NETWORK ADAPTERS
           ??           C
                ]       C
                        C
                        C  ;--------------------------------------
                        C  ;       EGA/PGA PALETTE POINTER       :
                        C  ;--------------------------------------
                        C
00A8 ????????           C  @SAVE_PTR       DD      ?             ; POINTER TO EGA PARAMETER CONTROL BLOCK
                        C
                        C                                        ; RESERVED
                        C  ;--------------------------------------
                        C  ;       DATA AREA - PRINT SCREEN      :
                        C  ;--------------------------------------
                        C
0100                    C                  ORG     100H          ; ADDRESS= 0040:0100   (REF 0050:0000)
                        C
0100 ??                 C  @STATUS_BYTE    DB      ?             ; PRINT SCREEN STATUS BYTE
                        C                                        ;  00=READY/OK,  01=BUSY,  FF=ERROR
                        C
0101                    C  DATA            ENDS                  ; END OF BIOS DATA SEGMENT
                        .LIST
```

SECTION 5

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                        POSTEQU.INC - COMMON EQUATES

                        PAGE
                C       INCLUDE POSTEQU.INC
                C       ;--------------------------------------
                C       ;       EQUATES USED BY POST AND BIOS   :
                C       ;--------------------------------------
                C
= 00FC          C       MODEL_BYTE      EQU     0FCH            ; SYSTEM MODEL BYTE
= 0000          C       SUB_MODEL_BYTE  EQU     000H            ; SYSTEM SUB-MODEL TYPE
= 0001          C       BIOS_LEVEL      EQU     001H            ; BIOS REVISION LEVEL
= F8A7          C       RATE_UPPER      EQU     0F8A7H          ; 0F952H +10%
= F9FD          C       RATE_LOWER      EQU     0F9FDH          ; 0F952H -10%
                C
                C       ;--------- 8042 KEYBOARD INTERFACE AND DIAGNOSTIC CONTROL REGISTERS ------------
= 0060          C       PORT_A          EQU     060H            ; 8042 KEYBOARD SCAN CODE/CONTROL PORT
= 0061          C       PORT_B          EQU     061H            ; PORT B READ/WRITE DIAGNOSTIC REGISTER
= 00F3          C       RAM_PAR_ON      EQU     11110011B       ; AND MASK FOR PARITY CHECKING ENABLE ON
= 000C          C       RAM_PAR_OFF     EQU     00001100B       ; OR MASK FOR PARITY CHECKING ENABLE OFF
= 00C0          C       PARITY_ERR      EQU     11000000B       ; R/W MEMORY - I/O CHANNEL PARITY ERROR
= 0001          C       GATE2           EQU     00000001B       ; TIMER 2 INPUT GATE CLOCK BIT
= 0002          C       SPK2            EQU     00000010B       ; SPEAKER OUTPUT DATA ENABLE BIT
= 0010          C       REFRESH_BIT     EQU     00010000B       ; REFRESH TEST BIT
= 0020          C       OUT2            EQU     00100000B       ; SPEAKER TIMER OUT2 INPUT BIT
= 0040          C       IO_CHECK        EQU     01000000B       ; I/O (MEMORY) CHECK OCCURRED BIT MASK
= 0080          C       PARITY_CHECK    EQU     10000000B       ; MEMORY PARITY CHECK OCCURRED BIT MASK
= 0064          C       STATUS_PORT     EQU     064H            ; 8042 STATUS PORT
= 0001          C       OUT_BUF_FULL    EQU     00000001B       ;   0 = +OUTPUT BUFFER FULL
= 0002          C       INPT_BUF_FULL   EQU     00000010B       ;   1 = +INPUT BUFFER FULL
= 0004          C       SYS_FLAG        EQU     00000100B       ;   2 = -SYSTEM FLAG -POST/-SELF TEST
= 0008          C       CMD_DATA        EQU     00001000B       ;   3 = -COMMAND/+DATA
= 0010          C       KYBD_INH        EQU     00010000B       ;   4 = +KEYBOARD INHIBITED
= 0020          C       TRANS_TMOUT     EQU     00100000B       ;   5 = +TRANSMIT TIMEOUT
= 0040          C       RCV_TMOUT       EQU     01000000B       ;   6 = +RECEIVE TIME OUT
= 0080          C       PARITY_EVEN     EQU     10000000B       ;   7 = +PARITY IS EVEN
                C
                C       ;--------- 8042 INPUT PORT BIT DEFINITION SAVED IN @MFG_TST --------------------
= 0008          C       BASE_MEM8       EQU     00001000B       ; BASE PLANAR R/W MEMORY EXTENSION 640/X
= 0010          C       BASE_MEM        EQU     00010000B       ; BASE PLANAR R/W MEMORY SIZE 256/512
= 0020          C       MFG_LOOP        EQU     00100000B       ; LOOP POST JUMPER BIT FOR MANUFACTURING
= 0040          C       DSP_JMP         EQU     01000000B       ; DISPLAY TYPE SWITCH JUMPER BIT
= 0080          C       KEY_BD_INHIB    EQU     10000000B       ; KEYBOARD INHIBIT SWITCH BIT
                C
                C       ;--------- 8042 COMMANDS -------------------------------------------------------
= 0060          C       WRITE_8042_LOC  EQU     060H            ; WRITE 8042 COMMAND BYTE
= 00AA          C       SELF_TEST       EQU     0AAH            ; 8042 SELF TEST
= 00AB          C       INTR_FACE_CK    EQU     0ABH            ; CHECK 8042 INTERFACE COMMAND
= 00AD          C       DIS_KBD         EQU     0ADH            ; DISABLE KEYBOARD COMMAND
= 00AE          C       ENA_KBD         EQU     0AEH            ; ENABLE KEYBOARD COMMAND
= 00C0          C       READ_8042_INPUT EQU     0C0H            ; READ 8042 INPUT PORT
= 00DD          C       DISABLE_BIT20   EQU     0DDH            ; DISABLE ADDRESS LINE BIT 20
= 00DF          C       ENABLE_BIT20    EQU     0DFH            ; ENABLE ADDRESS LINE BIT 20
= 00E0          C       KYBD_CLK_DATA   EQU     0E0H            ; GET KEYBOARD CLOCK AND DATA COMMAND
= 00FE          C       SHUT_CMD        EQU     0FEH            ; CAUSE A SHUTDOWN COMMAND
= 0001          C       KYBD_CLK        EQU     001H            ; KEYBOARD CLOCK BIT 0
                C
                C       ;---------- KEYBOARD/LED COMMANDS -----------------------------------------------
= 00ED          C       LED_CMD         EQU     0EDH            ; LED WRITE COMMAND
= 00F2          C       KB_READ_ID      EQU     0F2H            ; READ KEYBOARD ID COMMAND
= 00F4          C       KB_ENABLE       EQU     0F4H            ; KEYBOARD ENABLE
                C
                C       ;---------- 8042 KEYBOARD RESPONSE ---------------------------------------------
= 00AA          C       KB_OK           EQU     0AAH            ; RESPONSE FROM SELF DIAGNOSTIC
= 00FA          C       KB_ACK          EQU     0FAH            ; ACKNOWLEDGE FROM TRANSMISSION
= 00FE          C       KB_RESEND       EQU     0FEH            ; RESEND REQUEST
= 00FF          C       KB_OVER_RUN     EQU     0FFH            ; OVER RUN SCAN CODE
                C
                C       ;---------- FLAG EQUATES WITHIN  @KB_FLAG ---------------------------------------
= 0001          C       RIGHT_SHIFT     EQU     00000001B       ; RIGHT SHIFT KEY DEPRESSED
= 0002          C       LEFT_SHIFT      EQU     00000010B       ; LEFT SHIFT KEY DEPRESSED
= 0004          C       CTL_SHIFT       EQU     00000100B       ; CONTROL SHIFT KEY DEPRESSED
= 0008          C       ALT_SHIFT       EQU     00001000B       ; ALTERNATE SHIFT KEY DEPRESSED
= 0010          C       SCROLL_STATE    EQU     00010000B       ; SCROLL LOCK STATE HAS BEEN TOGGLED
= 0020          C       NUM_STATE       EQU     00100000B       ; NUM LOCK STATE HAS BEEN TOGGLED
= 0040          C       CAPS_STATE      EQU     01000000B       ; CAPS LOCK STATE HAS BEEN TOGGLED
= 0080          C       INS_STATE       EQU     10000000B       ; INSERT STATE IS ACTIVE
                C
                C       ;---------- FLAG EQUATES WITHIN  @KB_FLAG_1 -------------------------------------
= 0004          C       SYS_SHIFT       EQU     00000100B       ; SYSTEM KEY DEPRESSED AND HELD
= 0008          C       HOLD_STATE      EQU     00001000B       ; SUSPEND KEY HAS BEEN TOGGLED
= 0010          C       SCROLL_SHIFT    EQU     00010000B       ; SCROLL LOCK KEY IS DEPRESSED
= 0020          C       NUM_SHIFT       EQU     00100000B       ; NUM LOCK KEY IS DEPRESSED
= 0040          C       CAPS_SHIFT      EQU     01000000B       ; CAPS LOCK KEY IS DEPRESSED
= 0080          C       INS_SHIFT       EQU     10000000B       ; INSERT KEY IS DEPRESSED
                C
                C       ;---------- FLAGS EQUATES WITHIN  @KB_FLAG_2 -------------------------------------
= 0007          C       KB_LEDS         EQU     00000111B       ; KEYBOARD LED STATE BITS
                C       ;               EQU     00001000B       ; RESERVED (MUST BE ZERO)
= 0010          C       KB_FA           EQU     00010000B       ; ACKNOWLEDGMENT RECEIVED
= 0020          C       KB_FE           EQU     00100000B       ; RESEND RECEIVED FLAG
= 0040          C       KB_PR_LED       EQU     01000000B       ; MODE INDICATOR UPDATE
= 0080          C       KB_ERR          EQU     10000000B       ; KEYBOARD TRANSMIT ERROR FLAG
                C
                C       ;---------- FLAGS EQUATES WITHIN  @KB_FLAG_3 -------------------------------------
= 0001          C       KBX             EQU     00000001B       ; KBX INSTALLED
= 0002          C       LC_HC           EQU     00000010B       ; LAST SCAN CODED WAS A HIDDEN CODE
= 0004          C       GRAPH_ON        EQU     00000100B       ; ALL GRAPHICS KEY DOWN (W.T. ONLY)
                C       ;               EQU     00011000B       ; RESERVED (MUST BE ZERO)
= 0020          C       SET_NUM_LK      EQU     00100000B       ; FORCE NUM LOCK IF READ ID AND KBX
= 0040          C       LC_AB           EQU     01000000B       ; LAST CHARACTER WAS FIRST ID CHARACTER
= 0080          C       RD_ID           EQU     10000000B       ; DOING A READ ID (MUST BE BIT0)
                C
                C       ;---------- KEYBOARD SCAN CODES --------------------------------------------------
= 00AB          C       ID_1            EQU     0ABH            ; 1ST ID CHARACTER FOR KBX
= 0041          C       ID_2            EQU     041H            ; 2ND ID CHARACTER FOR KBX
= 0038          C       ALT_KEY         EQU     56              ; SCAN CODE FOR  ALTERNATE SHIFT KEY
= 001D          C       CTL_KEY         EQU     29              ; SCAN CODE FOR  CONTROL KEY
= 003A          C       CAPS_KEY        EQU     58              ; SCAN CODE FOR  SHIFT LOCK KEY
= 0053          C       DEL_KEY         EQU     83              ; SCAN CODE FOR  DELETE KEY
= 0052          C       INS_KEY         EQU     82              ; SCAN CODE FOR  INSERT KEY
= 002A          C       LEFT_KEY        EQU     42              ; SCAN CODE FOR  LEFT SHIFT
= 0045          C       NUM_KEY         EQU     69              ; SCAN CODE FOR  NUMBER LOCK KEY
= 0036          C       RIGHT_KEY       EQU     54              ; SCAN CODE FOR  RIGHT SHIFT
= 0046          C       SCROLL_KEY      EQU     70              ; SCAN CODE FOR  SCROLL LOCK KEY
= 0054          C       SYS_KEY         EQU     84              ; SCAN CODE FOR  SYSTEM KEY
```

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                        C  PAGE
                        C  ;--------------------------------------
                        C  ;          CMOS EQUATES FOR THIS SYSTEM    ;
                        C  ;--------------------------------------------------------------------------
= 0070                  C  CMOS_PORT        EQU     070H            ; I/O ADDRESS OF CMOS ADDRESS PORT
= 0071                  C  CMOS_DATA        EQU     071H            ; I/O ADDRESS OF CMOS DATA PORT
= 0080                  C  NMI              EQU     10000000B       ; DISABLE NMI INTERRUPTS MASK -
                        C                                           ;  HIGH BIT OF CMOS LOCATION ADDRESS
                        C
                        C  ;---------- CMOS TABLE LOCATION ADDRESS'S ## ------------------------------
= 0000                  C  CMOS_SECONDS     EQU     000H            ; SECONDS
= 0001                  C  CMOS_SEC_ALARM   EQU     001H            ; SECONDS ALARM  ## NOTE:  ALL LOCATIONS
= 0002                  C  CMOS_MINUTES     EQU     002H            ; MINUTES                | IN THE CMOS AREA
= 0003                  C  CMOS_MIN_ALARM   EQU     003H            ; MINUTES ALARM          | ARE IBM USE ONLY
= 0004                  C  CMOS_HOURS       EQU     004H            ; HOURS                  | AND  SUBJECT  TO
= 0005                  C  CMOS_HR_ALARM    EQU     005H            ; HOURS ALARM            | CHANGE.  ONLY THE
= 0006                  C  CMOS_DAY_WEEK    EQU     006H            ; DAY OF THE WEEK        | POST & BIOS CODE
= 0007                  C  CMOS_DAY_MONTH   EQU     007H            ; DAY OF THE MONTH       | SHOULD  DIRECTLY
= 0008                  C  CMOS_MONTH       EQU     008H            ; MONTH                  | ACCESS LOCATIONS
= 0009                  C  CMOS_YEAR        EQU     009H            ; YEAR (TWO DIGITS)      | IN CMOS STORAGE.
= 000A                  C  CMOS_REG_A       EQU     00AH            ; STATUS REGISTER A      '--------------------
= 000B                  C  CMOS_REG_B       EQU     00BH            ; STATUS REGISTER B  ALARM
= 000C                  C  CMOS_REG_C       EQU     00CH            ; STATUS REGISTER C  FLAGS
= 000D                  C  CMOS_REG_D       EQU     00DH            ; STATUS REGISTER D  BATTERY
= 000E                  C  CMOS_DIAG        EQU     00EH            ; POST DIAGNOSTIC STATUS RESULTS BYTE
= 000F                  C  CMOS_SHUT_DOWN   EQU     00FH            ; SHUTDOWN STATUS COMMAND BYTE
= 0010                  C  CMOS_DISKETTE    EQU     010H            ; DISKETTE DRIVE TYPE BYTE              ;
                        C  ;                EQU     011H            ; - RESERVED                            ;C
= 0012                  C  CMOS_DISK        EQU     012H            ; FIXED DISK TYPE BYTE                  ;H
                        C  ;                EQU     013H            ; - RESERVED                            ;E
= 0014                  C  CMOS_EQUIP       EQU     014H            ; EQUIPMENT WORD LOW BYTE               ;C
= 0015                  C  CMOS_B_M_S_LO    EQU     015H            ; BASE MEMORY SIZE - LOW BYTE (X1024)   ;K
= 0016                  C  CMOS_B_M_S_HI    EQU     016H            ; BASE MEMORY SIZE - HIGH BYTE          ;S
= 0017                  C  CMOS_E_M_S_LO    EQU     017H            ; EXPANSION MEMORY SIZE - LOW BYTE      ;U
= 0018                  C  CMOS_E_M_S_HI    EQU     018H            ; EXPANSION MEMORY SIZE - HIGH BYTE     ;M
= 0019                  C  CMOS_DISK_1      EQU     019H            ; FIXED DISK TYPE - DRIVE C EXTENSION   ;E
= 001A                  C  CMOS_DISK_2      EQU     01AH            ; FIXED DISK TYPE - DRIVE D EXTENSION   ;D
                        C  ;                EQU     01BH            ; - 1BH THROUGH 2DH - RESERVED          ;
= 002E                  C  CMOS_CKSUM_HI    EQU     02EH            ; CMOS CHECKSUM - HIGH BYTE             ;*
= 002F                  C  CMOS_CKSUM_LO    EQU     02FH            ; CMOS CHECKSUM - LOW BYTE              ;*
= 0030                  C  CMOS_U_M_S_LO    EQU     030H            ; USABLE MEMORY ABOVE 1 MEG - LOW BYTE
= 0031                  C  CMOS_U_M_S_HI    EQU     031H            ; USABLE MEMORY ABOVE 1 MEG - HIGH BYTE
= 0032                  C  CMOS_CENTURY     EQU     032H            ; DATE CENTURY BYTE (BCD)
= 0033                  C  CMOS_INFO128     EQU     033H            ; 128KB INFORMATION STATUS FLAG BYTE
                        C  ;                EQU     034H            ; - 34H THROUGH 3FH - RESERVED
                        C
                        C  ;---------- CMOS DIAGNOSTIC STATUS ERROR FLAGS WITHIN CMOS_DIAG ----------------
= 0004                  C  CMOS_CLK_FAIL    EQU     00000100B       ; CMOS CLOCK NOT UPDATING OR NOT VALID
= 0008                  C  HF_FAIL          EQU     00001000B       ; FIXED DISK FAILURE ON INITIALIZATION
= 0010                  C  W_MEM_SIZE       EQU     00010000B       ; MEMORY SIZE NOT EQUAL TO CONFIGURATION
= 0020                  C  BAD_CONFIG       EQU     00100000B       ; MINIMUM CONFIG USED INSTEAD OF CMOS
= 0040                  C  BAD_CKSUM        EQU     01000000B       ; CHECKSUM ERROR
= 0080                  C  BAD_BAT          EQU     10000000B       ; DEAD BATTERY - CMOS LOST POWER
                        C
                        C  ;---------- CMOS INFORMATION FLAGS ---------------------------------------------
= 0080                  C  M640K            EQU     10000000B       ; 512K -> 640K OPTION INSTALLED  (128K)
                        C  ;                EQU     01000000B       ; FLAG USED BY CMOS SETUP UTILITY
                        C
                        C
                        C  ;---------- DISKETTE EQUATES ---------------------------------------------------
= 0001                  C  DUAL             EQU     00000001B       ; MASK FOR COMBO/DSP ADAPTER
= 0080                  C  INT_FLAG         EQU     10000000B       ; INTERRUPT OCCURRENCE FLAG
= 0080                  C  DSK_CHG          EQU     10000000B       ; DISKETTE CHANGE FLAG MASK BIT
= 0010                  C  DETERMINED       EQU     00010000B       ; SET STATE DETERMINED IN STATE BITS
= 0010                  C  HOME             EQU     00010000B       ; TRACK 0 MASK
= 0004                  C  SENSE_DRV_ST     EQU     00000100B       ; SENSE DRIVE STATUS COMMAND
= 0030                  C  TRK_SLAP         EQU     030H            ; CRASH STOP (48 TPI DRIVES)
= 000A                  C  QUIET_SEEK       EQU     00AH            ; SEEK TO TRACK 10
= 0002                  C  MAX_DRV          EQU     2               ; MAX NUMBER OF DRIVES
= 000F                  C  HD12_SETTLE      EQU     15              ; 1.2 M HEAD SETTLE TIME
= 0014                  C  HD320_SETTLE     EQU     20              ; 320 K HEAD SETTLE TIME
= 0025                  C  MOTOR_WAIT       EQU     37              ; 2 SECONDS OF COUNTS FOR MOTOR TURN OFF
                        C
                        C  ;---------- DISKETTE ERRORS ----------------------------------------------------
= 0080                  C  TIME_OUT         EQU     080H            ; ATTACHMENT FAILED TO RESPOND
= 0040                  C  BAD_SEEK         EQU     040H            ; SEEK OPERATION FAILED
= 0020                  C  BAD_NEC          EQU     020H            ; DISKETTE CONTROLLER HAS FAILED
= 0010                  C  BAD_CRC          EQU     010H            ; BAD CRC ON DISKETTE READ
= 0009                  C  DMA_BOUNDARY     EQU     009H            ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
= 0008                  C  BAD_DMA          EQU     008H            ; DMA OVERRUN ON OPERATION
= 0006                  C  MEDIA_CHANGE     EQU     006H            ; MEDIA REMOVED ON DUAL ATTACH CARD
= 0004                  C  RECORD_NOT_FND   EQU     004H            ; REQUESTED SECTOR NOT FOUND
= 0003                  C  WRITE_PROTECT    EQU     003H            ; WRITE ATTEMPTED ON WRITE PROTECT DISK
= 0002                  C  BAD_ADDR_MARK    EQU     002H            ; ADDRESS MARK NOT FOUND
= 0001                  C  BAD_CMD          EQU     001H            ; BAD COMMAND PASSED TO DISKETTE I/O
                        C
                        C  ;---------- DISK CHANGE LINE EQUATES -------------------------------------------
= 0001                  C  NOCHGLN          EQU     001H            ; NO DISK CHANGE LINE AVAILABLE
= 0002                  C  CHGLN            EQU     002H            ; DISK CHANGE LINE AVAILABLE
                        C
                        C  ;---------- MEDIA/DRIVE STATE INDICATORS ----------------------------------------
= 0001                  C  TRK_CAPA         EQU     00000001B       ; 80 TRACK CAPABILITY
= 0002                  C  FMT_CAPA         EQU     00000010B       ; MULTIPLE FORMAT CAPABILITY (1.2M)
= 0004                  C  DRV_DET          EQU     00000100B       ; DRIVE DETERMINED
= 0010                  C  MED_DET          EQU     00010000B       ; MEDIA DETERMINED BIT
= 0020                  C  DBL_STEP         EQU     00100000B       ; DOUBLE STEP BIT
= 00C0                  C  RATE_MSK         EQU     11000000B       ; MASK FOR CLEARING ALL BUT RATE
= 0000                  C  RATE_500         EQU     00000000B       ; 500 KBS DATA RATE
= 0040                  C  RATE_300         EQU     01000000B       ; 300 KBS DATA RATE
= 0080                  C  RATE_250         EQU     10000000B       ; 250 KBS DATA RATE
= 000C                  C  STRT_MSK         EQU     00001100B       ; OPERATION START RATE MASK
= 00C0                  C  SEND_MSK         EQU     11000000B       ; MASK FOR SEND RATE BITS
                        C
                        C  ;---------- MEDIA/DRIVE STATE INDICATORS COMPATIBILITY --------------------------
= 0000                  C  M3D3U            EQU     00000000B       ; 360 MEDIA/DRIVE NOT ESTABLISHED
= 0001                  C  M3D1U            EQU     00000001B       ; 360 MEDIA,1.2DRIVE NOT ESTABLISHED
= 0002                  C  M1D1U            EQU     00000010B       ; 1.2 MEDIA/DRIVE NOT ESTABLISHED
= 0007                  C  MED_UNK          EQU     00000111B       ; NONE OF THE ABOVE
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SECTION 5

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                        C  PAGE
                        C  ;---------- INTERRUPT EQUATES ----------------------------------------------------
= 0020                  C  EOI             EQU     020H            ; END OF INTERRUPT COMMAND TO 8259
= 0020                  C  INTA00          EQU     020H            ; 8259 PORT
= 0021                  C  INTA01          EQU     021H            ; 8259 PORT
= 00A0                  C  INTB00          EQU     0A0H            ; 2ND 8259
= 00A1                  C  INTB01          EQU     0A1H            ;
= 0070                  C  INT_TYPE        EQU     070H            ; START OF 8259 INTERRUPT TABLE LOCATION
= 0010                  C  INT_VIDEO       EQU     010H            ; VIDEO VECTOR
                        C  ;--------------------------------------------------------------------------------
= 0008                  C  DMA08           EQU     008H            ; DMA STATUS REGISTER PORT ADDRESS
= 0000                  C  DMA             EQU     000H            ; DMA CH.0 ADDRESS REGISTER PORT ADDRESS
= 00D0                  C  DMA18           EQU     0D0H            ; 2ND DMA STATUS PORT ADDRESS
= 00C0                  C  DMA1            EQU     0C0H            ; 2ND DMA CH.0 ADDRESS REGISTER ADDRESS
                        C  ;--------------------------------------------------------------------------------
= 0040                  C  TIMER           EQU     040H            ; 8254 TIMER - BASE ADDRESS
                        C
                        C  ;--------- MANUFACTURING PORT ----------------------------------------------------
= 0080                  C  MFG_PORT        EQU     80H             ; MANUFACTURING AND POST CHECKPOINT PORT
                        C                                          ;  DMA CHANNEL 0 PAGE REGISTER ADDRESS
                        C
                        C  ;--------- MANUFACTURING BIT DEFINITION FOR @MFG_ERR_FLAG+1 ----------------------
= 0001                  C  MEM_FAIL        EQU     00000001B       ; STORAGE TEST FAILED          (ERROR 20X)
= 0002                  C  PRO_FAIL        EQU     00000010B       ; VIRTUAL MODE TEST FAILED     (ERROR 104)
= 0004                  C  LMCS_FAIL       EQU     00000100B       ; LOW MEG CHIP SELECT FAILED   (ERROR 109)
= 0008                  C  KYCLK_FAIL      EQU     00001000B       ; KEYBOARD CLOCK TEST FAILED   (ERROR 304)
= 0010                  C  KY_SYS_FAIL     EQU     00010000B       ; KEYBOARD OR SYSTEM FAILED    (ERROR 303)
= 0020                  C  KYBD_FAIL       EQU     00100000B       ; KEYBOARD FAILED              (ERROR 301)
= 0040                  C  DSK_FAIL        EQU     01000000B       ; DISKETTE TEST FAILED         (ERROR 601)
= 0080                  C  KEY_FAIL        EQU     10000000B       ; KEYBOARD LOCKED              (ERROR 302)
                        C
                        C  ;--------------------------------------------------------------------------------
= 0081                  C  DMA_PAGE        EQU     081H            ; START OF DMA PAGE REGISTERS
= 008F                  C  LAST_DMA_PAGE   EQU     08FH            ; LAST DMA PAGE REGISTER
                        C
                        C  ;--------------------------------------------------------------------------------
= 00F0                  C  X287            EQU     0F0H            ; MATH COPROCESSOR CONTROL PORT
                        C
                        C  ;--------------------------------------------------------------------------------
= 0000                  C  POST_SS         EQU     00000H          ; POST STACK SEGMENT
= 8000                  C  POST_SP         EQU     08000H          ; POST STACK POINTER
                        C
                        C  ;--------------------------------------------------------------------------------
= 000D                  C  CR              EQU     000DH           ; CARRIAGE RETURN CHARACTER
= 000A                  C  LF              EQU     000AH           ; LINE FEED CHARACTER
= 0008                  C  RVRT            EQU     00001000B       ; VIDEO VERTICAL RETRACE BIT
= 0001                  C  RHRZ            EQU     00000001B       ; VIDEO HORIZONTAL RETRACE BIT
= 0100                  C  H               EQU     256             ; HIGH BYTE FACTOR (X 100H)
= 0101                  C  X               EQU     H+1             ; HIGH AND LOW BYTE FACTOR (X 101H)

                            .LIST
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                        SYSDATA.INC - DESCRIPTOR EQUATES

                        PAGE
                    C   INCLUDE SYSDATA.INC
                    C   ;--------------------------------------------------------------------------------
                    C   ;       PROTECTED MODE EQUATES FOR POST TESTS AND BIOS ROUTINES                  :
                    C   ;--------------------------------------------------------------------------------
                    C
                    C   ;-----         LENGTH EQUATES FOR PROTECTED MODE TESTS
                    C
= 0300              C   SDA_LEN         EQU     00300H          ; SYSTEM DATA AREA LENGTH
= 0800              C   SYS_IDT_LEN     EQU     256*8           ; 256 SYSTEM IDT ENTRIES, 8 BYTES EACH
= 0088              C   GDT_LEN         EQU     TYPE GDT_DEF    ; GDT STRUCTURE LENGTH
= 0008              C   DESC_LEN        EQU     TYPE DATA_DESC  ; LENGTH OF A DESCRIPTOR
= 1000              C   MCRT_SIZE       EQU     4*1024          ; MONOCHROME CRT SIZE
= 4000              C   CCRT_SIZE       EQU     16*1024         ; COMPATIBLE COLOR CRT SIZE
= FFFF              C   ECCRT_SIZE      EQU     0FFFFH          ; SIZE OF EACH PORTION OF THE ENHANCED
= FFFF              C   MAX_SEG_LEN     EQU     0FFFFH          ; MAXIMUM SEGMENT LENGTH = 64K
= 0000              C   NULL_SEG_LEN    EQU     00000H          ; NULL SEGMENT LENGTH = 0
                    C
                    C   ;-----         LOCATION EQUATES FOR PROTECTED MODE TESTS
                    C
= D0A0              C   SYS_IDT_LOC     EQU     0D0A0H          ; THE SYSTEM IDT IS AT THE BOTTOM
= 0400              C   SDA_LOC         EQU     00400H          ; SAME AS REAL
= D8A0              C   GDT_LOC         EQU     (SYS_IDT_LOC + SYS_IDT_LEN)
= 0000              C   MCRT@_LO        EQU     0000H           ; MONOCHROME CRT ADDRESS
= 000B              C   MCRT@_HI        EQU     0BH             ; (0B0000H)
= 8000              C   CCRT@_LO        EQU     8000H           ; COMPATIBLE COLOR CRT ADDRESS
= 000B              C   CCRT@_HI        EQU     0BH             ; (0B8000H)
= 0000              C   ECCRT@_LO_LO    EQU     0000H
= 000A              C   ECCRT@_LO_HI    EQU     0AH             ; (0A0000H)
= 0000              C   ECCRT@_HI_LO    EQU     0000H
= 000B              C   ECCRT@_HI_HI    EQU     0BH             ; (0B0000H)
= 0000              C   CSEG@_LO        EQU     0000H           ; CODE SEGMENT POST/BIOS
= 000F              C   CSEG@_HI        EQU     0FH             ; (0F0000H) FOR TESTS
= 0000              C   NSEG@_LO        EQU     0000H           ; ABS0
= 0000              C   NSEG@_HI        EQU     00H
                    C
                    C   ;-----  DEFINITIONS FOR ACCESS RIGHTS BYTES
                    C
= 00F3              C   CPL3_DATA_ACCESS        EQU     11110011B       ; PRESENT
                    C                                                   ; DPL = 3
                    C                                                   ; CODE/DATA SEGMENT
                    C                                                   ; NOT EXECUTABLE
                    C                                                   ; GROW-UP (OFFSET <= LIMIT)
                    C                                                   ; WRITABLE
                    C                                                   ; ACCESSED
= 0093              C   CPL0_DATA_ACCESS        EQU     10010011B       ; DPL = 0
= 009B              C   CPL0_CODE_ACCESS        EQU     10011011B       ; CPL 0 - NON-CONFORMING
= 00E2              C   LDT_DESC                EQU     11100010B
= 0081              C   FREE_TSS                EQU     10000001B
= 0086              C   INT_GATE                EQU     10000110B
= 0087              C   TRAP_GATE               EQU     10000111B
                    C
= 0001              C   VIRTUAL_ENABLE          EQU     0000000000000001B       ; PROTECTED MODE ENABLE
                    C
                    C
                    C   ;-----  THE GLOBAL DESCRIPTOR TABLE DEFINITION FOR POWER ON SELF TESTS
                    C
                    C   GDT_DEF             STRUC
0000 ???????????????? C   GDT_NULL            DQ      ?               ; UNUSED ENTRY
0008 ???????????????? C   GDT_PTR             DQ      ?               ; THIS ENTRY POINTS TO THIS TABLE
0010 ???????????????? C   SYS_IDT_PTR         DQ      ?               ; POST INTERRUPT DESCRIPTOR TABLE
0018 ???????????????? C   RSDA_PTR            DQ      ?               ; THE REAL SYSTEM DATA AREA FOR POST
0020 ???????????????? C   C_BWCRT_PTR         DQ      ?               ; COMPATIBLE BW CRT FOR POST
0028 ???????????????? C   C_CCRT_PTR          DQ      ?               ; COMPATIBLE COLOR CRT FOR POST
0030 ???????????????? C   E_CCRT_PTR          DQ      ?               ; ENHANCED COLOR GRAPHICS CRT (16 BYTES)
0038 ???????????????? C   E_CCRT_PTR2         DQ      ?
0040 ???????????????? C   SYS_ROM_CS          DQ      ?               ; CS - POST IDT, ROM RESIDENT
0048 ???????????????? C   ES_TEMP             DQ      ?               ; DYNAMIC POINTER FOR ES
0050 ???????????????? C   CS_TEMP             DQ      ?               ; DYNAMIC POINTER FOR CS
0058 ???????????????? C   SS_TEMP             DQ      ?               ; DYNAMIC POINTER FOR SS
0060 ???????????????? C   DS_TEMP             DQ      ?               ; DYNAMIC POINTER FOR DS
0068 ???????????????? C   POST_TR             DQ      ?               ; TR VALUE FOR THIS MACHINE'S TSS
0070 ???????????????? C   POST_TSS_PTR        DQ      ?
0078 ???????????????? C   POST_LDTR          DQ      ?               ; LDTR VALUE FOR THIS MACHINE'S LDT
0080 ???????????????? C   POST_LDT_PTR        DQ      ?
0088                C   GDT_DEF             ENDS
                    C
                    C   ;-----  SEGMENT DESCRIPTOR TABLE ENTRY STRUCTURE
                    C
                    C   DATA_DESC           STRUC
0000 ????           C   SEG_LIMIT           DW      ?               ; SEGMENT LIMIT (1 - 65535 BYTES)
0002 ????           C   BASE_LO_WORD        DW      ?               ; 24 BIT SEGMENT PHYSICAL
0004 ??             C   BASE_HI_BYTE        DB      ?               ;       ADDRESS (0 - (16M-1))
0005 ??             C   DATA_ACC_RIGHTS     DB      ?               ; ACCESS RIGHTS BYTE
0006 ????           C   DATA_RESERVED       DW      ?               ; RESERVED - MUST BE 0000 FOR THE 80286
0008                C   DATA_DESC           ENDS
                    C
                    C   ;-----  GATE DESCRIPTOR TABLE ENTRY STRUCTURE
                    C
                    C   GATE_DESC           STRUC
0000 ????           C   ENTRY_POINT         DW      ?               ; DESTINATION ROUTINE ENTRY POINT
0002 ????           C   CS_SELECTOR         DW      ?               ; SELECTOR FOR DESTINATION SEGMENT
0004 ??             C   WORD_COUNT          DB      ?               ; NUMBER OF WORDS TO COPY FROM STACK
0005 ??             C   GATE_ACC_RIGHTS     DB      ?               ; ACCESS RIGHTS BYTE
0006 ????           C   GATE_RESERVED       DW      ?               ; RESERVED - MUST BE 0000 FOR THE 80286
0008                C   GATE_DESC           ENDS

                        .LIST
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                        PAGE
0000                    CODE    SEGMENT WORD PUBLIC

                                PUBLIC  C8042
                                PUBLIC  OBF_42
                                PUBLIC  POST1
                                PUBLIC  START_1

                                EXTRN   CMOS_READ:NEAR
                                EXTRN   CMOS_WRITE:NEAR
                                EXTRN   CONFTG_BAD:NEAR
                                EXTRN   D11:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   DUMMY_RETURN:NEAR
                                EXTRN   ERR_BEEP:NEAR
                                EXTRN   GATE_A20:NEAR
                                EXTRN   KBD_RESET:NEAR
                                EXTRN   NMI_INT:NEAR
                                EXTRN   POST2:NEAR
                                EXTRN   PRINT_SCREEN:NEAR
                                EXTRN   PROC_SHUTDOWN:NEAR
                                EXTRN   ROM_CHECK:NEAR
                                EXTRN   SHUT2:NEAR
                                EXTRN   SHUT3:NEAR
                                EXTRN   SHUT4:NEAR
                                EXTRN   SHUT6:NEAR
                                EXTRN   SHUT7:NEAR
                                EXTRN   SHUT9:NEAR
                                EXTRN   SLAVE_VECTOR_TABLE:NEAR
                                EXTRN   STGTST_CNT:NEAR
                                EXTRN   SYSINIT1:NEAR
                                EXTRN   VECTOR_TABLE:NEAR
                                EXTRN   VIDEO_PARMS:BYTE

                                ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

0000                    POST1   PROC    NEAR

= 0000                  BEGIN   EQU     $
0000 36 34 38 30 30 39          DB      '6480090COPR. IBM CORP. 1981,1985  '           ;COPYRIGHT NOTICE
     30 43 4F 50 52 2E
     20 49 42 4D 20 43
     4F 52 50 2E 20 31
     39 38 31 2C 31 39
     38 35 20 20

                                EVEN                                                    ;EVEN BOUNDARY
                                ;        6 4 8 0 0 9 0   C O P R .   I B M   1 9 8 5   ;EVEN MODULE
                                ;          6 4 8 0 0 9 1   C O P R .   I B M   1 9 8 5 ;ODD  MODULE
0022 36 36 34 34 38 38          DB      '66448800009901  CCOOPPRR..  IIBBMM  11998855' ;COPYRIGHT NOTICE
     30 30 30 30 39 39
     30 31 20 20 43 43
     4F 4F 50 50 52 52
     2E 2E 20 20 49 49
     42 42 4D 4D 20 20
     31 31 39 39 38 38
     35 35
004E 20 20                      DB      '  '                                            ;PAD

                        ;-----------------------------------------
                        ;       INITIAL RELIABILITY TESTS -- (POST1)    :
                        ;-----------------------------------------

                        ;-----------------------------------------
                        ; TEST.01                                :
                        ;       80286 PROCESSOR TEST (REAL MODE) :
                        ; DESCRIPTION                           :
                        ;       VERIFY FLAGS, REGISTERS         :
                        ;       AND CONDITIONAL JUMPS.          :
                        ;-----------------------------------------

                                ASSUME  DS:DATA

0050                    START_1:
0050 FA                         CLI                             ; DISABLE INTERRUPTS
0051 B8 D58D                    MOV     AX,0D500H+CMOS_REG_D+NMI; FLAG MASK IN (AH) AND NMI MASK IN (AL)
0054 E6 70                      OUT     CMOS_PORT,AL            ; DISABLE NMI INTERRUPTS
0056 9E                         SAHF                            ; SET "SF" "ZF" "AF" "PF" "CF" FLAGS ON
0057 73 27                      JNC     ERR02                   ; GO TO ERROR ROUTINE IF "CF" NOT SET
0059 75 25                      JNZ     ERR02                   ; GO TO ERROR ROUTINE IF "ZF" NOT SET
005B 7B 23                      JNP     ERR02                   ; GO TO ERROR ROUTINE IF "PF" NOT SET
005D 79 21                      JNS     ERR02                   ; GO TO ERROR ROUTINE IF "SF" NOT SET
005F 9F                         LAHF                            ; LOAD FLAG IMAGE TO (AH)
0060 B1 05                      MOV     CL,5                    ; LOAD COUNT REGISTER WITH SHIFT COUNT
0062 D2 EC                      SHR     AH,CL                   ; SHIFT "AF" INTO CARRY BIT POSITION
0064 73 1A                      JNC     ERR02                   ; GO TO ERROR ROUTINE IF "AF" NOT SET
0066 B0 40                      MOV     AL,40H                  ; SET THE "OF" FLAG ON
0068 D0 E0                      SHL     AL,1                    ; SETUP FOR TESTING
006A 71 14                      JNO     ERR02                   ; GO TO ERROR ROUTINE IF "OF" NOT SET
006C 32 E4                      XOR     AH,AH                   ; SET (AH) = 0
006E 9E                         SAHF                            ; CLEAR "SF", "CF", "ZF", AND "PF"
006F 76 0F                      JBE     ERR02                   ; GO TO ERROR ROUTINE IF "CF" ON
                                                                ; GO TO ERROR ROUTINE IF "ZF" ON
0071 78 0D                      JS      ERR02                   ; GO TO ERROR ROUTINE IF "SF" ON
0073 7A 0B                      JP      ERR02                   ; GO TO ERROR ROUTINE IF "PF" ON
0075 9F                         LAHF                            ; LOAD FLAG IMAGE TO (AH)
0076 D2 EC                      SHR     AH,CL                   ; SHIFT "AF" INTO CARRY BIT POSITION
0078 72 06                      JC      ERR02                   ; GO TO ERROR ROUTINE IF ON
007A D0 E4                      SHL     AH,1                    ; CHECK THAT "OF" IS CLEAR
007C 70 02                      JO      ERR02                   ; GO TO ERROR ROUTINE IF ON
007E 74 03                      JZ      C7A                     ; CONTINUE CONFIDENCE TESTS IF "ZF" SET
0080                    ERR02:
0080 F4                         HLT                             ;       ERROR HALT
0081 EB FD                      JMP     ERR02                   ; ERROR LOOP TRAP

0083                    C7A:
0083 B8 ---- R                  MOV     AX,DATA                 ; SET DATA SEGMENT
0086 8E D8                      MOV     DS,AX                   ; INTO THE (DS) SEGMENT REGISTER

                        ;-----  CHECK FOR PROCESSOR SHUTDOWN

0088 E4 64                      IN      AL,STATUS_PORT          ; READ CURRENT KEYBOARD PROCESSOR STATUS
008A A8 04                      TEST    AL,SYS_FLAG             ; CHECK FOR SHUTDOWN IN PROCESS FLAG
008C 75 03                      JNZ     C7B                     ; GO IF YES
008E E9 0123 R                  JMP     SHUT0                   ; ELSE CONTINUE NORMAL POWER ON CODE
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                        PAGE
                        ;-----  CHECK FOR SHUTDOWN 09
0091                    C7B:
0091 B0 8F                      MOV     AL,CMOS_SHUT_DOWN+NMI   ; CMOS ADDRESS FOR SHUTDOWN BYTE
0093 E6 70                      OUT     CMOS_PORT,AL
0095 EB 00                      JMP     $+2                     ; I/O DELAY
0097 E4 71                      IN      AL,CMOS_DATA            ; GET REQUEST NUMBER
0099 3C 09                      CMP     AL,09H                  ; WAS IT SHUTDOWN REQUEST 9?
009B 86 C4                      XCHG    AL,AH                   ; SAVE THE SHUTDOWN REQUEST
009D 74 41                      JE      C7C                     ; BYPASS INITIALIZING INTERRUPT CHIPS

                        ;-----  CHECK FOR SHUTDOWN 0A

009F 80 FC 0A                   CMP     AH,0AH                  ; WAS IT SHUTDOWN REQUEST A?
00A2 74 3C                      JE      C7C                     ; BYPASS INITIALIZING INTERRUPT CHIPS

00A4 2A C0                      SUB     AL,AL                   ; INSURE MATH PROCESSOR RESET
00A6 E6 F1                      OUT     X287+1,AL

                        ;--------------------------------------------------------
                        ;    RE-INITIALIZE THE 8259 INTERRUPT #1 CONTROLLER CHIP :
                        ;--------------------------------------------------------
00A8 B0 11                      MOV     AL,11H                  ; ICW1 - EDGE, MASTER, ICW4
00AA E6 20                      OUT     INTA00,AL
00AC EB 00                      JMP     $+2                     ; WAIT STATE FOR I/O
00AE B0 08                      MOV     AL,08H                  ; SETUP ICW2 - INTERRUPT TYPE 8H (8-F)
00B0 E6 21                      OUT     INTA01,AL
00B2 EB 00                      JMP     $+2                     ; WAIT STATE FOR I/O
00B4 B0 04                      MOV     AL,04H                  ; SETUP ICW3 - MASTER LEVEL 2
00B6 E6 21                      OUT     INTA01,AL               ;
00B8 EB 00                      JMP     $+2                     ; I/O WAIT STATE
00BA B0 01                      MOV     AL,01H                  ; SETUP ICW4 - MASTER,8086 MODE
00BC E6 21                      OUT     INTA01,AL               ;
00BE EB 00                      JMP     $+2                     ; WAIT STATE FOR I/O
00C0 B0 FF                      MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
00C2 E6 21                      OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTERRUPTS)
                        ;--------------------------------------------------------
                        ;    RE-INITIALIZE THE 8259 INTERRUPT #2 CONTROLLER CHIP :
                        ;--------------------------------------------------------
00C4 B0 11                      MOV     AL,11H                  ; ICW1 - EDGE, SLAVE ICW4
00C6 E6 A0                      OUT     INTB00,AL
00C8 EB 00                      JMP     $+2                     ; WAIT STATE FOR I/O
00CA B0 70                      MOV     AL,INT_TYPE             ; SETUP ICW2 - INTERRUPT TYPE 70 (70-7F)
00CC E6 A1                      OUT     INTB01,AL
00CE B0 02                      MOV     AL,02H                  ; SETUP ICW3 - SLAVE LEVEL 2
00D0 EB 00                      JMP     $+2
00D2 E6 A1                      OUT     INTB01,AL
00D4 EB 00                      JMP     $+2                     ; I/O DELAY
00D6 B0 01                      MOV     AL,01H                  ; SETUP ICW4 - 8086 MODE, SLAVE
00D8 E6 A1                      OUT     INTB01,AL
00DA EB 00                      JMP     $+2                     ; WAIT STATE FOR I/O
00DC B0 FF                      MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
00DE E6 A1                      OUT     INTB01,AL
                        ;--------------------------------------------------------------------------------
                        ;  SHUTDOWN - RESTART                                                            :
                        ;       RETURN CONTROL AFTER A SHUTDOWN COMMAND IS ISSUED                        :
                        ;  DESCRIPTION                                                                   :
                        ;       A TEST IS MADE FOR THE SYSTEM FLAG BEING SET.  IF THE SYSTEM FLAG IS     :
                        ;       SET, THE SHUTDOWN BYTE IN CMOS IS USED TO DETERMINE WHERE CONTROL IS     :
                        ;       RETURNED.                                                                :
                        ;                                                                                :
                        ;       CMOS = 0   SOFT RESET OR UNEXPECTED SHUTDOWN                             :
                        ;       CMOS = 1   SHUT DOWN AFTER MEMORY SIZE                                   :
                        ;       CMOS = 2   SHUT DOWN AFTER MEMORY TEST                                   :
                        ;       CMOS = 3   SHUT DOWN WITH MEMORY ERROR                                   :
                        ;       CMOS = 4   SHUT DOWN WITH BOOT LOADER REQUEST                            :
                        ;       CMOS = 5   JMP DWORD REQUEST - (INTERRUPT CHIPS & 287 ARE INITIALIZED)   :
                        ;       CMOS = 6   PROTECTED MODE TEST3 PASSED                                   :
                        ;       CMOS = 7   PROTECTED MODE TEST3 FAILED                                   :
                        ;       CMOS = 8   PROTECTED MODE TEST1 FAILED                                   :
                        ;       CMOS = 9   BLOCK MOVE SHUTDOWN REQUEST                                   :
                        ;       CMOS = A   JMP DWORD REQUEST - (W/O INTERRUPT CHIPS INITIALIZED)         :
                        ;                                                                                :
                        ;          NOTES:  RETURNS ARE MADE WITH INTERRUPTS AND NMI DISABLED.            :
                        ;                  USER MUST RESTORE SS:SP (POST DEFAULT SET = 0030:0400),       :
                        ;                  ENABLE NON-MASKABLE INTERRUPTS (NMI) WITH AN OUT TO           :
                        ;                  PORT 70H WITH HIGH ORDER BIT OFF, AND THEN ISSUE A            :
                        ;                  STI TO ENABLE INTERRUPTS.  FOR SHUTDOWN (5) THE USER          :
                        ;                  MUST ALSO RESTORE THE INTERRUPT MASK REGISTERS.                :
                        ;--------------------------------------------------------------------------------

                        ;-----  CHECK FROM WHERE
00E0                    C7C:
00E0 B0 8F                      MOV     AL,CMOS_SHUT_DOWN+NMI   ; CLEAR CMOS BYTE
00E2 E6 70                      OUT     CMOS_PORT,AL
00E4 90                         NOP                             ; I/O DELAY
00E5 2A C0                      SUB     AL,AL                   ; SET BYTE TO 0
00E7 E6 71                      OUT     CMOS_DATA,AL
00E9 86 E0                      XCHG    AH,AL
00EB 3C 0A                      CMP     AL,0AH                  ; COMPARE WITH MAXIMUM TABLE ENTRIES
00ED 77 34                      JA      SHUT0                   ; SKIP TO POST IF GREATER THAN MAXIMUM
00EF BE 0103 R                  MOV     SI,OFFSET BRANCH        ; POINT TO THE START OF THE BRANCH TABLE
00F2 03 F0                      ADD     SI,AX
00F4 03 F0                      ADD     SI,AX                   ; POINT TO BRANCH ADDRESS
00F6 2E: 8B 1C                  MOV     BX,CS:[SI]              ; MOVE BRANCH TO ADDRESS TO BX REGISTER

                        ;-----  SET TEMPORARY STACK FOR POST

00F9 B8 ---- R                  MOV     AX,ABS0                 ; SET STACK SEGMENT TO ABS0 SEGMENT
00FC 8E D0                      MOV     SS,AX
00FE BC 0400 R                  MOV     SP,OFFSET @TOS          ; SET STACK POINTER TO END OF VECTORS
0101 FF E3                      JMP     BX                      ; JUMP BACK TO RETURN ROUTINE

0103 0123 R             BRANCH: DW      SHUT0                   ; NORMAL POWER UP/UNEXPECTED SHUTDOWN
0105 0990 R                     DW      SHUT1                   ; SHUT DOWN AFTER MEMORY SIZE
0107 0000 E                     DW      SHUT2                   ; SHUT DOWN AFTER MEMORY TEST
0109 0000 E                     DW      SHUT3                   ; SHUT DOWN WITH MEMORY ERROR
010B 0000 E                     DW      SHUT4                   ; SHUT DOWN WITH BOOT_LOADER REQUEST
010D 0119 R                     DW      SHUT5                   ; JMP DWORD REQUEST WITH INTERRUPT INIT
010F 0000 E                     DW      SHUT6                   ; PROTECTED MODE TEST7 PASSED
0111 0000 E                     DW      SHUT7                   ; PROTECTED MODE TEST7 FAILED
0113 0793 R                     DW      SHUT8                   ; PROTECTED MODE TEST1 FAILED
0115 0000 E                     DW      SHUT9                   ; BLOCK MOVE SHUTDOWN REQUEST
0117 011F R                     DW      SHUTA                   ; JMP DWORD REQUEST (W/O INTERRUPT INIT)
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                        PAGE
                        ;-----  @IO_ROM_INIT MUST BE INITIALIZED BY THE USER FOR VECTORED REQUESTS
                        SHUT5:
                                IN      AL,PORT_A               ; FLUSH THE KEYBOARD BUFFER
                                MOV     AL,EOI                  ; FLUSH LAST TIMER REQUEST IF PENDING
                                OUT     INTA00,AL               ;  - TO ALLOW TIMER INTERRUPTS
                        SHUTA:
                                JMP     DWORD PTR @IO_ROM_INIT  ; FAR JUMP TO USER DEFINED LOCATION
                                                                ;  AFTER SHUTDOWN TO REAL MODE CODE
                                                                ;  WITH INTERRUPTS AND NMI DISABLED
                        ;-----  CHECKPOINT 01
                        SHUT0:
                                MOV     AL,01H                  ;       <><><><><><><><><><><>
                                OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  01 <><>
                        ;-----  READ/WRITE/TEST THE 80286 REGISTERS WITH ONE'S AND ZERO'S
                                MOV     AX,0FFFFH               ; SETUP ONE'S PATTERN IN (AX)
                                STC                             ; SET CARRY FLAG
                                JNC     ERR01                   ; GO IF NO CARRY
                        C8:
                                MOV     DS,AX                   ; WRITE PATTERN TO ALL REGISTERS
                                MOV     BX,DS
                                MOV     ES,BX
                                MOV     CX,ES
                                MOV     SS,CX
                                MOV     DX,SS
                                MOV     SP,DX
                                MOV     BP,SP
                                MOV     SI,BP
                                MOV     DI,SI
                                JNC     C9
                                XOR     AX,DI                   ; PATTERN MAKE IT THROUGH ALL REGISTERS
                                JNZ     ERR01                   ; NO - GO TO ERROR ROUTINE
                                CLC                             ; CLEAR CARRY FLAG
                                JMP     C8
                        C9:                                     ; TSTIA
                                OR      AX,DI                   ; ZERO PATTERN MAKE IT THROUGH ?
                                JZ      C10A                    ; YES - GO TO NEXT TEST
                        ERR01:
                                HLT                             ; HALT SYSTEM

                        ;-----  INSURE THAT CMOS CLOCK INTERRUPTS ARE DISABLED
                        C10A:
                                MOV     AX,X*(CMOS_REG_B+NMI)   ; ADDRESS TO BOTH (AH) AND (AL)
                                OUT     CMOS_PORT,AL            ; ADDRESS CMOS ALARM BYTE WITH NMI=OFF
                                NOP                             ; I/O DELAY
                                IN      AL,CMOS_DATA            ; GET THE CURRENT CONTROL REGISTER
                                AND     AL,00000111B            ; CLEAR SET,PIE,AIE, AND SQWE BITS
                                XCHG    AL,AH                   ; SAVE IT
                                OUT     CMOS_PORT,AL
                                XCHG    AL,AH
                                OUT     CMOS_DATA,AL

                                MOV     AL,CMOS_REG_C+NMI       ; ADDRESS CMOS FLAGS BYTE WITH NMI=OFF
                                NOP                             ; I/O DELAY
                                OUT     CMOS_PORT,AL
                                NOP                             ; I/O DELAY
                                IN      AL,CMOS_DATA            ; READ STATUS TO CLEAR PENDING INTERRUPT

                        ;-----  RESET VIDEO

                                MOV     AL,0                    ; CLEAR DATA BYTE TO DISABLE VIDEO
                                MOV     DX,03D8H                ; GET COLOR MODE CONTROL PORT ADDRESS
                                OUT     DX,AL                   ; DISABLE COLOR VIDEO
                                INC     AL                      ; MONOCHROME MODE RESET MASK
                                MOV     DL,0B8H                 ; GET ADDRESS OF MONOCHROME MODE CONTROL
                                OUT     DX,AL                   ; DISABLE B/W VIDEO, ENABLE HIGH RES
                                MOV     DL,0BAH                 ; ADDRESS OF MONOCHROME STATUS REGISTER
                                IN      AL,DX                   ; READ STATUS TO DISABLE EGA VIDEO
                                MOV     DL,0DAH                 ; ADDRESS OF COLOR MODE STATUS REGISTER
                                IN      AL,DX                   ; READ STATUS TO DISABLE EGA VIDEO
                                MOV     AL,0                    ; SELECT ATTRIBUTE PALETTE REGISTER 0
                                MOV     DL,0C0H                 ; WRITE 0 TO ATTRIBUTE ADDRESS REGISTER
                                OUT     DX,AL                   ; TO DISABLE EGA VIDEO
                                MOV     AL,11111100B            ; DISABLE PARITY CHECKERS
                                OUT     PORT_B,AL

                        ;--------------------------------------
                        ; TEST.02                              :
                        ;       ROM CHECKSUM TEST 1            :
                        ; DESCRIPTION                          :
                        ;       A CHECKSUM IS DONE FOR THE 32K :
                        ;       READ ONLY MEMORY MODULES (TWO) :
                        ;       CONTAINING POST, BASIC AND BIOS.:
                        ;--------------------------------------

                        ;-----  CHECKPOINT 02

                                MOV     AL,02H                  ;       <><><><><><><><><><><>
                                OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  02 <><>

                                ASSUME  SS:CODE
                                MOV     AX,CS                   ; SETUP SS SEGMENT REGISTER
                                MOV     SS,AX
                                MOV     DS,AX                   ; SET UP DATA SEGMENT TO POINT TO
                                XOR     SI,SI                   ; ROM ADDRESS START
                                XOR     BX,BX                   ; CLEAR CHECK REGISTER
                                MOV     CH,080H                 ; COUNT FOR 32K WORDS
                        C11:
                                LODSW                           ; MOVE TWO BYTES INTO AX -- SI=SI+2
                                ADD     BL,AH                   ; ADD ODD BYTE AT DS:SI+1 TO CHECKSUM
                                ADD     BL,AL                   ; ADD EVEN BYTE AT DS:SI TO CHECKSUM
                                LOOP    C11                     ; LOOP COUNT FOR 65K BYTES (32K WORDS)
                                JNC     C11E                    ;  EXIT IF "LOOP" RESET THE CARRY FLAG
                                                                ;  (NOTE: MODEL BYTE MUST NOT = ZERO)
                                JZ      C11A                    ; CONTINUE IF CHECKSUM VALID (ZERO)
                        C11E:
                                HLT                             ; ELSE HALT IF CHECKSUM PROBLEM
                        ;--------------------------------------
                        ; TEST.03                              :
                        ;       VERIFY CMOS SHUTDOWN BYTE      :
```

```
                        ; DESCRIPTION                          :
                        ;       ROLLING BIT WRITTEN AND        :
                        ;       VERIFIED AT SHUTDOWN ADDRESS.  :
                        ;---------------------------------------

                        ;-----  VERIFY AND CLEAR SHUTDOWN FLAG
019F                    C11A:
019F B0 03                      MOV     AL,03H                  ;       <><><><><><><><><>
01A1 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  03 <><>

01A3 B9 0009                    MOV     CX,09H                  ; LOOP COUNT
01A6 B4 01                      MOV     AH,1                    ; START WITH BIT 0
01A8                    C11B:
01A8 B0 8F                      MOV     AL,CMOS_SHUT_DOWN+NMI
01AA E6 70                      OUT     CMOS_PORT,AL
01AC 8A C4                      MOV     AL,AH                   ; OUTPUT ROLLING BIT
01AE E6 71                      OUT     CMOS_DATA,AL
01B0 B0 8F                      MOV     AL,CMOS_SHUT_DOWN+NMI   ; READ CMOS
01B2 90                         NOP                             ; I/O DELAY
01B3 E6 70                      OUT     CMOS_PORT,AL
01B5 90                         NOP                             ; I/O DELAY
01B6 E4 71                      IN      AL,CMOS_DATA
01B8 3A C4                      CMP     AL,AH                   ; MUST BE THE SAME
01BA 75 92                      JNZ     ERR01                   ; ERROR IF NOT
01BC D0 D4                      RCL     AH,1                    ; ROLL A BIT THROUGH SHUTDOWN BYTE
01BE E2 E8                      LOOP    C11B                    ; LOOP TILL DONE

                        ;---------------------------------------
                        ; TEST.04                              :
                        ;       8254 CHECK TIMER 1 ALL BITS ON :
                        ; DESCRIPTION                          :
                        ;       SET TIMER COUNT                :
                        ;       CHECK THAT TIMER 1 ALL BITS ON :
                        ;---------------------------------------

                                ASSUME  DS:DATA
01C0 B8 ---- R                  MOV     AX,DATA                 ; SET DATA SEGMENT
01C3 8E D8                      MOV     DS,AX
01C5 B0 04                      MOV     AL,04H                  ;       <><><><><><><><><>
01C7 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  04 <><>

                        ;-----  DISABLE DMA CONTROLLER
                                                                ; (AL) ALREADY = 04H
01C9 E6 08                      OUT     DMA08,AL                ; DISABLE DMA CONTROLLER 1
01CB E6 D0                      OUT     DMA18,AL                ; DISABLE DMA CONTROLLER 2

                        ;-----  VERIFY THAT TIMER 1 FUNCTIONS OK

01CD 8B 16 0072 R               MOV     DX,@RESET_FLAG          ; SAVE RESET FLAG WHILE REFRESH IS OFF
01D1 B0 54                      MOV     AL,54H                  ; SELECT TIMER 1,LSB,MODE 2
01D3 E6 43                      OUT     TIMER+3,AL
01D5 EB 00                      JMP     $+2                     ; I/O DELAY
01D7 8A C1                      MOV     AL,CL                   ; SET INITIAL TIMER COUNT TO 0
01D9 E6 41                      OUT     TIMER+1,AL
01DB B7 05                      MOV     BH,05H                  ; LOOP COUNT
01DD                    C12:                                    ; TIMER1_BITS_ON
01DD B0 40                      MOV     AL,40H                  ; LATCH TIMER 1 COUNT
01DF EB 00                      JMP     $+2                     ; I/O DELAY
01E1 E6 43                      OUT     TIMER+3,AL
01E3 80 FB FF                   CMP     BL,0FFH                 ; YES - SEE IF ALL BITS GO OFF
01E6 74 0B                      JE      C13                     ; TIMER1_BITS_OFF
01E8 E4 41                      IN      AL,TIMER+1              ; READ TIMER 1 COUNT
01EA 0A D8                      OR      BL,AL                   ; ALL BITS ON IN TIMER
01EC E2 EF                      LOOP    C12                     ; TIMER1_BITS_ON
01EE FE CF                      DEC     BH
01F0 75 EB                      JNZ     C12                     ; TRY AGAIN
01F2 F4                         HLT                             ; TIMER 1 FAILURE, HALT SYSTEM
                                                                ; TIMER1_BITS_OFF
                        ;---------------------------------------
                        ; TEST.05                              :
                        ;       8254 CHECK TIMER 1 ALL BIT OFF :
                        ; DESCRIPTION                          :
                        ;       SET TIMER COUNT                :
                        ;       CHECK THAT TIMER 1 ALL BITS OFF :
                        ;---------------------------------------

                        ;-----  CHECKPOINT 05

01F3 B0 05              C13:    MOV     AL,05H                  ;       <><><><><><><><><>
01F5 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  05 <><>

01F7 8A C3                      MOV     AL,BL                   ; SET TIMER 1 COUNT
01F9 2B C9                      SUB     CX,CX
01FB E6 41                      OUT     TIMER+1,AL
01FD B7 05                      MOV     BH,05H                  ; SET TRY AGAIN COUNT
01FF                    C14:                                    ; TIMER_LOOP
01FF B0 40                      MOV     AL,40H                  ; LATCH TIMER 1 COUNT
0201 E6 43                      OUT     TIMER+3,AL
0203 EB 00                      JMP     $+2                     ; DELAY FOR TIMER
0205 EB 00                      JMP     $+2                     ; ADDED DELAY FOR TIMER
0207 E4 41                      IN      AL,TIMER+1              ; READ TIMER 1 COUNT
0209 22 D8                      AND     BL,AL
020B 74 07                      JZ      C15                     ; GO TO WRAP DMA REGISTER TESTS
020D E2 F0                      LOOP    C14                     ; TIMER_LOOP
020F FE CF                      DEC     BH
0211 75 EC                      JNZ     C14
0213 F4                         HLT                             ; HALT SYSTEM

                        ;---------------------------------------
                        ; TEST.06                              :
                        ;       8237 DMA 0 INITIALIZATION      :
                        ;       CHANNEL REGISTER TEST          :
                        ; DESCRIPTION                          :
                        ;       DISABLE THE 8237 DMA CONTROLLER.:
                        ;       WRITE/READ THE CURRENT ADDRESS :
                        ;       AND WORD COUNT REGISTERS FOR   :
                        ;       ALL CHANNELS.                  :
                        ;---------------------------------------

                        ;-----  CHECKPOINT 06

0214                    C15:
0214 B8 ---- R                  MOV     AX,DATA                 ; SET DATA SEGMENT
0217 8E D8                      MOV     DS,AX
0219 B0 06                      MOV     AL,06H                  ;       <><><><><><><><><>
```

```
                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  06 <><>
                        MOV     @RESET_FLAG,DX          ; RESTORE SOFT RESET FLAG
                        OUT     DMA+0DH,AL              ; SEND MASTER CLEAR TO DMA

                ;-----  WRAP DMA 0 CHANNEL ADDRESS AND COUNT REGISTERS

                        MOV     AL,0FFH                 ; WRITE PATTERN "FF" TO ALL REGISTERS
                C16:    MOV     BL,AL                   ; SAVE PATTERN FOR COMPARE
                        MOV     BH,AL
                        MOV     CX,8                    ; SETUP LOOP COUNT
                        MOV     DX,DMA                  ; SETUP I/O PORT ADDRESS OF REGISTER
                C17:    OUT     DX,AL                   ; WRITE PATTERN TO REGISTER, LSB
                        JMP     $+2                     ; I/O DELAY
                        OUT     DX,AL                   ; MSB OF 16 BIT REGISTER
                        MOV     AL,01H                  ; AL TO ANOTHER PATTERN BEFORE READ
                        JMP     $+2                     ; I/O DELAY
                        IN      AL,DX                   ; READ 16-BIT DMA CH REG, LSB  2ST DMA
                        JMP     $+2                     ; I/O DELAY
                        MOV     AH,AL                   ; SAVE LSB OF 16-BIT REGISTER
                        IN      AL,DX                   ; READ MSB OF DMA CHANNEL REGISTER
                        CMP     BX,AX                   ; PATTERN READ AS WRITTEN?
                        JE      C18                     ; YES - CHECK NEXT REGISTER
                        HLT                             ; NO - HALT THE SYSTEM
                C18:                                    ; NXT_DMA_CH
                        INC     DX                      ; SET I/O PORT TO NEXT CHANNEL REGISTER
                        LOOP    C17                     ; WRITE PATTERN TO NEXT REGISTER
                        INC     AL                      ; SET PATTERN TO 0
                        JZ      C16                     ; YES CONTINUE

                ;-----  WRITE DMA WITH 55 PATTERN

                        CMP     BL,055H                 ; CHECK IF "55" PATTERN DONE
                        JZ      C19                     ; GO IF YES
                        CMP     BL,0AAH                 ; CHECK IF "AA" PATTERN DONE
                        JZ      C20                     ; GO IF YES
                        MOV     AL,055H
                        JMP     C16

                ;-----  WRITE DMA WITH AA PATTERN

                C19:    MOV     AL,0AAH
                        JMP     C16

                ;----------------------------------------
                ; TEST.07                               :
                ;       8237 DMA 1 INITIALIZATION       :
                ;       CHANNEL REGISTER TEST           :
                ; DESCRIPTION                           :
                ;       DISABLE 8237 DMA CONTROLLER 1.  :
                ;       WRITE/READ THE CURRENT DMA 1    :
                ;       ADDRESS AND WORD COUNT          :
                ;       REGISTERS FOR ALL CHANNELS.     :
                ;----------------------------------------

                ;-----  CHECKPOINT 07 - DMA 1

                C20:    MOV     AL,07H                  ;       <><><><><><><><><><><><><>
                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  07 <><>
                        OUT     DMA1+0DH*2,AL           ; SEND MASTER CLEAR TO 2ND DMA

                ;-----  WRAP DMA 1 CHANNEL ADDRESS AND COUNT REGISTERS

                        MOV     AL,0FFH                 ; WRITE PATTERN FF TO ALL REGISTERS
                C16A:   MOV     BL,AL                   ; SAVE PATTERN FOR COMPARE
                        MOV     BH,AL
                        MOV     CX,8                    ; SETUP LOOP COUNT
                        MOV     DX,DMA1                 ; SETUP I/O PORT ADDRESS OF REGISTER
                C17A:   OUT     DX,AL                   ; WRITE PATTERN TO REGISTER, LSB
                        JMP     $+2                     ; I/O DELAY
                        OUT     DX,AL                   ; MSB OF 16 BIT REGISTER
                        MOV     AL,01H                  ; AL TO ANOTHER PAT BEFORE RD
                        JMP     $+2                     ; I/O DELAY
                        IN      AL,DX                   ; READ 16-BIT DMA CH REG, LSB  2ST DMA
                        JMP     $+2                     ; I/O DELAY
                        MOV     AH,AL                   ; SAVE LSB OF 16-BIT REGISTER
                        IN      AL,DX                   ; READ MSB OF DMA CH REGISTER
                        CMP     BX,AX                   ; PATTERN READ AS WRITTEN?
                        JE      C18A                    ; YES - CHECK NEXT REGISTER
                        HLT                             ; NO - HALT THE SYSTEM
                C18A:                                   ; NXT_DMA_CH
                        ADD     DX,2                    ; SET I/O PORT TO NEXT CHANNEL REGISTER
                        LOOP    C17A                    ; WRITE PATTERN TO NEXT REGISTER
                        INC     AL                      ; SET PATTERN TO 0
                        JZ      C16A                    ; YES CONTINUE

                ;-----  WRITE DMA WITH 55 PATTERN

                        CMP     BL,55H                  ; CHECK IF 55 PATTERN DONE
                        JZ      C20A                    ; GO IF YES
                        CMP     BL,0AAH                 ; CHECK IF AA PATTERN DONE
                        JZ      C21                     ; GO IF YES
                        MOV     AL,55H
                        JMP     C16A

                ;-----  WRITE DMA WITH AA PATTERN

                C20A:   MOV     AL,0AAH
                        JMP     C16A

                ;-----  INITIALIZE AND START MEMORY REFRESH

                C21:
                        MOV     BX,@RESET_FLAG          ; GET THE RESET FLAG
                        MOV     @EQUIP_FLAG,AX          ; DO A DUMMY MEMORY WRITE BEFORE REFRESH
                        MOV     AL,18                   ; START REFRESH TIMER
                        OUT     TIMER+1,AL

                ;-----  SET DMA COMMAND

                        SUB     AL,AL                   ; DACK SENSE LOW,DREQ SENSE HIGH
                        OUT     DMA+8,AL                ; LATE WRITE, FIXED PRIORITY, NORMAL
                                                        ; TIMING, CONTROLLER ENABLE, CH0 ADDRESS
                                                        ; HOLD DISABLE, MEMORY TO MEMORY DISABLE
                        OUT     DMA18,AL                ; SAME TO SECOND CONTROLLER
```

```
                        ;-----  MODE SET ALL DMA CHANNELS
02AC B0 40                      MOV     AL,40H                  ; SET MODE FOR CHANNEL 0
02AE E6 0B                      OUT     DMA+0BH,AL
02B0 B0 C0                      MOV     AL,0C0H                 ; SET CASCADE MODE ON CHANNEL 4
02B2 E6 D6                      OUT     DMA18+06H,AL
02B4 EB 00                      JMP     $+2                     ; I/O DELAY
02B6 B0 41                      MOV     AL,41H                  ; SET MODE FOR CHANNEL 1
02B8 E6 0B                      OUT     DMA+0BH,AL
02BA E6 D6                      OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 5
02BC EB 00                      JMP     $+2                     ; I/O DELAY
02BE B0 42                      MOV     AL,42H                  ; SET MODE FOR CHANNEL 2
02C0 E6 0B                      OUT     DMA+0BH,AL
02C2 E6 D6                      OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 6
02C4 EB 00                      JMP     $+2                     ; I/O DELAY
02C6 B0 43                      MOV     AL,43H                  ; SET MODE FOR CHANNEL 3
02C8 E6 0B                      OUT     DMA+0BH,AL
02CA E6 D6                      OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 7

                        ;-----  RESTORE RESET FLAG

02CC 89 1E 0072 R               MOV     @RESET_FLAG,BX

                        ;--------------------------------------
                        ; TEST.08                             :
                        ;       DMA PAGE REGISTER TEST        :
                        ; DESCRIPTION                        :
                        ;       WRITE/READ ALL PAGE REGISTERS :
                        ;--------------------------------------

                        ;-----  CHECKPOINT 08

02D0 B0 08                      MOV     AL,08H                  ;       <><><><><><><><><><>
02D2 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  08 <><>
02D4 2A C0                      SUB     AL,AL
02D6 BA 0081                    MOV     DX,DMA_PAGE
02D9 B9 00FF                    MOV     CX,0FFH                 ; DO ALL DATA PATTERNS
02DC EE                 C22A:   OUT     DX,AL
02DD 42                         INC     DX
02DE FE C0                      INC     AL
02E0 81 FA 008F                 CMP     DX,8FH                  ; TEST DMA PAGES 81 THROUGH 8EH
02E4 75 F6                      JNZ     C22A
02E6 86 E0                      XCHG    AH,AL                   ; SAVE CURRENT DATA PATTERN
02E8 FE CC                      DEC     AH                      ; CHECK LAST WRITTEN
02EA 4A                         DEC     DX                      ;
02EB 2A C0              C22B:   SUB     AL,AL                   ; CHANGE DATA BEFORE READ
02ED EC                         IN      AL,DX
02EE 3A C4                      CMP     AL,AH                   ; DATA AS WRITTEN?
02F0 75 30                      JNZ     C26                     ; GO ERROR HALT IF NOT
02F2 FE CC                      DEC     AH
02F4 4A                         DEC     DX
02F5 81 FA 0080                 CMP     DX,MFG_PORT             ; CONTINUE TILL PORT 80
02F9 75 F0                      JNZ     C22B
02FB FE C4                      INC     AH                      ; NEXT PATTERN TO RIPPLE
02FD 8A C4                      MOV     AL,AH
02FF E2 DB                      LOOP    C22A

                        ;-----  TEST LAST DMA PAGE REGISTER (USED FOR ADDRESS LINES DURING REFRESH)

0301 B0 CC                      MOV     AL,0CCH                 ; WRITE AN CC TO PAGE REGISTERS
0303 BA 008F            C22:    MOV     DX,LAST_DMA_PAGE
0306 8A E0                      MOV     AH,AL                   ; SAVE THE DATA PATTERN
0308 EE                         OUT     DX,AL                   ; OUTPUT PAGE REGISTER

                        ;-----  VERIFY PAGE REGISTER 8F

0309 2A C0                      SUB     AL,AL                   ; CHANGE DATA PATTERN BEFORE READ
030B EC                         IN      AL,DX                   ; GET THE DATA FROM PAGE REGISTER
030C 3A C4                      CMP     AL,AH
030E 75 12                      JNZ     C26                     ; GO IF ERROR
0310 80 FC CC                   CMP     AH,0CCH
0313 75 04                      JNZ     C25                     ; GO IF ERROR
0315 B0 33                      MOV     AL,033H                 ; SET UP DATA PATTERN OF 33
0317 EB EA                      JMP     C22                     ; DO DATA 33
0319                    C25:
0319 80 FC 00                   CMP     AH,0                    ; CHECK DONE
031C 74 05                      JZ      C27                     ; GO IF YES
031E 2A C0                      SUB     AL,AL                   ; SET UP FOR DATA PATTERN 00
0320 EB E1                      JMP     C22                     ; DO DATA 0

                        ;-----  ERROR HALT

0322                    C26:
0322 F4                         HLT                             ; HALT SYSTEM

                        ;--------------------------------------
                        ; TEST.09                             :
                        ;       STORAGE REFRESH TEST          :
                        ; DESCRIPTION                        :
                        ;       VERIFY REFRESH IS OCCURRING   :
                        ;--------------------------------------

                        ;-----  CHECKPOINT 09 - TEST MEMORY REFRESH

0323                    C27:
0323 B0 09                      MOV     AL,09H                  ;       <><><><><><><><><><>
0325 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  09 <><>
0327 2B C9                      SUB     CX,CX                   ;
0329                    C28:
0329 E4 61                      IN      AL,PORT_B               ; INSURE REFRESH BIT IS TOGGLING
032B A8 10                      TEST    AL,REFRESH_BIT
032D E1 FA                      LOOPZ   C28                     ; INSURE REFRESH IS OFF
032F E3 F1                      JCXZ    C26                     ; ERROR HALT IF TIMEOUT
0331                    C29:
0331 E4 61                      IN      AL,PORT_B
0333 A8 10                      TEST    AL,REFRESH_BIT          ; INSURE REFRESH IS ON
0335 E0 FA                      LOOPNZ  C29
0337 E3 E9                      JCXZ    C26                     ; ERROR HALT IF NO REFRESH BIT

                        ;--------------------------------------
                        ; TEST.10                             :
                        ;       8042 INTERFACE TEST           :
                        ;       READ CONFIGURATION JUMPERS    :
                        ; DESCRIPTION                        :
                        ;       ISSUE A SELF TEST TO THE 8042. :
```

```
                        ;       INSURE A 55H IS RECEIVED.       :
                        ;       READ MANUFACTURING AND DISPLAY  :
                        ;       JUMPERS AND SAVE IN MFG_TEST.   :
                        ;---------------------------------------

                        ;-----  CHECKPOINT 0A

0339 B0 0A                      MOV     AL,0AH                  ;       <><><><><><><><><><>
033B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0A <><

                        ;-----  SOFT RESET (HANDLE ALL POSSIBLE CONDITIONS)

033D 2B C9                      SUB     CX,CX                   ; 100 MILLISECONDS FOR THIS LOOP
033F E4 64              TST1:   IN      AL,STATUS_PORT          ; CHECK FOR INPUT BUFFER FULL
0341 8A E0                      MOV     AH,AL
0343 F6 C4 01                   TEST    AH,OUT_BUF_FULL
0346 74 02                      JZ      TST2                    ; GO IF NOT
0348 E4 60                      IN      AL,PORT_A               ; FLUSH
034A F6 C4 02           TST2:   TEST    AH,INPT_BUF_FULL        ; IS THE OUTPUT BUFFER ALSO FULL?
034D E0 F0                      LOOPNZ  TST1                    ; TRY AGAIN
034F 74 01                      JZ      TST4                    ; CONTINUE IF OK

0351 F4                 ERR0:   HLT                             ; HALT SYSTEM IF BUFFER FULL

                        ;-----  ISSUE A RESET TO THE 8042

0352 B0 0B              TST4:   MOV     AL,0BH                  ;       <><><><><><><><><><>
0354 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0B <><

0356 B0 AA                      MOV     AL,SELF_TEST            ; SELF TEST COMMAND
0358 BC 03EE R                  MOV     SP,OFFSET C8042A        ; SET RETURN ADDRESS
035B EB 39                      JMP     SHORT C8042
035D A8 01              TST4_B: TEST    AL,OUT_BUF_FULL         ; IS THE OUTPUT BUFFER FULL?
035F 74 02                      JZ      TST4_A                  ; GO IF NOT
0361 E4 60                      IN      AL,PORT_A               ; FLUSH
0363 BC 03F0 R          TST4_A: MOV     SP,OFFSET OBF_42A       ; SET RETURN ADDRESS
0366 EB 3A                      JMP     SHORT OBF_42            ; GO WAIT FOR BUFFER
0368 E4 60              TST4_C: IN      AL,PORT_A               ; GET THE ENDING RESPONSE
036A 3C 55                      CMP     AL,55H

036C B0 0C                      MOV     AL,0CH                  ;       <><><><><><><><><><>
036E E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0C <><

0370 75 DF                      JNZ     ERR0                    ; GO IF NOT OK

                        ;-----  GET THE SWITCH SETTINGS

0372 B0 C0                      MOV     AL,READ_8042_INPUT      ; READ INPUT COMMAND
0374 BC 03F4 R                  MOV     SP,OFFSET C8042C        ; SET RETURN ADDRESS
0377 EB 1D                      JMP     SHORT C8042             ; ISSUE COMMAND
0379 BC 03F6 R          E30B:   MOV     SP,OFFSET OBF_42B       ; SET RETURN ADDRESS
037C EB 24                      JMP     SHORT OBF_42            ; GO WAIT FOR RESPONSE
037E E4 60              E30C:   IN      AL,PORT_A               ; GET THE SWITCH
0380 E6 82                      OUT     DMA_PAGE+1,AL           ; SAVE TEMPORARY

                        ;-----  WRITE BYTE 0 OF 8042 MEMORY

0382 B0 60                      MOV     AL,WRITE_8042_LOC       ; WRITE BYTE COMMAND
0384 BC 03F2 R                  MOV     SP,OFFSET C8042B        ; SET RETURN ADDRESS
0387 EB 0D                      JMP     SHORT C8042             ; ISSUE THE COMMAND
0389 74 05              TST4_D: JZ      TST4_D1                 ; CONTINUE IF COMMAND ACCEPTED

038B B0 0D                      MOV     AL,0DH                  ;       <><><><><><><><><><>
038D E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0D <><
038F F4                         HLT
0390                    TST4_D1:
0390 B0 5D                      MOV     AL,5DH                  ; ENABLE OUTPUT BUFFER FULL INTERRUPT,
0392 E6 60                      OUT     PORT_A,AL               ; DISABLE KEYBOARD, SET SYSTEM FLAG,
0394 EB 1D                      JMP     SHORT E30A              ; PC I COMPATIBILITY, INHIBIT OVERRIDE

                        ;-----  ISSUE THE COMMAND TO THE 8042

0396 FA                 C8042:  CLI                             ; NO INTERRUPTS ALLOWED
0397 E6 64                      OUT     STATUS_PORT,AL          ; SEND COMMAND IN AL REGISTER

0399 2B C9                      SUB     CX,CX                   ; LOOP COUNT
039B E4 64              C42_1:  IN      AL,STATUS_PORT          ; WAIT FOR THE COMMAND ACCEPTED
039D A8 02                      TEST    AL,INPT_BUF_FULL
039F E0 FA                      LOOPNZ  C42_1
03A1 C3                         RET

                        ;-----  WAIT FOR 8042 RESPONSE

03A2 2B C9              OBF_42: SUB     CX,CX
03A4 B3 06                      MOV     BL,6                    ; 200MS/PER LOOP * 6  =1200 MS +
03A6 E4 64              C42_2:  IN      AL,STATUS_PORT          ; CHECK FOR RESPONSE
03A8 A8 01                      TEST    AL,OUT_BUF_FULL
03AA 75 06                      JNZ     C42_3                   ; GO IF RESPONSE
03AC E2 F8                      LOOP    C42_2                   ; TRY AGAIN
03AE FE CB                      DEC     BL                      ; DECREMENT LOOP COUNT
03B0 75 F4                      JNZ     C42_2
03B2 C3                 C42_3:  RET                             ; RETURN TO CALLER

                        ;---------------------------------------
                        ; TEST.11                              :
                        ;       BASE 64K READ/WRITE MEMORY TEST :
                        ; DESCRIPTION                          :
                        ;       WRITE/READ/VERIFY DATA PATTERNS :
                        ;       AA,55,FF,01, AND 00 TO 1 ST 64K :
                        ;       OF STORAGE. VERIFY STORAGE      :
                        ;       ADDRESSABILITY.                 :
                        ;---------------------------------------

                        ;-----  FILL MEMORY WITH DATA

03B3 B0 0E              E30A:   MOV     AL,0EH                  ;       <><><><><><><><><><>
03B5 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0E <><

03B7 B8 ---- R                  MOV     AX,DATA                 ; GET THE SYSTEM SEGMENT
03BA 8E D8                      MOV     DS,AX                   ;  OF DATA
03BC 8B 1E 0072 R               MOV     BX,@RESET_FLAG          ; SAVE @RESET_FLAG IN BX
03C0 FC                         CLD                             ; SET DIRECTION FLAG TO INCREMENT
03C1 B9 8000                    MOV     CX,2000H*4              ; SET FOR 32K WORDS
03C4 2B FF                      SUB     DI,DI                   ; FIRST 16K
```

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03C6 2B F6                      SUB     SI,SI
03C8 2B C0                      SUB     AX,AX
03CA 8E D8                      MOV     DS,AX
03CC 8E C0                      MOV     ES,AX
03CE 81 FB 1234                 CMP     BX,1234H                ; WARM START?
03D2 75 03                      JNZ     E30A_0                  ; GO IF NOT
03D4 E9 0582 R                  JMP     CLR_STG

                        ;-----  GET THE INPUT BUFFER (SWITCH SETTINGS)

03D7 B0 0F              E30A_0: MOV     AL,0FH                  ;       <><><><><><><><><><><><>
03D9 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0F <><>

03DB B0 80                      MOV     AL,PARITY_CHECK         ; SET BASE MEMORY PARITY
03DD E6 87                      OUT     DMA_PAGE+5,AL           ; USE AS TEMPORARY SAVE
03DF BC 03EC R                  MOV     SP,OFFSET C2            ; SET RETURN ADDRESS
03E2 E9 0000 E                  JMP     STGTST_CNT
03E5 8B D8              C30:    MOV     BX,AX                   ; SAVE FAILING BIT PATTERN
03E7 75 0F                      JNZ     C31
03E9 E9 058D R                  JMP     C33                     ; STORAGE OK, CONTINUE

                        ;-----  TEMPORARY STACK FOR POST ROUTINES

03EC 03E5 R             C2      DW      C30
03EE 035D R             C8042A  DW      TST4_B
03F0 0368 R             OBF_42A DW      TST4_C
03F2 0389 R             C8042B  DW      TST4_D
03F4 0379 R             C8042C  DW      E30B
03F6 037E R             OBF_42B DW      E30C

                        ;--------------------------------------------
                        ; BASE 64K STORAGE FAILURE
                        ;   DISPLAY THE CHECKPOINT (MFG CHECKPOINT)
                        ;     AND XOR EXPECTED WITH READ IN MFG_PORT
                        ;   DISPLAY CHECKPOINT IN MFG_PORT+3
                        ;   DISPLAY XOR'D DATA HIGH BYTE MFG_PORT+1
                        ;     LOW BYTE IN MFG_PORT+2
                        ;   A READ/WRITE SCOPE LOOP OF THE FIRST
                        ;   WORD FOR POSSIBLE ADDRESS LINE FAILURES
                        ;--------------------------------------------

03F8                    C31:
03F8 8A C7                      MOV     AL,BH                   ; SAVE HIGH BYTE
03FA E6 81                      OUT     MFG_PORT+1,AL
03FC 8A C3                      MOV     AL,BL                   ; SAVE LOW BYTE
03FE E6 82                      OUT     MFG_PORT+2,AL

                        ;-----  CHECK FOR VIDEO ROM

0400 B9 C000                    MOV     CX,0C000H               ; START OF I/O ROM
0403 8E D9              M1:     MOV     DS,CX                   ; POINT TO SEGMENT
0405 2B DB                      SUB     BX,BX                   ; GET THE FIRST 2 LOCATIONS
0407 8B 07                      MOV     AX,[BX]
0409 EB 00                      JMP     $+2                     ; BUS SETTLE
040B 3D AA55                    CMP     AX,0AA55H               ; IS THE VIDEO ROM PRESENT?
040E 6A 00                      POP
0410 74 0C                      JZ      Z5                      ; GO IF YES
0412 81 C1 0080                 ADD     CX,080H                 ; POINT TO NEXT 2K BLOCK
0416 81 F9 C800                 CMP     CX,0C800H               ; TOP OF VIDEO ROM AREA YET?
041A 7C E7                      JL      M1                      ; TRY AGAIN
041C 23 C9                      AND     CX,CX                   ; SET NON ZERO FLAG
041E                    Z5:
041E 75 03                      JNZ     C32                     ; GO IF NOT
0420 E9 050F R                  JMP     C31_0                   ; BYPASS ERROR DISPLAY IF VIDEO ROM

                        ;--------------------------------------------------------
                        ; SET VIDEO MODE TO DISPLAY MEMORY ERROR
                        ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO
                        ;       TO DISPLAY FIRST 64K STORAGE ERRORS.
                        ; BOTH COLOR AND MONOCHROME ATTACHMENTS ARE INITIALIZED.
                        ;--------------------------------------------------------

                        ;-----  INITIALIZE COLOR/MONOCHROME

0423 BA 03D8            C32:    MOV     DX,3D8H                 ; CONTROL REGISTER ADDRESS OF COLOR CARD
0426 2A C0                      SUB     AL,AL                   ; MODE SET
0428 EE                         OUT     DX,AL

0429 BA 03B8                    MOV     DX,03B8H                ; CONTROL REGISTER ADDRESS OF B/W CARD
042C B0 01                      MOV     AL,1                    ; MODE SET FOR CARD
042E EE                         OUT     DX,AL                   ; RESET VIDEO
042F 83 EA 04                   SUB     DX,4                    ; BACK TO BASE REGISTER

= 0010                  M4      EQU     10H

0432 BB 0030 E                  MOV     BX,OFFSET VIDEO_PARMS+M4*3  ; POINT TO VIDEO PARAMETERS
                                ASSUME  DS:CODE
0435 B9 0010            Z_2:    MOV     CX,M4                   ; COUNT OF MONOCHROME VIDEO PARAMETERS

                        ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

0438 32 E4                      XOR     AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                        ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE

043A 8A C4              M10:    MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
043C EE                         OUT     DX,AL
043D 42                         INC     DX                      ; POINT TO DATA PORT
043E FE C4                      INC     AH                      ; NEXT REGISTER VALUE
0440 2E: 8A 07                  MOV     AL,CS:[BX]              ; GET TABLE VALUE
0443 EE                         OUT     DX,AL                   ; OUT TO CHIP
0444 43                         INC     BX                      ; NEXT IN TABLE
0445 4A                         DEC     DX                      ; BACK TO POINTER REGISTER
0446 E2 F2                      LOOP    M10                     ; DO THE WHOLE TABLE
0448 8A E2                      MOV     AH,DL                   ; CHECK IF COLOR CARD DONE
044A 80 E4 F0                   AND     AH,0F0H                 ; STRIP UNWANTED BITS
044D 80 FC D0                   CMP     AH,0D0H                 ; IS IT THE COLOR CARD?
0450 74 08                      JZ      Z_3                     ; CONTINUE IF COLOR
0452 BB 0000 E                  MOV     BX,OFFSET VIDEO_PARMS   ; POINT TO VIDEO PARAMETERS
0455 BA 03D4                    MOV     DX,3D4H                 ; COLOR BASE
0458 EB DB                      JMP     Z_2                     ; CONTINUE

                        ;-----  FILL REGEN AREA WITH BLANK
```

```
045A 33 FF              Z_3:    XOR     DI,DI                   ; SET UP POINTER FOR REGEN
045C B8 B000                    MOV     AX,0B000H               ; SET UP ES TO VIDEO REGEN
045F 8E C0                      MOV     ES,AX
                        ;-----  ENABLE VIDEO AND CORRECT PORT SETTING
0471 BA 03B8                    MOV     DX,3B8H
0478 B0 29                      MOV     AL,29H
047A EE                         OUT     DX,AL                   ; SET VIDEO ENABLE PORT
                        ;-----  SET UP OVERSCAN REGISTER
047B 42                         INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
047C B0 30                      MOV     AL,30H                  ; VALUE 30H FOR ALL MODES EXCEPT 640X200
047E EE                         OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
                        ;-----  ENABLE COLOR VIDEO AND CORRECT PORT SETTING
047F BA 03D8                    MOV     DX,3D8H
0482 B0 28                      MOV     AL,28H
0484 EE                         OUT     DX,AL                   ; SET VIDEO ENABLE PORT
                        ;-----  SET UP OVERSCAN REGISTER
0485 42                         INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
0486 B0 30                      MOV     AL,30H                  ; VALUE 30H FOR ALL MODES EXCEPT 640X200
0488 EE                         OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
                        ;-----  DISPLAY FAILING CHECKPOINT AND
0489 8C C8                      MOV     AX,CS                   ; SET STACK SEGMENT TO CODE SEGMENT
048B 8E D0                      MOV     SS,AX
048D BB B000                    MOV     BX,0B000H
0490 8E DB                      MOV     DS,BX                   ; SET DS TO B/W DISPLAY BUFFER
0492 B0 30              Z_0:    MOV     AL,'0'                  ; DISPLAY BANK 000000
0494 B9 0006                    MOV     CX,6
0497 2B FF                      SUB     DI,DI                   ; START AT 0
0499 88 05              Z:      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
049B 47                         INC     DI                      ; POINT TO NEXT POSITION
049C 47                         INC     DI
049D E2 FA                      LOOP    Z
049F 80 FF B8                   CMP     BH,0B8H                 ; CHECK THAT COLOR BUFFER WRITTEN
04A2 74 0C                      JZ      Z_1
04A4 2B FF                      SUB     DI,DI                   ; POINT TO START OF BUFFER
04A6 B7 B0                      MOV     BH,0B0H
04A8 8E C3                      MOV     ES,BX                   ; ES = MONOCHROME
04AA B7 B8                      MOV     BH,0B8H                 ; SET SEGMENT TO COLOR
04AC 8E DB                      MOV     DS,BX                   ; DS = COLOR
04AE EB E2                      JMP     Z_0
                        ;-----  PRINT FAILING BIT PATTERN
04B0 B0 20              Z_1:    MOV     AL,' '                  ; DISPLAY A BLANK
04B2 88 05                      MOV     [DI],AL                 ; WRITE TO COLOR BUFFER
04B4 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME REGEN BUFFER
04B7 47                         INC     DI                      ; POINT TO NEXT POSITION
04B8 47                         INC     DI
04B9 E4 81                      IN      AL,MFG_PORT+1           ; GET THE HIGH BYTE OF FAILING PATTERN
04BB B1 04                      MOV     CL,4                    ; SHIFT COUNT
04BD D2 E8                      SHR     AL,CL                   ; NIBBLE SWAP
04BF BC 057A R                  MOV     SP,OFFSET Z1_0
04C2 EB 1B                      JMP     SHORT PR
04C4 E4 81              Z1:     IN      AL,MFG_PORT+1
04C6 24 0F                      AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
04C8 BC 057C R                  MOV     SP,OFFSET Z2_0
04CB EB 12                      JMP     SHORT PR
04CD E4 82              Z2:     IN      AL,MFG_PORT+2           ; GET THE HIGH BYTE OF FAILING PATTERN
04CF B1 04                      MOV     CL,4                    ; SHIFT COUNT
04D1 D2 E8                      SHR     AL,CL                   ; NIBBLE SWAP
04D3 BC 057E R                  MOV     SP,OFFSET Z3_0
04D6 EB 07                      JMP     SHORT PR
04D8 E4 82              Z3:     IN      AL,MFG_PORT+2
04DA 24 0F                      AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
04DC BC 0580 R                  MOV     SP,OFFSET Z4_0          ; RETURN TO Z4:
                        ;-----  CONVERT AND PRINT
                                                                ; CONVERT 00-0F TO ASCII CHARACTER
04DF 04 90              PR:     ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
04E1 27                         DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
04E2 14 40                      ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
04E4 27                         DAA                             ; ADJUST HIGH NIBBLE TO ASCII RANGE
04E5 88 05                      MOV     [DI],AL                 ; WRITE TO COLOR BUFFER
04E7 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04EA 47                         INC     DI                      ; POINT TO NEXT POSITION
04EB 47                         INC     DI
04EC C3                         RET
                        ;-----  DISPLAY 201 ERROR
04ED B0 20              Z4:     MOV     AL,' '                  ; DISPLAY A BLANK
04EF 88 05                      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04F1 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04F4 47                         INC     DI                      ; POINT TO NEXT POSITION
04F5 47                         INC     DI
04F6 B0 32                      MOV     AL,'2'                  ; DISPLAY 201 ERROR
04F8 88 05                      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04FA 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04FD 47                         INC     DI                      ; POINT TO NEXT POSITION
```

```
                                        INC     DI
                                        MOV     AL,'0'
                                        MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
                                        MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
                                        INC     DI                      ; POINT TO NEXT POSITION
                                        INC     DI
                                        MOV     AL,'1'
                                        MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
                                        MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER

                                ;-----  ROLL ERROR CODE IN MFG_PORT --> FIRST THE CHECKPOINT

                                C31_0:  MOV     AL,0DDH                 ;       <><><><><><><><><>
                                        OUT     MFG_PORT,AL             ;           <><> CHECKPOINT  DD <><>
                                        OUT     MFG_PORT+3,AL           ; ALSO DISPLAY CHECK POINT IN PORT 83
                                        SUB     CX,CX
                                C31_A:

                                        SUB     AX,AX                   ; SETUP SEGMENT
                                        MOV     DS,AX
                                        MOV     AX,0AA55H               ; WRITE AN AA55
                                        SUB     DI,DI
                                        MOV     [DI],AX
                                        MOV     AX,[DI]                 ; READ THE FIRST WORD
                                        LOOP    C31_A                   ; DISPLAY CHECKPOINT LONGER
                                C31_B:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_B
                                C31_C:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_C
                                C31_D:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_D
                                C31_E:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_E

                                ;-----  ROLL ERROR CODE IN MFG_PORT --> NEXT THE HIGH BYTE

                                        IN      AL,MFG_PORT+1           ; XOR OF FAILING BIT PATTERN
                                        OUT     MFG_PORT,AL             ; HIGH BYTE
                                C31_G:
                                        MOV     AX,0AA55H               ; WRITE AN AA55
                                        MOV     [DI],AX
                                        MOV     AX,[DI]                 ; READ THE FIRST WORD
                                        LOOP    C31_G
                                C31_H:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_H
                                C31_I:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_I

                                ;-----  ROLL ERROR CODE IN MFG_PORT --> THEN THE LOW BYTE

                                        IN      AL,MFG_PORT+2           ; LOW BYTE
                                        OUT     MFG_PORT,AL
                                        MOV     AX,0AA55H               ; WRITE AN AA55
                                C31_K:  SUB     DI,DI
                                        MOV     [DI],AX
                                        MOV     AX,[DI]                 ; READ THE FIRST WORD
                                        LOOP    C31_K
                                C31_L:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_L
                                C31_M:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_M
                                C31_N:
                                        MOV     [DI],AX
                                        MOV     AX,[DI]
                                        LOOP    C31_N
                                        JMP     C31_0                   ; DO AGAIN

                                Z1_0    DW      Z1                      ; TEMPORARY STACK
                                Z2_0    DW      Z2                      ; TEMPORARY STACK
                                Z3_0    DW      Z3                      ; TEMPORARY STACK
                                Z4_0    DW      Z4                      ; TEMPORARY STACK


                                ;-----  CLEAR STORAGE ENTRY


                                CLR_STG:
                                        ASSUME  DS:DATA
                                        REP     STOSW                   ; STORE 32K WORDS OF 0000
                                        MOV     AX,DATA                 ; RESTORE DATA SEGMENT
                                        MOV     DS,AX
                                        MOV     @RESET_FLAG,BX          ; RESTORE RESET FLAG

                                ;-----  SETUP STACK SEGMENT AND SP

                                C33:
                                        MOV     AX,DATA                 ; SET DATA SEGMENT
                                        MOV     DS,AX
                                        MOV     SP,POST_SS              ; GET STACK VALUE
                                        MOV     SS,SP                   ; SET THE STACK UP
                                        MOV     SP,POST_SP              ; STACK IS READY TO GO

                                ;-----  INITIALIZE DISPLAY ROW COUNT

                                        MOV     @ROWS,25-1              ; SET ROWS FOR PRINT SCREEN DEFAULT

                                        MOV     AL,11H                  ;       <><><><><><><><><>
                                        OUT     MFG_PORT,AL             ;           <><> CHECKPOINT  11 <><>
```

```
                        ;-----  VERIFY SPEED/REFRESH CLOCK RATES  ( ERROR = 1 LONG AND 1 SHORT BEEP )

05A3 32 DB                      XOR     BL,BL                   ; CLEAR REFRESH CYCLE REPEAT COUNT
05A5 33 C9                      XOR     CX,CX                   ; INITIALIZE SPEED RATE REGISTER
05A7 90                         EVEN                            ; PLACE ON EVEN WORD BOUNDARY
05A8                    C34:
05A8 E4 61                      IN      AL,PORT_B               ; READ REFRESH BIT REGISTER
05AA A8 10                      TEST    AL,REFRESH_BIT          ; MASK FOR BIT
05AC E1 FA                      LOOPZ   C34                     ; DECREMENT LOOP COUNTER TILL ON
05AE                    C35:
05AE E4 61                      IN      AL,PORT_B               ; READ REFRESH BIT REGISTER
05B0 A8 10                      TEST    AL,REFRESH_BIT          ; MASK FOR BIT
05B2 E0 FA                      LOOPNZ  C35                     ; DECREMENT LOOP COUNTER TILL OFF

05B4 FE CB                      DEC     BL                      ; DECREMENT REFRESH CYCLE REPEAT COUNT
05B6 75 F0                      JNZ     C34                     ; REPEAT TILL CYCLE COUNT DONE

05B8 81 F9 F8A7                 CMP     CX,RATE_UPPER           ; CHECK FOR RATE BELOW UPPER LIMIT
05BC 73 07                      JAE     C36                     ; SKIP ERROR BEEP IF BELOW MAXIMUM
05BE                    C36E:
05BE BA 0101                    MOV     DX,0101H                ; GET BEEP COUNTS FOR REFRESH ERROR
05C1 E8 0000 E                  CALL    ERR_BEEP                ; CALL TO POST ERROR BEEP ROUTINES
05C4 F4                         HLT                             ; HALT SYSTEM - BAD REFRESH RATE
05C5                    C36:
05C5 81 F9 F9FD                 CMP     CX,RATE_LOWER           ; CHECK FOR RATE ABOVE LOWER LIMIT
05C9 77 F3                      JA      C36E                    ; GO TO ERROR BEEP IF BELOW MINIMUM

                        ;-----  GET THE INPUT BUFFER (SWITCH SETTINGS)

05CB E4 82                      IN      AL,DMA_PAGE+1           ; GET THE SWITCH SETTINGS
05CD 24 F8                      AND     AL,KEY_BD_INHIB+DSP_JMP+MFG_LOOP+BASE_MEM+BASE_MEM8 ; STRIP BITS
05CF A2 0012 R                  MOV     @MFG_TST,AL             ; SAVE SETTINGS
05D2 2A C0                      SUB     AL,AL                   ; RESET DMA_PAGE
05D4 E6 82                      OUT     DMA_PAGE+1,AL

                        ;-----------------------------------------
                        ; TEST.11A                               :
                        ;       VERIFY 286 LGDT/SGDT LIDT/SIDT  :
                        ;       INSTRUCTIONS                    :
                        ; DESCRIPTION                           :
                        ;       LOAD GDT AND IDT REGISTERS WITH :
                        ;       AA,55,00 AND VERIFY CORRECT.    :
                        ;-----------------------------------------

                        ;-----  VERIFY STATUS INDICATE COMPATIBILITY (REAL) MODE

                        +       SMSW    AX                      ; GET THE CURRENT STATUS WORD
05D6 0F 01 E0           +       DB      00FH,001H,0E0H
05D9 A9 000F                    TEST    AX,0FH                  ; PE/MP/EM/TS BITS SHOULD BE ZERO
05DC 75 34                      JNZ     ERR_PROT                ; GO IF STATUS NOT REAL MODE

                        ;-----  TEST PROTECTED MODE REGISTERS

05DE B0 12                      MOV     AL,12H                  ;       <><><><><><><><><><><><>
05E0 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  12 <><>

05E2 1E                         PUSH    DS                      ; SET ES TO SAME SEGMENT AS DS
05E3 07                         POP     ES
05E4 BF D0A0                    MOV     DI,SYS_IDT_LOC          ; USE THIS AREA TO BUILD TEST PATTERN
05E7 B9 0003                    MOV     CX,3
05EA B8 AAAA                    MOV     AX,0AAAAH               ; FIRST PATTERN
05ED E8 0615 R                  CALL    WRT_PAT
05F0 B8 5555                    MOV     AX,05555H
05F3 E8 0615 R                  CALL    WRT_PAT                 ; WRITE NEXT PATTERN
05F6 2B C0                      SUB     AX,AX                   ; WRITE 0
05F8 E8 0615 R                  CALL    WRT_PAT

                        ;-----  TEST 286 CONTROL FLAGS

05FB FD                         STD                             ; SET DIRECTION FLAG FOR DECREMENT
05FC 9C                         PUSHF                           ; GET THE FLAGS
05FD 58                         POP     AX
05FE A9 0200                    TEST    AX,0200H                ; INTERRUPT FLAG SHOULD BE OFF
0601 75 0F                      JNZ     ERR_PROT                ; GO IF NOT
0603 A9 0400                    TEST    AX,0400H                ; CHECK DIRECTION FLAG
0606 74 0A                      JZ      ERR_PROT                ; GO IF NOT SET
0608 FC                         CLD                             ; CLEAR DIRECTION FLAG
0609 9C                         PUSHF                           ; INSURE DIRECTION FLAG IS RESET
060A 58                         POP     AX
060B A9 0400                    TEST    AX,0400H
060E 75 02                      JNZ     ERR_PROT                ; GO IF NOT

0610 EB 3D                      JMP     SHORT C37A              ; TEST OK CONTINUE
0612                    ERR_PROT:
0612 F4                         HLT                             ; PROTECTED MODE REGISTER FAILURE
0613 EB FD                      JMP     SHORT ERR_PROT          ; INSURE NO BREAKOUT OF HALT

                        ;-----  WRITE TO 286 REGISTERS

0615 B9 0003            WRT_PAT:MOV     CX,3
0618 F3/ AB                     REP     STOSW                   ; STORE 6 BYTES OF PATTERN
061A BD D0A0                    MOV     BP,SYS_IDT_LOC
                                SEGOV   ES                      ; LOAD THE IDT
061D 26                 +       DB      026H
                                LIDT    [BP]                    ; REGISTER FROM THIS AREA
061E 0F                 +       DB      00FH
061F                    + ??0001 LABEL  BYTE
061F 8B 5E 00           +       MOV     BX,WORD PTR [BP]
0622                    + ??0002 LABEL  BYTE
061F                    +       ORG     OFFSET CS:??0001
061F 01                 +       DB      001H
0622                    +       ORG     OFFSET CS:??0002
0622 BD D0A0                    MOV     BP,SYS_IDT_LOC
                                SEGOV   ES                      ; LOAD THE GDT
0625 26                 +       DB      026H
                                LGDT    [BP]                    ; FROM THE SAME AREA
0626 0F                 +       DB      00FH
0627                    + ??0004 LABEL  BYTE
0627 8B 56 00           +       MOV     DX,WORD PTR [BP]
062A                    + ??0005 LABEL  BYTE
0627                    +       ORG     OFFSET CS:??0004
0627 01                 +       DB      001H
062A                    +       ORG     OFFSET CS:??0005
```

```
1997
1998                            ;-----  READ AND VERIFY 286 REGISTERS
1999
2000 062A BD D8A0                       MOV     BP,GDT_LOC              ; STORE THE REGISTERS HERE
2001                                    SEGOV   ES
2002 062D 26                    +       DB      026H
2003                                    SIDT    [BP]                    ; GET THE IDT REGISTERS
2004 062E 0F                    +       DB      00FH
2005 062F                       + ??0007 LABEL  BYTE
2006 062F 8B 4E 00              +       MOV     CX,[BP]
2007 0632                       + ??0008 LABEL  BYTE
2008 062F                       +       ORG     OFFSET CS:??0007
2009 062F 01                    +       DB      001H
2010 0632                       +       ORG     OFFSET CS:??0008
2011 0632 BD D8A5                       MOV     BP,GDT_LOC+5
2012                                    SEGOV   ES
2013 0635 26                    +       DB      026H
2014                                    SGDT    [BP]                    ; GET THE GDT REGISTERS
2015 0636 0F                    +       DB      00FH
2016 0637                       + ??000A LABEL  BYTE
2017 0637 03 46 00              +       ADD     AX,[BP]
2018 063A                       + ??000B LABEL  BYTE
2019 0637                       +       ORG     OFFSET CS:??000A
2020 0637 01                    +       DB      001H
2021 063A                       +       ORG     OFFSET CS:??000B
2022 063A BF D0A0                       MOV     DI,SYS_IDT_LOC
2023 063D 8B 05                         MOV     AX,[DI]                 ; GET THE PATTERN WRITTEN
2024 063F B9 0005                       MOV     CX,5                    ; CHECK ALL REGISTERS
2025 0642 BE D8A0                       MOV     SI,GDT_LOC              ; POINT TO THE BEGINNING
2026 0645 26: 3B 04             C37B:   CMP     AX,ES:[SI]
2027 0648 75 C8                         JNZ     ERR_PROT                ; HALT IF ERROR
2028 064A 46                            INC     SI                      ; POINT TO NEXT WORD
2029 064B 46                            INC     SI
2030 064C E2 F7                         LOOP    C37B                    ; CONTINUE TILL DONE
2031 064E C3                            RET
2032
2033
2034                            ;--------------------------------------------------------
2035                            ;       INITIALIZE THE 8259 INTERRUPT #1 CONTROLLER CHIP :
2036                            ;--------------------------------------------------------
2037 064F                       C37A:
2038 064F 2A C0                         SUB     AL,AL                   ; RESET MATH PROCESSOR
2039 0651 E6 F1                         OUT     X287+1,AL
2040 0653 B0 11                         MOV     AL,11H                  ; ICW1 - EDGE, MASTER, ICW4
2041 0655 E6 20                         OUT     INTA00,AL
2042 0657 EB 00                         JMP     $+2                     ; I/O DELAY
2043 0659 B0 08                         MOV     AL,8                    ; SETUP ICW2 - INTERRUPT TYPE 8 (8-F)
2044 065B E6 21                         OUT     INTA01,AL
2045 065D EB 00                         JMP     $+2                     ; I/O DELAY
2046
2047 065F B0 04                         MOV     AL,04H                  ; SETUP ICW3 - MASTER LEVEL 2
2048 0661 E6 21                         OUT     INTA01,AL
2049 0663 EB 00                         JMP     $+2                     ; I/O DELAY
2050 0665 B0 01                         MOV     AL,01H                  ; SETUP ICW4 - MASTER,8086 MODE
2051 0667 E6 21                         OUT     INTA01,AL
2052 0669 EB 00                         JMP     $+2                     ; I/O DELAY
2053 066B B0 FF                         MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
2054 066D E6 21                         OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTERRUPTS)
2055
2056                            ;--------------------------------------------------------
2057                            ;       INITIALIZE THE 8259 INTERRUPT #2 CONTROLLER CHIP  :
2058                            ;--------------------------------------------------------
2059
2060 066F B0 13                         MOV     AL,13H                  ;       <><><><><><><><><>
2061 0671 E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  13 <><>
2062
2063 0673 B0 11                         MOV     AL,11H                  ; ICW1 - EDGE, SLAVE ICW4
2064 0675 E6 A0                         OUT     INTB00,AL
2065 0677 EB 00                         JMP     $+2                     ; I/O DELAY
2066 0679 B0 70                         MOV     AL,INT_TYPE             ; SETUP ICW2 - INTERRUPT TYPE 70 (70-7F)
2067 067B E6 A1                         OUT     INTB01,AL
2068 067D B0 02                         MOV     AL,02H                  ; SETUP ICW3 - SLAVE LEVEL 2
2069 067F EB 00                         JMP     $+2
2070 0681 E6 A1                         OUT     INTB01,AL
2071 0683 EB 00                         JMP     $+2                     ; I/O DELAY
2072 0685 B0 01                         MOV     AL,01H                  ; SETUP ICW4 - 8086 MODE, SLAVE
2073 0687 E6 A1                         OUT     INTB01,AL
2074 0689 EB 00                         JMP     $+2                     ; I/O DELAY
2075 068B B0 FF                         MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
2076 068D E6 A1                         OUT     INTB01,AL
2077
2078                            ;-----  SET UP THE INTERRUPT VECTORS TO TEMPORARY INTERRUPT
2079
2080 068F B0 14                         MOV     AL,14H                  ;       <><><><><><><><><>
2081 0691 E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  14 <><>
2082
2083 0693 B9 0078                       MOV     CX,78H                  ; FILL ALL INTERRUPT LOCATIONS
2084 0696 2B FF                         SUB     DI,DI                   ; FIRST INTERRUPT LOCATION
2085 0698 8E C7                         MOV     ES,DI                   ; SET (ES) ALSO
2086 069A B8 0000 E             D3:     MOV     AX,OFFSET DI1           ; GET ADDRESS OF INTERRUPT OFFSET
2087 069D AB                            STOSW                           ; PLACE IN INTERRUPT VECTOR LOCATION
2088 069E 8C C8                         MOV     AX,CS                   ; GET THE CURRENT CODE SEGMENT
2089 06A0 AB                            STOSW                           ; PLACE CODE SEGMENT IN VECTOR LOCATION
2090 06A1 E2 F7                         LOOP    D3
2091
2092                            ;-----  ESTABLISH BIOS SUBROUTINE CALL INTERRUPT VECTORS
2093
2094 06A3 B0 15                         MOV     AL,15H                  ;       <><><><><><><><><>
2095 06A5 E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  15 <><>
2096
2097
2098 06A7 BF 0040 R                     MOV     DI,OFFSET @VIDEO_INT    ; SET VIDEO INTERRUPT AREA
2099 06AA 0E                            PUSH    CS
2100 06AB 1F                            POP     DS                      ; SET UP ADDRESS OF VECTOR TABLE
2101 06AC 8C D8                         MOV     AX,DS                   ; SET AX=SEGMENT
2102 06AE BE 0010 E                     MOV     SI,OFFSET VECTOR_TABLE+16 ;START WITH VIDEO ENTRY
2103 06B1 B9 0010                       MOV     CX,16
2104
2105 06B4 A5                    D3A:    MOVSW                           ; MOVE VECTOR TABLE TO LOW MEMORY
2106 06B5 47                            INC     DI
2107 06B6 47                            INC     DI                      ; SKIP SEGMENT POINTER
2108 06B7 E2 FB                         LOOP    D3A
2109
2110                            ;---------------------------------------
```

SECTION 5

```
                        ; TEST.12                                       :
                        ;       VERIFY CMOS CHECKSUM/BATTERY OK         :
                        ; DESCRIPTION                                   :
                        ;       DETERMINE IF CONFIG RECORD              :
                        ;       CAN BE USED FOR INITIALIZATION.         :
                        ;---------------------------------------------------
                                ASSUME  DS:DATA
06B9 E8 0000 E                  CALL    DDS                     ; SET THE DATA SEGMENT

06BC B0 16                      MOV     AL,16H                  ;       <><><><><><><><><><>
06BE E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  16 <><>

                        ;-----  IS THE BATTERY LOW THIS POWER UP?

06C0 B0 8D                      MOV     AL,CMOS_REG_D+NMI       ; CHECK BATTERY CONDITION
06C2 E8 0000 E                  CALL    CMOS_READ               ; READ THE BATTERY STATUS
06C5 A8 80                      TEST    AL,10000000B            ; IS THE BATTERY LOW?
06C7 74 0B                      JZ      CMOS1A                  ; ERROR IF YES

06C9 B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; GET THE OLD STATUS
06CB E8 0000 E                  CALL    CMOS_READ               ; FROM DIAGNOSTIC STATUS BYTE
06CE A8 80                      TEST    AL,BAD_BAT              ; HAS CUSTOMER SETUP BEEN EXECUTED?
06D0 74 15                      JZ      CMOS1                   ; GO CHECK CHECKSUM IF YES

06D2 EB 64                      JMP     SHORT CMOS4             ; CONTINUE WITHOUT CONFIGURATION

                        ;-----  SET DEFECTIVE BATTERY FLAG

06D4 B0 17              CMOS1A: MOV     AL,17H                  ;       <><><><><><><><><><>
06D6 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  17 <><>

06D8 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; CMOS DIAGNOSTIC STATUS BYTE
06DB E8 0000 E                  CALL    CMOS_READ               ; GET THE CURRENT STATUS
06DE 0C 80                      OR      AL,BAD_BAT              ; SET THE DEAD BATTERY FLAG
06E0 86 C4                      XCHG    AL,AH                   ; SAVE
06E2 E8 0000 E                  CALL    CMOS_WRITE              ; OUTPUT THE STATUS
06E5 EB 51                      JMP     SHORT  CMOS4            ; GO TO MINIMUM CONFIGURATION

                        ;-----  VERIFY CHECKSUM

06E7 B8 8E8E            CMOS1:  MOV     AX,X*(CMOS_DIAG+NMI)    ; CLEAR OLD STATUS
06EA E8 0000 E                  CALL    CMOS_READ               ; GET THE CURRENT STATUS
06ED 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; IS THIS A SOFT RESET
06F3 75 04                      JNZ     CMOS1_A                 ; GO IF NOT

06F5 24 10                      AND     AL,W_MEM_SIZE           ; CLEAR ALL BUT THE CMOS/POR MEMORY SIZE
06F7 EB 02                      JMP     SHORT CMOS1_B
06F9                    CMOS1_A:
06F9 2A C0                      SUB     AL,AL                   ; CLEAR STATUS IF POWER ON RESET
06FB                    CMOS1_B:
06FB 86 C4                      XCHG    AL,AH                   ; SAVE THE CURRENT STATUS
06FD E8 0000 E                  CALL    CMOS_WRITE

0700 2B DB                      SUB     BX,BX
0702 2B C9                      SUB     CX,CX
0704 B1 90                      MOV     CL,CMOS_DISKETTE+NMI    ; SET START OF CMOS CHECKSUMED AREA
0706 B5 AE                      MOV     CH,CMOS_CKSUM_HI+NMI    ; SET END OF CMOS CHECKSUMED AREA +1
                                                                ;  (FIRST BYTE OF CHECKSUM)
0708 8A C1              CMOS2:  MOV     AL,CL
070A E8 0000 E                  CALL    CMOS_READ               ; ADDRESS THE BEGINNING
070D 2A E4                      SUB     AH,AH                   ; INSURE AH=0
070F 03 D8                      ADD     BX,AX                   ; ADD TO CURRENT VALUE
0711 FE C1                      INC     CL                      ; POINT TO NEXT BYTE ADDRESS IN CMOS
0713 3A E9                      CMP     CH,CL                   ; FINISHED?  (AT CHECKSUM BYTE HIGH)
0715 75 F1                      JNZ     CMOS2                   ; GO IF NOT
0717 0B DB                      OR      BX,BX                   ; BX MUST NOT BE 0
0719 74 10                      JZ      CMOS3                   ; CMOS BAD IF CHECKSUM=0
071B B0 AE                      MOV     AL,CMOS_CKSUM_HI+NMI    ; GET THE CHECK SUM HIGH BYTE
071D E8 0000 E                  CALL    CMOS_READ               ; FIRST BYTE OF CHECKSUM
0720 8A E0                      MOV     AH,AL                   ; SAVE IT
0722 B0 AF                      MOV     AL,CMOS_CKSUM_LO+NMI    ; SECOND BYTE OF CHECKSUM
0724 E8 0000 E                  CALL    CMOS_READ
0727 3B C3                      CMP     AX,BX                   ; IS THE CHECKSUM OK
0729 74 0D                      JZ      CMOS4                   ; GO IF YES

                        ;-----  SET CMOS CHECKSUM ERROR

072B B8 8E8E            CMOS3:  MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS DIAGNOSTIC STATUS
072E E8 0000 E                  CALL    CMOS_READ               ; GET THE CURRENT STATUS
0731 0C 40                      OR      AL,BAD_CKSUM            ; SET BAD CHECKSUM FLAG
0733 86 C4                      XCHG    AL,AH                   ; SAVE IT
0735 E8 0000 E                  CALL    CMOS_WRITE              ; SET FLAG

                        ;-----  INSURE CMOS DIVIDERS SET

                        CMOS4:
0738 B8 8A8A                    MOV     AX,X*(CMOS_REG_A+NMI)   ; ADDRESS CMOS REGISTER A
073B E8 0000 E                  CALL    CMOS_READ               ; GET CURRENT DIVISORS
073E 24 0F                      AND     AL,00FH                 ; LOOK AT PERIODIC RATE BITS
0740 75 07                      JNZ     CMOS9                   ; EXIT IF SET TO SOMETHING USEFUL

0742 B0 26                      MOV     AL,26H                  ; ELSE SET THE STANDARD DEFAULT USED BY
0744 86 C4                      XCHG    AL,AH                   ;  BIOS FOR THE 976.56 US RATE
0746 E8 0000 E                  CALL    CMOS_WRITE              ;  FOR THE PERIODIC CLOCK
0749                    CMOS9:
0749 B0 18                      MOV     AL,18H                  ;       <><><><><><><><><><>
074B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  18 <><>

                        ;-----  ENABLE PROTECTED MODE

074D E4 61                      IN      AL,PORT_B               ; DISABLE MEMORY AND I/O PARITY CHECKS
074F 0C 0C                      OR      AL,RAM_PAR_OFF
0751 E6 61                      OUT     PORT_B,AL

                        ;-----  SET RETURN ADDRESS BYTE IN CMOS

0753 B0 19                      MOV     AL,19H                  ;       <><><><><><><><><><>
0755 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  19 <><>

0757 B8 018F                    MOV     AX,1*H+(CMOS_SHUT_DOWN+NMI)     ; SET THE RETURN ADDRESS FOR
075A E8 0000 E                  CALL    CMOS_WRITE              ; THE FIRST SHUTDOWN RETURN ADDRESS

075D BC 0000                    MOV     SP,POST_SS              ; SET STACK FOR SYSINIT!
0760 8E D4                      MOV     SS,SP
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0762 BC 8000                    MOV     SP,POST_SP
0765 E8 0000 E                  CALL    SYSINITT                ; CALL THE DESCRIPTOR TABLE BUILDER
                                                                ; AND REAL-TO-PROTECTED MODE SWITCHER

0768 B0 1A                      MOV     AL,1AH                  ;       <><><><><><><><><><>
076A E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1A <><>

                        ;-----  SET TEMPORARY STACK

076C 6A 08                      PUSH    BYTE PTR GDT_PTR        ; SET (DS:) SELECTOR TO GDT SEGMENT
076E 1F                         POP     DS
076F C7 06 005A 0000            MOV     DS:SS_TEMP.BASE_LO_WORD,0
0775 C6 06 005C 00              MOV     BYTE PTR DS:(SS_TEMP.BASE_HI_BYTE),0
077A BE 0058                    MOV     SI,SS_TEMP
077D 8E D6                      MOV     SS,SI
077F BC FFFD                    MOV     SP,MAX_SEG_LEN-2

                        ;--------------------------------------------------------------------------------
                        ; TEST.13                                                                      :
                        ;  PROTECTED MODE TEST AND MEMORY SIZE DETERMINE  ( 0 --> 640K )              :
                        ;                                                                             :
                        ; DESCRIPTION:                                                                :
                        ;     THIS ROUTINE RUNS IN PROTECTED MODE IN ORDER TO ADDRESS ALL OF STORAGE.  :
                        ;     IT CHECKS THE MACHINE STATUS WORD (MSW) FOR PROTECTED MODE AND THE BASE  :
                        ;     MEMORY SIZE IS DETERMINED AND SAVED.  BIT 4 OF THE CMOS DIAGNOSTIC      :
                        ;     STATUS BYTE IS SET IF 512K --> 640K MEMORY IS INSTALLED.                :
                        ;     DURING A POWER UP SEQUENCE THE MEMORY SIZE DETERMINE IS DONE WITH       :
                        ;     PLANAR AND I/O PARITY CHECKS DISABLED.  DURING A SOFT RESET THE MEMORY  :
                        ;     SIZE DETERMINE WILL CHECK FOR PARITY ERRORS.                            :
                        ;--------------------------------------------------------------------------------

                        ;-----  INSURE PROTECTED MODE

                                SMSW    AX                      ; GET THE MACHINE STATUS WORD
0782 0F 01 E0           +       DB      00FH,001H,0E0H
0785 A9 0001                    TEST    AX,VIRTUAL_ENABLE       ; ARE WE IN PROTECTED MODE
0788 75 0C                      JNZ     VIR_OK

078A B8 088F            SHUT_8: MOV     AX,8*H+(CMOS_SHUT_DOWN+NMI)     ; SET THE RETURN ADDRESS
078D E8 0000 E                  CALL    CMOS_WRITE              ; AND SET SHUTDOWN 8
0790 E9 0000 E                  JMP     PROC_SHUTDOWN           ; CAUSE A SHUTDOWN

                        ;-----  VIRTUAL MODE ERROR HALT

0793 F4                 SHUT8:  HLT
0794 EB FD                      JMP     SHUT8                   ; ERROR HALT

                        ;-----  64K SEGMENT LIMIT

0796 C7 06 0048 FFFF    VIR_OK: MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN

                        ;-----  CPL0, DATA ACCESS RIGHTS

079C C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                        ;-----  START WITH SEGMENT ADDRESS 01-0000 (SECOND 64K)

07A1 C6 06 004C 01              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),01H
07A6 C7 06 004A 0000            MOV     DS:ES_TEMP.BASE_LO_WORD,0H

07AC B0 1B                      MOV     AL,1BH                  ;       <><><><><><><><><><>
07AE E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1B <><>

07B0 BB 0040                    MOV     BX,16*4                 ; SET THE FIRST 64K DONE

                        ;-----  START STORAGE SIZE/CLEAR

07B3                    NOT_DONE:
07B3 6A 48                      PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
07B5 07                         POP     ES                      ; POINT TO SEGMENT TO TEST
07B6 E8 07D2 R                  CALL    HOW_BIG                 ; DO THE FIRST 64K
07B9 74 03                      JZ      NOT_FIN                 ; CHECK IF TOP OF MEMORY
07BB E9 0870 R                  JMP     DONE

07BE                    NOT_FIN:
07BE 83 C3 40                   ADD     BX,16*4                 ; BUMP MEMORY COUNT BY 64K

                        ;-----  DO NEXT 64K (0X0000) BLOCK

07C1 FE 06 004C                 INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                        ;-----  CHECK FOR END OF FIRST 640K (END OF BASE MEMORY)

07C5 80 3E 004C 0A              CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0AH
07CA 75 E7                      JNZ     NOT_DONE                ; GO IF NOT
07CC E8 084D R                  CALL    HOW_BIG_END             ; GO SET MEMORY SIZE
07CF E9 0870 R                  JMP     DONE

                        ;-----  FILL/CHECK LOOP

07D2                    HOW_BIG:
07D2 2B FF                      SUB     DI,DI
07D4 B8 AA55                    MOV     AX,0AA55H               ; TEST PATTERN
07D7 8B C8                      MOV     CX,AX                   ; SAVE PATTERN
07D9 26: 89 05                  MOV     ES:[DI],AX              ; WRITE PATTERN TO MEMORY
07DC B0 0F                      MOV     AL,0FH                  ; PUT SOMETHING IN AL
07DE 26: 8B 05                  MOV     AX,ES:[DI]              ; GET PATTERN
07E1 26: 89 05                  MOV     ES:[DI],AX              ; INSURE NO PARITY I/O CHECK
07E4 33 C1                      XOR     AX,CX                   ; COMPARE PATTERNS
07E6 75 65                      JNZ     HOW_BIG_END             ; GO END IF NO COMPARE

07E8 1E                         PUSH    DS
07E9 6A 18                      PUSH    BYTE PTR RSDA_PTR       ; POINT TO SYSTEM DATA AREA
07EB 1F                         POP     DS                      ; GET (DS:)

                        ;-----  IS THIS A SOFT RESET

07EC 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; SOFT RESET
07F2 1F                         POP     DS                      ; RESTORE DS
07F3 75 36                      JNZ     HOW_BIG_2               ; GO IF NOT SOFT RESET

                        ;-----  INSURE NO PARITY WITH PARITY BITS OFF

07F5 26: C7 05 0101             MOV     WORD PTR ES:[DI],0101H  ; TURN OFF BOTH PARITY BITS
```

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                                        IN      AL,PORT_B
                                        OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
                                        OUT     PORT_B,AL
                                        AND     AL,RAM_PAR_ON
                                        OUT     PORT_B,AL
                                        PUSH    BYTE PTR 0FFH           ; PLACE 0FFFFH IN STACK (BUS BITS ON)
                                        POP     AX                      ; DELAY - CAUSING BUS BITS ON
                                        MOV     AX,ES:[DI]              ; CHECK PARITY

                                        IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
                                        AND     AL,PARITY_ERR
                                        MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
                                        JNZ     HOW_BIG_END             ; GO IF PLANAR OR I/O PARITY CHECK

                                ;-----  CHECK ALL BITS WRITE OK

                                        MOV     WORD PTR ES:[DI],0FFFFH ; TURN ON ALL BITS
                                        MOV     AX,ES:[DI]              ; CHECK FOR FFFFH
                                        PUSH    AX                      ; SAVE RESULTS
                                        IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
                                        AND     AL,PARITY_ERR
                                        MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
                                        POP     AX                      ; GET RESULTS
                                        JNZ     HOW_BIG_END             ; GO IF PARITY CHECK
                                        CMP     AX,0FFFFH
                                        JNZ     HOW_BIG_END

                                ;-----  CHECK 64K BLOCK FOR PARITY CHECK

                                HOW_BIG_2:
                                        SUB     AX,AX                   ; WRITE ZEROS
                                        MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
                                        REP     STOSW                   ; FILL 32K WORDS

                                        PUSH    DS
                                        PUSH    ES
                                        PUSH    ES                      ; GET ES TO DS
                                        POP     DS
                                        MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
                                        SUB     SI,SI
                                        REP     LODSW
                                        SUB     DI,DI                   ; SET TO BEGINNING OF BLOCK
                                        IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
                                        AND     AL,PARITY_ERR
                                        MOV     WORD PTR ES:[DI],0      ; CLEAR POSSIBLE PARITY ERROR
                                        POP     ES                      ; RESTORE SEGMENTS
                                        POP     DS
                                        JNZ     HOW_BIG_END             ; GO IF PLANAR OR I/O PARITY CHECK

                                        RET

                                HOW_BIG_END:
                                        PUSHF                           ; SAVE THE CURRENT FLAGS
                                        MOV     AL,1CH                  ;       <><><><><><><><><><><><>
                                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1C <><>

                                ;-----  SET OR RESET 512 TO 640 INSTALLED FLAG

                                        MOV     AX,X*(CMOS_INFO128+NMI) ; SET/RESET 640K STATUS FLAG
                                        CALL    CMOS_READ               ; GET THE DIAGNOSTIC STATUS
                                        OR      AL,M640K
                                        CMP     BX,512                  ; CHECK MEMORY SIZE
                                        JA      K640                    ; SET FLAG FOR 512 -> 640 INSTALLED
                                        AND     AL,NOT M640K
                                K640:
                                        XCHG    AL,AH                   ; SAVE THE STATUS
                                        CALL    CMOS_WRITE              ; RESTORE THE STATUS

                                        PUSH    BYTE PTR RSDA_PTR       ; RESTORE THE DATA SEGMENT
                                        POP     DS
                                        MOV     @MEMORY_SIZE,BX         ; SAVE MEMORY SIZE
                                        POPF                            ; RESTORE THE MEMORY REGISTER
                                        RET

                                ;--------------------------------------------------------------------------------
                                ; TEST.13A                                                                      :
                                ;  PROTECTED MODE TEST AND MEMORY SIZE DETERMINE  ( ABOVE 1024K )              :
                                ;                                                                              :
                                ; DESCRIPTION:                                                                 :
                                ;      THIS ROUTINE RUNS IN PROTECTED MODE IN ORDER TO ADDRESS ABOVE 1 MEG.     :
                                ;      THE MEMORY SIZE IS DETERMINED AND SAVED IN CMOS.                        :
                                ;      DURING A POWER UP SEQUENCE THE MEMORY SIZE DETERMINE IS DONE WITH       :
                                ;      PLANAR AND I/O PARITY CHECKS DISABLED.  DURING A SOFT RESET THE MEMORY  :
                                ;      SIZE DETERMINE WILL CHECK FOR PARITY ERRORS.                            :
                                ;--------------------------------------------------------------------------------

                                DONE:
                                        PUSH    BYTE PTR GDT_PTR        ; POINT DS TO THE DESCRIPTOR TABLE
                                        POP     DS

                                ;-----  START WITH SEGMENT ADDRESS 10-0000 (ONE MEG AND ABOVE)

                                        MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H
                                        MOV     DS:ES_TEMP.BASE_LO_WORD,0H

                                        MOV     AL,1DH                  ;       <><><><><><><><><><><><>
                                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1D <><>

                                        SUB     BX,BX                   ; START WITH COUNT 0

                                ;-----  START STORAGE SIZE/CLEAR

                                NOT_DONE1:
                                        PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
                                        POP     ES                      ; POINT TO SEGMENT TO TEST
                                        CALL    HOW_BIG1                ; DO THE FIRST 64K
                                        JZ      DONEA                   ; CHECK IF TOP

                                        JMP     DONE1                   ; GO IF TOP

                                DONEA:  ADD     BX,16*4                 ; BUMP MEMORY COUNT BY 64K

                                ;-----  DO NEXT 64K (XX0000) BLOCK
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                                ;-----  CHECK FOR TOP OF MEMORY (FE0000)
0892 FE 06 004C                         INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)
0896 80 3E 004C FE                      CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0FEH ; LAST OF MEMORY?
089B 75 E7                              JNZ     NOT_DONE1                               ; GO IF NOT
089D E8 0917 R                          CALL    HOW_BIG_END1                            ; GO SET MEMORY SIZE
08A0 E9 092A R                          JMP     DONE1

                                ;-----  FILL/CHECK LOOP

08A3                            HOW_BIG1:
08A3 2B FF                              SUB     DI,DI
08A5 B8 AA55                            MOV     AX,0AA55H               ; TEST PATTERN
08A8 8B C8                              MOV     CX,AX                   ; SAVE PATTERN
08AA 26: 89 05                          MOV     ES:[DI],AX              ; SEND PATTERN TO MEMORY
08AD B0 0F                              MOV     AL,0FH                  ; PUT SOMETHING IN AL
08AF 26: 8B 05                          MOV     AX,ES:[DI]              ; GET PATTERN
08B2 26: 89 05                          MOV     ES:[DI],AX              ; INSURE NO PARITY I/O CHECK
08B5 33 C1                              XOR     AX,CX                   ; COMPARE PATTERNS
08B7 75 5E                              JNZ     HOW_BIG_END1            ; GO END IF NO COMPARE

                                ;-----  IS THIS A SOFT RESET

08B9 1E                                 PUSH    DS
08BA 6A 18                              PUSH    BYTE PTR RSDA_PTR       ; POINT TO SYSTEM DATA AREA
08BC 1F                                 POP     DS
08BD 81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; SOFT RESET
08C3 1F                                 POP     DS                      ; RESTORE DS
08C4 75 2F                              JNZ     HOW_BIG_2A              ; GO IF NOT SOFT RESET

                                ;-----  CHECK PARITY WITH PARITY BITS OFF

08C6 26: C7 05 0101                     MOV     WORD PTR ES:[DI],0101H  ; TURN OFF BOTH PARITY BITS
08CB 6A FF                              PUSH    BYTE PTR 0FFH           ; PLACE 0FFFFH IN STACK (BUS BITS ON)
08CD 58                                 POP     AX                      ; DELAY - CAUSING BUS BITS ON
08CE 26: 8B 05                          MOV     AX,ES:[DI]              ; CHECK PARITY

08D1 E4 61                              IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
08D3 24 C0                              AND     AL,PARITY_ERR
08D5 26: 89 05                          MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
08D8 75 3D                              JNZ     HOW_BIG_END1            ; GO IF PLANAR OR I/O PARITY CHECK

                                ;-----  CHECK ALL BITS

08DA 26: C7 05 FFFF                     MOV     WORD PTR ES:[DI],0FFFFH ; TURN ON ALL BITS
08DF 6A 00                              PUSH    BYTE PTR 0              ; PLACE 00000H IN STACK (BUS BITS OFF)
08E1 58                                 POP     AX                      ; DELAY - CAUSING BUS BITS OFF
08E2 26: 8B 05                          MOV     AX,ES:[DI]              ; CHECK FOR FFFFH
08E5 50                                 PUSH    AX                      ; SAVE RESULTS
08E6 E4 61                              IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
08E8 24 C0                              AND     AL,PARITY_ERR
08EA 26: 89 05                          MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
08ED 58                                 POP     AX                      ; GET RESULTS
08EE 75 27                              JNZ     HOW_BIG_END1            ; GO IF PLANAR OR I/O PARITY CHECK
08F0 3D FFFF                            CMP     AX,0FFFFH
08F3 75 22                              JNZ     HOW_BIG_END1

                                ;-----  CLEAR 64K BLOCK OF MEMORY

08F5                            HOW_BIG_2A:
08F5 2B C0                              SUB     AX,AX                   ; WRITE ZEROS
08F7 B9 8000                            MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
08FA F3/ AB                             REP     STOSW                   ; FILL 32K WORDS

                                ;-----  CHECK 64K BLOCK FOR PARITY CHECK (VALID TEST DURING SOFT RESET ONLY)

08FC 1E                                 PUSH    DS
08FD 06                                 PUSH    ES
08FE 06                                 PUSH    ES                      ; GET ES TO DS
08FF 1F                                 POP     DS
0900 B9 8000                            MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
0903 2B F6                              SUB     SI,SI
0905 F3/ AD                             REP     LODSW
0907 2B FF                              SUB     DI,DI                   ; SET TO BEGINNING OF BLOCK
0909 E4 61                              IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
090B 24 C0                              AND     AL,PARITY_ERR
090D 26: C7 05 0000                     MOV     WORD PTR ES:[DI],0      ; CLEAR POSSIBLE PARITY ERROR
0912 07                                 POP     ES                      ; RESTORE SEGMENT
0913 1F                                 POP     DS
0914 75 01                              JNZ     HOW_BIG_END1            ; GO IF PLANAR OR I/O PARITY CHECK

0916 C3                                 RET

0917                            HOW_BIG_END1:
0917 B0 1E                              MOV     AL,1EH                  ;       <><><><><><><><><><><>
0919 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1E <><>

                                ;-----  SET EXPANSION MEMORY SIZE DETERMINED IN CMOS

091B B0 B0                              MOV     AL,CMOS_U_M_S_LO+NMI    ; ADDRESS LOW BYTE
091D 8A E3                              MOV     AH,BL                   ; GET LOW MEMORY SIZE
091F E8 0000 E                          CALL    CMOS_WRITE              ; SET LOW BYTE
0922 B0 B1                              MOV     AL,CMOS_U_M_S_HI+NMI    ; ADDRESS HI BYTE
0924 8A E7                              MOV     AH,BH                   ; GET THE HIGH MEMORY SIZE
0926 E8 0000 E                          CALL    CMOS_WRITE              ; PLACE IN CMOS
0929 C3                                 RET

                                ;-----  TEST ADDRESS LINES 19 - 23

092A B0 1F                      DONE1:  MOV     AL,1FH                  ;       <><><><><><><><><><><>
092C E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1F <><>
092E C6 06 004C 00                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),00H
0933 2B FF                              SUB     DI,DI                   ; SET LOCATION POINTER TO ZERO
0935 BA FFFF                            MOV     DX,0FFFFH               ; WRITE FFFF AT ADDRESS 0
0938 E8 0967 R                          CALL    SD0
093B 2B D2                              SUB     DX,DX                   ; WRITE 0

093D C6 06 004C 08                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),08H
0942 E8 0967 R                          CALL    SD0
0945 C6 06 004C 10                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H
094A E8 0967 R                          CALL    SD0
094D C6 06 004C 20                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),20H
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0952 E8 0967 R                  CALL    SD0
0955 C6 06 004C 40              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),40H
095A E8 0967 R                  CALL    SD0
095D C6 06 004C 80              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),80H
0962 E8 0967 R                  CALL    SD0

0965 EB 18                      JMP     SHORT SD2               ; TEST PASSED CONTINUE

0967                    SD0:
0967 6A 48                      PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0969 07                         POP     ES                      ; POINT TO SEGMENT TO TEST
096A 26: 89 15                  MOV     ES:[DI],DX              ; WRITE THE PATTERN

096D C6 06 004C 00              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),00H

0972 6A 48                      PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0974 07                         POP     ES                      ; POINT TO SEGMENT TO TEST
0975 26: 83 3D FF               CMP     WORD PTR ES:[DI],0FFFFH ; DID LOCATION 0 CHANGE?
0979 74 03                      JZ      SD1                     ; CONTINUE IF NOT
097B E9 078A R                  JMP     SHUT_8                  ; GO HALT IF YES
097E                    SD1:
097E C3                         RET

                        ;-----  CAUSE A SHUTDOWN

097F B0 20              SD2:    MOV     AL,20H                  ;       <><><><><><><><><><><><>
0981 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  20 <><>
0983 E4 61                      IN      AL,PORT_B
0985 0C 0C                      OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
0987 E6 61                      OUT     PORT_B,AL
0989 24 F3                      AND     AL,RAM_PAR_ON
098B E6 61                      OUT     PORT_B,AL
098D E9 0000 E                  JMP     PROC_SHUTDOWN           ; CAUSE A SHUTDOWN (RETURN VIA JUMP)

                        ;--------------------------------------
                        ; RETURN ! FROM SHUTDOWN               :
                        ;--------------------------------------

0990 B0 21              SHUT1:  MOV     AL,21H                  ;       <><><><><><><><><><><><>
0992 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  21 <><>
0994 BC ---- R                  MOV     SP,@BOS                 ; SET REAL MODE STACK
0997 8E D4                      MOV     SS,SP
0999 BC 0400 R                  MOV     SP,OFFSET @TOS

                        ;-----  SET DIVIDE 0 VECTOR OFFSET

099C 2B FF                      SUB     DI,DI                   ; POINT TO FIRST INTERRUPT LOCATION
099E 8E C7                      MOV     ES,DI                   ; SET ES TO ABS0 SEGMENT
09A0 B8 0000 E                  MOV     AX,OFFSET D11           ; GET ADDRESS OF INTERRUPT OFFSET
09A3 AB                         STOSW                           ; PLACE OFFSET IF NULL HANDLER IN VECTOR

09A4 E8 0000 E                  CALL    DDS                     ; SET UP THE REAL DATA AREA

                        ;-----  GET THE CONFIGURATION FROM CMOS

09A7 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; CHECK CMOS GOOD
09AA E8 0000 E                  CALL    CMOS_READ               ; GET THE STATUS
09AD A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; VALID CMOS ?
09AF 74 03                      JZ      M_OK                    ; GO IF YES
09B1 E9 0A3A R                  JMP     BAD_MOS                 ; GO IF NOT
09B4                    M_OK:
09B4 24 DF                      AND     AL,0DFH                 ; CLEAR THE MINIMUM CONFIG BIT
09B6 86 C4                      XCHG    AL,AH                   ; SAVE THE STATUS BYTE
09B8 E8 0000 E                  CALL    CMOS_WRITE              ; BACK INTO CMOS

                        ;-----  CHECK FOR CMOS RUN IN MODE

09BB 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; CHECK FOR SOFT RESET
09C1 74 10                      JE      M_OK_64                 ; BYPASS IF SOFT RESET

09C3 B0 96                      MOV     AL,CMOS_B_M_S_HI+NMI    ; GET THE BASE MEMORY SIZE HIGH BYTE
09C5 E8 0000 E                  CALL    CMOS_READ
09C8 24 C0                      AND     AL,0C0H                 ; MASK FOR MANUFACTURING TEST BITS
09CA 3C C0                      CMP     AL,0C0H                 ; CHECK FOR MANUFACTURING TEST MODE SET
09CC 75 05                      JNE     M_OK_64                 ; SKIP IF NOT MANUFACTURING LINE TEST

09CE C6 06 0072 R 64            MOV     BYTE PTR @RESET_FLAG,64H; ELSE SET THE MFG TEST FLAG

                        ;-----  INSURE CONFIGURATION HAS CORRECT VIDEO TYPE

09D3                    M_OK_64:
09D3 B0 94                      MOV     AL,CMOS_EQUIP+NMI       ; GET THE EQUIPMENT BYTE
09D5 E8 0000 E                  CALL    CMOS_READ
09D8 8A E0                      MOV     AH,AL                   ; SAVE VIDEO TYPE
09DA A8 30                      TEST    AL,030H                 ; ANY VIDEO?
09DC 75 31                      JNZ     MOS_OK_1                ; CONTINUE
09DE E8 09EC R                  CALL    CHK_VIDEO               ; INSURE VIDEO ROM PRESENT
09E1 74 4C                      JZ      MOS_OK                  ; CONTINUE

09E3 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; EXCEPT IF MFG JUMPER IS INSTALLED
09E8 74 6F                      JZ      NORMAL_CONFIG           ; GO IF INSTALLED

09EA EB 4E                      JMP     SHORT BAD_MOS           ; GO DEFAULT

                        ;-----  ROUTINE CHECK FOR VIDEO FEATURE ROM PRESENT

09EC                    CHK_VIDEO:
09EC B9 C000                    MOV     CX,0C000H               ; START OF FEATURE I/O ROM
09EF                    CHK_VIDEO1:
09EF 50                         PUSH    AX                      ; SAVE THE CONFIGURATION
09F0 1E                         PUSH    DS                      ; SAVE THE DATA SEGMENT
09F1 57                         PUSH    DI                      ; SAVE COMPARE REGISTER
09F2 8E D9                      MOV     DS,CX                   ; GET ROM SEGMENT
09F4 BF AA55                    MOV     DI,0AA55H               ; GET THE PRESENCE SIGNATURE
09F7 2B DB                      SUB     BX,BX                   ; CLEAR INDEX POINTER
09F9 8B 07                      MOV     AX,[BX]                 ; GET THE FIRST 2 LOCATIONS
09FB 3B C7                      CMP     AX,DI                   ; IS THE VIDEO FEATURE ROM PRESENT?
09FD 5F                         POP     DI                      ; RESTORE WORK REGISTER
09FE 1F                         POP     DS                      ; RESTORE DATA SEGMENT
09FF 58                         POP     AX                      ; GET THE CONFIGURATION
0A00 74 0C                      JZ      CHK_VIDEO2              ; GO IF VIDEO ROM INSTALLED

0A02 81 C1 0080                 ADD     CX,080H                 ; POINT TO NEXT 2K BLOCK
0A06 81 F9 C800                 CMP     CX,0C800H               ; TOP OF VIDEO ROM AREA YET?
```

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0A0A 7C E3                      JL      CHK_VIDEO1              ; TRY AGAIN
0A0C 23 C9                      AND     CX,CX                   ; SET NON ZERO FLAG
0A0E                    CHK_VIDEO2:
0A0E C3                         RET                             ; RETURN TO CALLER

                        ;-----  CMOS VIDEO BITS NON ZERO (CHECK FOR PRIMARY DISPLAY AND NO VIDEO ROM)

0A0F                    MOS_OK_1:
0A0F E8 09EC R                  CALL    CHK_VIDEO               ; IS THE VIDEO ROM INSTALLED?
0A12 74 26                      JZ      BAD_MOS                 ; WRONG CONFIGURATION IN CONFIG BYTE

0A14 8A C4                      MOV     AL,AH                   ; RESTORE CONFIGURATION
0A16 F6 06 0012 R 40            TEST    @MFG_TST,DSP_JMP        ; CHECK FOR DISPLAY JUMPER
0A1B 74 0A                      JZ      MOS_OK_2                ; GO IF COLOR CARD IS PRIMARY DISPLAY

                        ;-----  MONOCHROME CARD IS PRIMARY DISPLAY     (NO JUMPER INSTALLED)

0A1D 24 30                      AND     AL,30H                  ; INSURE MONOCHROME IS PRIMARY
0A1F 3C 30                      CMP     AL,30H                  ; CONFIGURATION OK?
0A21 75 17                      JNZ     BAD_MOS                 ; GO IF NOT
0A23 8A C4                      MOV     AL,AH                   ; RESTORE CONFIGURATION
0A25 EB 08                      JMP     SHORT MOS_OK            ; USE THE CONFIGURATION BYTE FOR DISPLAY

                        ;-----  COLOR CARD

0A27                    MOS_OK_2:
0A27 24 30                      AND     AL,30H                  ; STRIP UNWANTED BITS
0A29 3C 30                      CMP     AL,30H                  ; MUST NOT BE MONO WITH JUMPER INSTALLED
0A2B 8A C4                      MOV     AL,AH                   ; RESTORE CONFIGURATION
0A2D 74 0B                      JZ      BAD_MOS                 ; GO IF YES

                        ;-----  CONFIGURATION MUST HAVE AT LEAST ONE DISKETTE

0A2F A8 01              MOS_OK: TEST    AL,01H                  ; MUST HAVE AT LEAST ONE DISKETTE
0A31 75 26                      JNZ     NORMAL_CONFIG           ; GO SET CONFIGURATION IF OK
0A33 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; EXCEPT IF MFG JUMPER IS INSTALLED
0A38 74 1F                      JZ      NORMAL_CONFIG           ; GO IF INSTALLED

                        ;-----  MINIMUM CONFIGURATION WITH BAD CMOS OR NON VALID VIDEO

0A3A                    BAD_MOS:
0A3A B8 008E                    MOV     AX,CMOS_DIAG+NMI        ; GET THE DIAGNOSTIC STATUS
0A3D E8 0000 E                  CALL    CMOS_READ
0A40 A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; WAS BATTERY DEFECTIVE OR BAD CHECKSUM
0A42 75 03                      JNZ     BAD_MOS1                ; GO IF YES

0A44 E8 0000 E                  CALL    CONFIG_BAD              ; SET THE MINIMUM CONFIGURATION FLAG
0A47                    BAD_MOS1:
0A47 E8 09EC R                  CALL    CHK_VIDEO               ; CHECK FOR VIDEO ROM
0A4A B0 01                      MOV     AL,01H                  ; DISKETTE ONLY
0A4C 74 0B                      JZ      NORMAL_CONFIG           ; GO IF VIDEO ROM PRESENT

0A4E F6 06 0012 R 40            TEST    @MFG_TST,DSP_JMP        ; CHECK FOR DISPLAY JUMPER
0A53 B0 11                      MOV     AL,11H                  ; DEFAULT TO 40X25 COLOR
0A55 74 02                      JZ      NORMAL_CONFIG           ; GO IF JUMPER IS INSTALLED

0A57 B0 31                      MOV     AL,31H                  ; DISKETTE / B/W DISPLAY 80X25

                        ;---------------------------------------
                        ;       CONFIGURATION AND MFG MODE      :
                        ;---------------------------------------

0A59                    NORMAL_CONFIG:
0A59 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; IS THE MANUFACTURING JUMPER INSTALLED
0A5E 75 02                      JNZ     NORM1                   ; GO IF NOT
0A60 24 3E                      AND     AL,03EH                 ; STRIP DISKETTE FOR MFG TEST

0A62 2A E4              NORM1:  SUB     AH,AH
0A64 A3 0010 R                  MOV     @EQUIP_FLAG,AX          ; SAVE SWITCH INFORMATION
0A67 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; BYPASS IF SOFT RESET
0A6D 74 2C                      JZ      E6

                        ;-----  GET THE FIRST SELF TEST RESULTS FROM KEYBOARD

0A6F B0 60                      MOV     AL,WRITE_8042_LOC       ; ENABLE KEYBOARD
0A71 E8 0396 R                  CALL    C8042                   ; ISSUE WRITE BYTE COMMAND
0A74 B0 4D                      MOV     AL,4DH                  ; ENABLE OUTPUT BUFFER FULL INTERRUPT,
                                                                ; SET SYSTEM FLAG, PC I COMPATIBILITY,
0A76 E6 60                      OUT     PORT_A,AL               ; INHIBIT OVERRIDE, ENABLE KEYBOARD

0A78 2B C9                      SUB     CX,CX                   ; WAIT FOR COMMAND ACCEPTED
0A7A E8 039B R                  CALL    C42_1

0A7D B9 7FFF                    MOV     CX,07FFFH               ; SET LOOP COUNT FOR APPROXIMATELY 100MS
                                                                ; TO RESPOND
0A80 E4 64              TST6:   IN      AL,STATUS_PORT          ; WAIT FOR OUTPUT BUFFER FULL
0A82 A8 01                      TEST    AL,OUT_BUF_FULL
0A84 E1 FA                      LOOPZ   TST6                    ; TRY AGAIN IF NOT

0A86 9C                         PUSHF                           ; SAVE FLAGS
0A87 B0 AD                      MOV     AL,DIS_KBD              ; DISABLE KEYBOARD
0A89 E8 0396 R                  CALL    C8042                   ; ISSUE THE COMMAND
0A8C 9D                         POPF                            ; RESTORE FLAGS
0A8D 74 0C                      JZ      E6                      ; CONTINUE WITHOUT RESULTS

0A8F E4 60                      IN      AL,PORT_A               ; GET INPUT FROM KEYBOARD
0A91 A2 0072 R                  MOV     BYTE PTR @RESET_FLAG,AL ; TEMPORARY SAVE FOR AA RECEIVED

                        ;-----  CHECK FOR MFG REQUEST

0A94 3C 65                      CMP     AL,065H                 ; LOAD MANUFACTURING TEST REQUEST?
0A96 75 03                      JNE     E6                      ; CONTINUE IF NOT
0A98 E9 0C27 R                  JMP     MFG_BOOT                ; ELSE GO TO MANUFACTURING BOOTSTRAP

                        ;-------------------------------------------------------
                        ; TEST.14                                              :
                        ;       INITIALIZE AND START CRT CONTROLLER (6845)     :
                        ;       TEST VIDEO READ/WRITE STORAGE.                 :
                        ; DESCRIPTION                                          :
                        ;       RESET THE VIDEO ENABLE SIGNAL.                 :
                        ;       SELECT ALPHANUMERIC MODE, 40 * 25, B & W.      :
                        ;       READ/WRITE DATA PATTERNS TO MEMORY. CHECK      :
                        ;       STORAGE ADDRESSABILITY.                        :
                        ; ERROR = 1 LONG AND 2 SHORT BEEPS                     :
```

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                        ;--------------------------------------------------------
                        E6:
0A9B A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; GET SENSE INFORMATION
0A9E 50                         PUSH    AX                      ; SAVE IT
0A9F B0 30                      MOV     AL,30H                  ; FORCE MONOCHROME TYPE
0AA1 A3 0010 R                  MOV     @EQUIP_FLAG,AX          ; INTO EQUIPMENT FLAG
0AA4 2B C0                      SUB     AX,AX                   ; MODE SET COMMAND FOR DEFAULT MODE
0AA6 CD 10                      INT     INT_VIDEO               ; SEND INITIALIZATION TO B/W CARD
0AA8 B0 20                      MOV     AL,20H                  ; FORCE COLOR AT 80 BY 25
0AAA A3 0010 R                  MOV     @EQUIP_FLAG,AX          ; INTO EQUIPMENT FLAG TO CLEAR BUFFERS
0AAD B8 0003                    MOV     AX,0003H                ; AND INITIALIZATION COLOR CARD 80X25
0AB0 CD 10                      INT     INT_VIDEO               ; MODE SET 80 X 25
0AB2 B8 0001                    MOV     AX,0001H                ; SET COLOR 40 X 25 MODE
0AB5 CD 10                      INT     INT_VIDEO               ; SET DEFAULT COLOR MODE
0AB7 58                         POP     AX                      ; RECOVER REAL SWITCH INFORMATION
0AB8 A3 0010 R                  MOV     @EQUIP_FLAG,AX          ; RESTORE IT
0ABB 24 30                      AND     AL,30H                  ; ISOLATE VIDEO SWITCHES
0ABD 75 11                      JNZ     E7                      ; VIDEO SWITCHES SET TO 0?
0ABF 1E                         PUSH    DS                      ; SAVE THE DATA SEGMENT
0AC0 50                         PUSH    AX
0AC1 2B C0                      SUB     AX,AX                   ; SET DATA SEGMENT TO 0
0AC3 8E D8                      MOV     DS,AX
0AC5 BF 0040 R                  MOV     DI,OFFSET @VIDEO_INT    ; SET INTERRUPT 10H TO DUMMY
0AC8 C7 05 0000 E               MOV     WORD PTR [DI],OFFSET DUMMY_RETURN  ; RETURN IF NO VIDEO CARD
0ACC 58                         POP     AX                      ; RESTORE REGISTERS
0ACD 1F                         POP     DS
0ACE EB 7F                      JMP     SHORT E18_1             ; BYPASS VIDEO TEST
0AD0                    E7:
0AD0 3C 30                      CMP     AL,30H                  ; B/W CARD ATTACHED?
0AD2 74 08                      JE      E8                      ; YES - SET MODE FOR B/W CARD
0AD4 FE C4                      INC     AH                      ; SET COLOR MODE FOR COLOR CARD
0AD6 3C 20                      CMP     AL,20H                  ; 80X25 MODE SELECTED?
0AD8 75 02                      JNE     E8                      ; NO - SET MODE FOR 40X25
0ADA B4 03                      MOV     AH,3                    ; SET MODE FOR 80X25
0ADC                    E8:
0ADC 86 E0                      XCHG    AH,AL
0ADE 50                         PUSH    AX                      ; SAVE VIDEO MODE ON STACK
0ADF 2A E4                      SUB     AH,AH                   ; INITIALIZE TO ALPHANUMERIC MD
0AE1 CD 10                      INT     INT_VIDEO               ; CALL VIDEO IO
0AE3 58                         POP     AX                      ; RESTORE VIDEO SENSE SWITCHES IN AH
0AE4 50                         PUSH    AX                      ; SAVE VALUE
0AE5 BB B000                    MOV     BX,0B000H               ; STARTING VIDEO MEMORY ADDRESS B/W CARD
0AE8 BA 03B8                    MOV     DX,3B8H                 ; MODE REGISTER FOR B/W
0AEB B9 0800                    MOV     CX,2048                 ; MEMORY WORD COUNT FOR B/W CARD
0AEE 80 FC 30                   CMP     AH,30H                  ; B/W VIDEO CARD ATTACHED?
0AF1 74 07                      JE      E9                      ; YES - GO TEST VIDEO STORAGE
0AF3 B7 B8                      MOV     BH,0B8H                 ; STARTING MEMORY ADDRESS FOR COLOR CARD
0AF5 BA 03D8                    MOV     DX,3D8H                 ; MODE REGISTER FOR COLOR CARD
0AF8 B5 20                      MOV     CH,20H                  ; MEMORY WORD COUNT FOR COLOR CARD
0AFA                    E9:
0AFA A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET CURRENT MODE SET VALUE
0AFD 24 37                      AND     AL,037H                 ; SET VIDEO BIT OFF
0AFF EE                         OUT     DX,AL                   ; DISABLE VIDEO FOR COLOR CARD
0B00 8E C3                      MOV     ES,BX                   ; POINT ES TO VIDEO MEMORY
0B02 8E DB                      MOV     DS,BX                   ; POINT DS TO VIDEO MEMORY
0B04 D1 C9                      ROR     CX,1                    ; DIVIDE BY 2 FOR WORD COUNT
0B06 E8 0000 E                  CALL    STGTST_CNT              ; GO TEST VIDEO READ/WRITE STORAGE
0B09 75 70                      JNE     E17                     ; R/W MEMORY FAILURE - BEEP SPEAKER

                        ;--------------------------------------------------
                        ; TEST.15                                        :
                        ;       SETUP VIDEO DATA ON SCREEN FOR VIDEO     :
                        ;       LINE TEST.                               :
                        ; DESCRIPTION                                    :
                        ;       ENABLE VIDEO SIGNAL AND SET MODE.        :
                        ;       DISPLAY A HORIZONTAL BAR ON SCREEN.      :
                        ;--------------------------------------------------

0B0B B0 22                      MOV     AL,22H                  ;       <><><><><><><><><><><><>
0B0D E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  22 <><>

0B0F 58                         POP     AX                      ; GET VIDEO SENSE SWITCHES (AH)
0B10 50                         PUSH    AX                      ; SAVE IT
0B11 B4 00                      MOV     AH,0                    ; ENABLE VIDEO AND SET MODE
0B13 CD 10                      INT     INT_VIDEO               ; VIDEO
0B15 B8 7020                    MOV     AX,7020H                ; WRITE BLANKS IN REVERSE VIDEO
0B18 2B FF                      SUB     DI,DI                   ; SETUP STARTING LOCATION
0B1A B9 0028                    MOV     CX,40                   ; NUMBER OF BLANKS TO DISPLAY
0B1D F3/ AB                     REP     STOSW                   ; WRITE VIDEO STORAGE

                        ;--------------------------------------
                        ; TEST.16                             :
                        ;       CRT INTERFACE LINES TEST      :
                        ; DESCRIPTION                         :
                        ;       SENSE ON/OFF TRANSITION OF THE  :
                        ;       VIDEO ENABLE AND HORIZONTAL   :
                        ;       SYNC LINES.                   :
                        ;--------------------------------------

0B1F 58                         POP     AX                      ; GET VIDEO SENSE SWITCH INFORMATION
0B20 50                         PUSH    AX                      ; SAVE IT
0B21 80 FC 30                   CMP     AH,30H                  ; B/W CARD ATTACHED?
0B24 BA 03BA                    MOV     DX,03BAH                ; SETUP ADDRESS OF B/W STATUS PORT
0B27 74 03                      JE      E11                     ; YES - GO TEST LINES
0B29 BA 03DA                    MOV     DX,03DAH                ; COLOR CARD IS ATTACHED
0B2C                    E11:
0B2C B4 08                      MOV     AH,8
0B2E                    E12:
0B2E 2B C9                      SUB     CX,CX
0B30                    E13:
0B30 EC                         IN      AL,DX                   ; READ CRT STATUS PORT
0B31 22 C4                      AND     AL,AH                   ; CHECK VIDEO/HORIZONTAL LINE
0B33 75 04                      JNZ     E14                     ; ITS ON - CHECK IF IT GOES OFF
0B35 E2 F9                      LOOP    E13                     ; LOOP UNTIL ON OR TIMEOUT
0B37 EB 42                      JMP     SHORT E17               ; GO PRINT ERROR MESSAGE
0B39                    E14:
0B39 2B C9                      SUB     CX,CX
0B3B                    E15:
0B3B EC                         IN      AL,DX                   ; READ CRT STATUS PORT
0B3C 22 C4                      AND     AL,AH                   ; CHECK VIDEO/HORIZONTAL LINE
0B3E 74 04                      JZ      E16                     ; ITS ON - CHECK NEXT LINE
0B40 E2 F9                      LOOP    E15                     ; LOOP IF ON UNTIL IT GOES OFF
0B42 EB 37                      JMP     SHORT E17               ; GO ERROR BEEP
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                        ;-----  CHECK HORIZONTAL LINE

0B44 B1 03              E16:    MOV     CL,3                    ; GET NEXT BIT TO CHECK
0B46 D2 EC                      SHR     AH,CL
0B48 75 E4                      JNZ     E12                     ; CONTINUE
0B4A                    E18:
0B4A 58                         POP     AX                      ; GET VIDEO SENSE SWITCHES (AH)
0B4B B4 00                      MOV     AH,0                    ; SET MODE AND DISPLAY CURSOR
0B4D CD 10                      INT     INT_VIDEO               ; CALL VIDEO I/O PROCEDURE

                        ;-----  CHECK FOR THE ADVANCED VIDEO CARD

0B4F BA C000            E18_1:  MOV     DX,0C000H               ; SET THE LOW SEGMENT VALUE
0B52                    E18A:
0B52 B0 23                      MOV     AL,23H                  ;       <><><><><><><><><><><><>
0B54 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  23 <><>
0B56 8E DA                      MOV     DS,DX
0B58 57                 PUSH    DI                              ; SAVE WORK REGISTER
0B59 BF AA55                    MOV     DI,0AA55H               ; PRESENCE SIGNATURE
0B5C 2B DB                      SUB     BX,BX                   ; CLEAR POINTER
0B5E 8B 07                      MOV     AX,[BX]                 ; GET FIRST 2 LOCATIONS
0B60 3B C7                      CMP     AX,DI                   ; PRESENT?
0B62 5F                         POP     DI                      ; RECOVER REGISTER
0B63 75 05                      JNZ     E18B                    ; NO? GO LOOK FOR OTHER MODULES

0B65 E8 0000 E                  CALL    ROM_CHECK               ; GO SCAN MODULE
0B68 EB 04                      JMP     SHORT E18C
0B6A                    E18B:
0B6A 81 C2 0080                 ADD     DX,0080H                ; POINT TO NEXT 2K BLOCK
0B6E                    E18C:
0B6E 81 FA C800                 CMP     DX,0C800H               ; TOP OF VIDEO ROM AREA YET?
0B72 7C DE                      JL      E18A                    ; GO SCAN FOR ANOTHER MODULE

0B74 B0 24                      MOV     AL,24H                  ;       <><><><><><><><><><><><>
0B76 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  24 <><>

0B78 E9 0000 E                  JMP     POST2                   ; GO TO NEXT TEST


                        ;-----  CRT ERROR SET MFG CHECKPOINT AND ERROR BEEP

0B7B E8 0000 E          E17:    CALL    DDS                     ; POINT TO DATA

                        ;-----  CHECKPOINT 0C = MONOCHROME FAILED

0B7E C6 06 0015 R 0C            MOV     @MFG_ERR_FLAG,0CH       ; <><> CRT ERROR CHECKPOINT  0C <><>
0B83 80 3E 0072 R 64            CMP     BYTE PTR @RESET_FLAG,064H ; IS THIS A MFG REQUEST?
0B88 74 0D                      JZ      E19                     ; BY PASS ERROR BEEP IF YES
0B8A F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; IS THE MFG LOOP JUMPER INSTALLED?
0B8F 74 06                      JZ      E19                     ; BY PASS ERROR BEEP IF YES
0B91 BA 0102                    MOV     DX,102H
0B94 E8 0000 E                  CALL    ERR_BEEP                ; GO BEEP SPEAKER
0B97                    E19:
0B97 1E                         PUSH    DS
0B98 A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; GET THE CURRENT VIDEO
0B9B 24 30                      AND     AL,30H                  ; STRIP OTHER BITS
0B9D 3C 30                      CMP     AL,30H                  ; IS IT MONOCHROME ?
0B9F 74 30                      JZ      TRY_COLOR               ; GO IF YES

                        ;-----  COLOR FAILED TRY MONOCHROME - CHECKPOINT 0D = COLOR FAILED

0BA1 C6 06 0015 R 0D            MOV     @MFG_ERR_FLAG,0DH       ; <><> CRT ERROR CHECKPOINT  0D <><>

0BA6 BA 03B8                    MOV     DX,3B8H                 ; DISABLE B/W
0BA9 B0 01                      MOV     AL,1
0BAB EE                         OUT     DX,AL                   ; OUTPUT THE DISABLE
0BAC BB B000                    MOV     BX,0B000H               ; CHECK FOR MONOCHROME VIDEO MEMORY
0BAF 8E DB                      MOV     DS,BX
0BB1 B8 AA55                    MOV     AX,0AA55H               ; WRITE AN AA55
0BB4 2B DB                      SUB     BX,BX                   ; TO THE FIRST LOCATION
0BB6 89 07                      MOV     [BX],AX
0BB8 EB 00                      JMP     $+2                     ; ALLOW BUS TO SETTLE
0BBA 8B 07                      MOV     AX,[BX]                 ; READ THE FIRST LOCATION
0BBC 3D AA55                    CMP     AX,0AA55H               ; IS THE MONOCHROME VIDEO CARD THERE?
0BBF 1F                         POP     DS                      ; RESTORE THE DATA SEGMENT
0BC0 75 55                      JNZ     E17_3                   ; GO IF NOT
0BC2 81 0E 0010 R 0030          OR      @EQUIP_FLAG,30H         ; TURN ON MONOCHROME BITS IN EQUIP FLAG
0BC8 A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; ENABLE VIDEO
0BCB 2A E4                      SUB     AH,AH
0BCD CD 10                      INT     INT_VIDEO
0BCF EB 34                      JMP     SHORT E17_1             ; CONTINUE

                        ;-----  MONOCHROME FAILED TRY COLOR

0BD1                    TRY_COLOR:
0BD1 B0 01                      MOV     AL,01H                  ; SET MODE COLOR 40X25
0BD3 2A E4                      SUB     AH,AH
0BD5 CD 10                      INT     INT_VIDEO
0BD7 BA 03D8                    MOV     DX,3D8H                 ; DISABLE COLOR
0BDA B0 00                      MOV     AL,0
0BDC EE                         OUT     DX,AL                   ; OUTPUT THE DISABLE
0BDD BB B800                    MOV     BX,0B800H               ; CHECK FOR COLOR VIDEO MEMORY
0BE0 8E DB                      MOV     DS,BX
0BE2 B8 AA55                    MOV     AX,0AA55H               ; WRITE AN AA55
0BE5 2B DB                      SUB     BX,BX                   ; TO THE FIRST LOCATION
0BE7 89 07                      MOV     [BX],AX
0BE9 EB 00                      JMP     $+2                     ; ALLOW BUS TO SETTLE
0BEB 8B 07                      MOV     AX,[BX]                 ; READ THE FIRST LOCATION
0BED 3D AA55                    CMP     AX,0AA55H               ; IS THE COLOR VIDEO CARD THERE?
0BF0 1F                         POP     DS                      ; RESTORE THE DATA SEGMENT
0BF1 75 24                      JNZ     E17_3                   ; GO IF NOT
0BF3 81 26 0010 R FFCF          AND     @EQUIP_FLAG,0FFCFH      ; TURN OFF VIDEO BITS
0BF9 81 0E 0010 R 0010          OR      @EQUIP_FLAG,10H         ; SET COLOR 40X24
0BFF B0 01                      MOV     AL,01H
0C01 2A E4                      SUB     AH,AH
0C03 CD 10                      INT     INT_VIDEO
0C05                    E17_1:
0C05 58                         POP     AX                      ; SET NEW VIDEO TYPE ON STACK
0C06 A1 0010 R                  MOV     AX,@EQUIP_FLAG
0C09 24 30                      AND     AL,30H
0C0B 3C 30                      CMP     AL,30H                  ; IS IT THE B/W?
0C0D 2A C0                      SUB     AL,AL
0C0F 74 02                      JZ      E17_2                   ; GO IF YES
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0C11 FE C0                      INC     AL                      ; INITIALIZE FOR 40X25
0C13                    E17_2:
0C13 50                         PUSH    AX
0C14                    E17_4:
0C14 E9 0B4A R                  JMP     E18

                        ;-----  BOTH VIDEO CARDS FAILED SET DUMMY RETURN IF RETRACE FAILURE

0C17                    E17_3:
0C17 1E                         PUSH    DS
0C18 2B C0                      SUB     AX,AX                   ; SET DS SEGMENT TO 0
0C1A 8E D8                      MOV     DS,AX
0C1C BF 0040 R                  MOV     DI,OFFSET @VIDEO_INT    ; SET INTERRUPT 10H TO DUMMY
0C1F C7 05 0000 E               MOV     WORD PTR [DI],OFFSET DUMMY_RETURN  ; RETURN IF NO VIDEO CARD
0C23 1F                         POP     DS
0C24 E9 0B4F R                  JMP     E18_1                   ; BYPASS REST OF VIDEO TEST
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                                PAGE
                                ;--------------------------------------------------------------------------------
                                ; MANUFACTURING BOOT TEST CODE ROUTINE                                          :
                                ;       LOAD A BLOCK OF TEST CODE THROUGH THE KEYBOARD PORT FOR MANUFACTURING   :
                                ;       TESTS.                                                                 :
                                ;       THIS ROUTINE WILL LOAD A TEST (MAX LENGTH=FAFFH) THROUGH THE KEYBOARD  :
                                ;       PORT. CODE WILL BE LOADED AT LOCATION  0000:0500.  AFTER LOADING,      :
                                ;       CONTROL WILL BE TRANSFERRED TO LOCATION  0000:0500.   THE STACK WILL   :
                                ;       BE LOCATED AT 0000:0400.  THIS ROUTINE ASSUMES THAT THE FIRST 2 BYTES  :
                                ;       TRANSFERRED CONTAIN THE COUNT OF BYTES TO BE LOADED                    :
                                ;       (BYTE 1=COUNT LOW, BYTE 2=COUNT HI.)                                   :
                                ;--------------------------------------------------------------------------------

                                ;-----  DEGATE ADDRESS LINE 20

0C27                            MFG_BOOT:
0C27 B4 DD                              MOV     AH,DISABLE_BIT20        ; DEGATE COMMAND FOR ADDRESS LINE 20
0C29 E8 0000 E                          CALL    GATE_A20                ; ISSUE TO KEYBOARD ADAPTER AND CLI

                                ;-----  SETUP HARDWARE INTERRUPT VECTOR TABLE LEVEL 0-7 AND SOFTWARE INTERRUPTS

0C2C 68 ---- R                          PUSH    ABS0                    ; SET ES SEGMENT REGISTER TO ABS0
0C2F 07                                 POP     ES
0C30 B9 0018                            MOV     CX,24                   ; GET VECTOR COUNT
0C33 8C C8                              MOV     AX,CS                   ; GET THE CURRENT CODE SEGMENT VALUE
0C35 8E D8                              MOV     DS,AX                   ; SETUP DS SEGMENT REGISTER TO
0C37 BE 0000 E                          MOV     SI,OFFSET VECTOR_TABLE  ; POINT TO THE ROUTINE ADDRESS TABLE
0C3A BF 0020 R                          MOV     DI,OFFSET @INT_PTR      ; SET DESTINATION TO FIRST USED VECTOR
0C3D                            MFG_B1:
0C3D A5                                 MOVSW                           ; MOVE ONE ROUTINE OFFSET ADDRESS
0C3E AB                                 STOSW                           ; INSERT CODE SEGMENT VALUE
0C3F E2 FC                              LOOP    MFG_B1                  ; MOVE THE NUMBER OF ENTRIES REQUIRED

                                ;-----  SETUP HARDWARE INTERRUPT VECTORS LEVEL 8-15 (VECTORS START AT INT 70 H)

0C41 B9 0008                            MOV     CX,08                   ; GET VECTOR COUNT
0C44 BE 0000 E                          MOV     SI,OFFSET SLAVE_VECTOR_TABLE
0C47 BF 01C0 R                          MOV     DI,OFFSET @SLAVE_INT_PTR
0C4A                            MFG_B2:
0C4A A5                                 MOVSW                           ; MOVE ONE ROUTINE OFFSET ADDRESS
0C4B AB                                 STOSW                           ; INSERT CODE SEGMENT VALUE
0C4C E2 FC                              LOOP    MFG_B2

                                ;-----  SET UP OTHER INTERRUPTS AS NECESSARY

                                        ASSUME  DS:ABS0,ES:ABS0
0C4E 06                                 PUSH    ES                              ; ES= ABS0
0C4F 1F                                 POP     DS                              ; SET DS TO ABS0
0C50 C7 06 0008 R 0000 E                MOV     WORD PTR @NMI_PTR,OFFSET NMI_INT        ; NMI INTERRUPT
0C56 C7 06 0014 R 0000 E                MOV     WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN  ; PRINT SCREEN
0C5C C7 06 0062 R F600                  MOV     WORD PTR @BASIC_PTR+2,0F600H            ; CASSETTE BASIC SEGMENT

                                ;-----  ENABLE KEYBOARD PORT

0C62 B0 60                              MOV     AL,60H                  ; WRITE 8042 MEMORY LOCATION 0
0C64 E8 0396 R                          CALL    C8042                   ; ISSUE THE COMMAND
0C67 B0 09                              MOV     AL,00001001B            ; SET INHIBIT OVERRIDE/ENABLE OBF
0C69 E6 60                              OUT     PORT_A,AL               ;   INTERRUPT AND NOT PC COMPATIBLE

0C6B E8 0C8D R                          CALL    MFG_B4                  ; GET COUNT LOW
0C6E 8A F8                              MOV     BH,AL                   ; SAVE IT
0C70 E8 0C8D R                          CALL    MFG_B4                  ; GET COUNT HI
0C73 8A E8                              MOV     CH,AL
0C75 8A CF                              MOV     CL,BH                   ; CX NOW HAS COUNT
0C77 FC                                 CLD                             ; SET DIRECTION FLAG TO INCREMENT
0C78 BF 0500 R                          MOV     DI,OFFSET @MFG_TEST_RTN ; SET TARGET OFFSET (DS=0000)
0C7B                            MFG_B3:
0C7B E4 64                              IN      AL,STATUS_PORT          ; GET 8042 STATUS PORT
0C7D A8 01                              TEST    AL,OUT_BUF_FULL         ; KEYBOARD REQUEST PENDING?
0C7F 74 FA                              JZ      MFG_B3                  ; LOOP TILL DATA PRESENT
0C81 E4 60                              IN      AL,PORT_A               ; GET DATA
0C83 AA                                 STOSB                           ; STORE IT
0C84 E6 80                              OUT     MFG_PORT,AL             ; DISPLAY CHARACTER AT MFG PORT
0C86 E2 F3                              LOOP    MFG_B3                  ; LOOP TILL ALL BYTES READ

0C88 EA 0500 ---- R                     JMP     @MFG_TEST_RTN           ; FAR JUMP TO CODE THAT WAS JUST LOADED

0C8D                            MFG_B4:
0C8D E4 64                              IN      AL,STATUS_PORT          ; CHECK FOR OUTPUT BUFFER FULL
0C8F A8 01                              TEST    AL,OUT_BUF_FULL         ;   HANG HERE IF NO DATA AVAILABLE
0C91 E1 FA                              LOOPZ   MFG_B4

0C93 E4 60                              IN      AL,PORT_A               ; GET THE COUNT
0C95 C3                                 RET

0C96                            POST1   ENDP
0C96                            CODE    ENDS
                                        END
```

```
                        PAGE 118,121
                        TITLE TEST2 ---- 06/10/85  POST TESTS AND INITIALIZATION ROUTINES
                        .286C
                        .287
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC
                                PUBLIC  C21
                                PUBLIC  POST2
                                PUBLIC  SHUT2
                                PUBLIC  SHUT3
                                PUBLIC  SHUT4
                                PUBLIC  SHUT6
                                PUBLIC  SHUT7

                                EXTRN   BLINK_INT:NEAR
                                EXTRN   C8042:NEAR
                                EXTRN   CMOS_READ:NEAR
                                EXTRN   CMOS_WRITE:NEAR
                                EXTRN   CONFIG_BAD:NEAR
                                EXTRN   D1:NEAR
                                EXTRN   D2:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   DISK_SETUP:NEAR
                                EXTRN   DSKETTE_SETUP:NEAR
                                EXTRN   ERR_BEEP:NEAR
                                EXTRN   E_MSG:NEAR
                                EXTRN   F3D:NEAR
                                EXTRN   F3D1:NEAR
                                EXTRN   GATE_A20:NEAR
                                EXTRN   HD_INT:NEAR
                                EXTRN   KBD_RESET:NEAR
                                EXTRN   NMI_INT:NEAR
                                EXTRN   OBF_42:NEAR
                                EXTRN   POST3:NEAR
                                EXTRN   PRINT_SCREEN:NEAR
                                EXTRN   PROC_SHUTDOWN:NEAR
                                EXTRN   PROT_PRT_HEX:NEAR
                                EXTRN   PRT_HEX:NEAR
                                EXTRN   P_MSG:NEAR
                                EXTRN   ROM_CHECK:NEAR
                                EXTRN   ROM_CHECKSUM:NEAR
                                EXTRN   SEEK:NEAR
                                EXTRN   SET_TOD:NEAR
                                EXTRN   SLAVE_VECTOR_TABLE:NEAR
                                EXTRN   SND_DATA:NEAR
                                EXTRN   START_1:NEAR
                                EXTRN   STGTST_CNT:NEAR
                                EXTRN   SYSINIT1:NEAR
                                EXTRN   VECTOR_TABLE:NEAR
                                EXTRN   WAITF:NEAR
                                EXTRN   XPC_BYTE:NEAR

                                EXTRN   E101:NEAR               ; 101 ERROR CODE - INTERRUPT FAILURE
                                EXTRN   E102:NEAR               ; 102 ERROR CODE - TIMER FAILURE
                                EXTRN   E103:NEAR               ; 103 ERROR CODE - TIMER INTERRUPT
                                EXTRN   E104:NEAR               ; 104 ERROR CODE - PROTECTED MODE ERROR
                                EXTRN   E105:NEAR               ; 105 ERROR CODE - 8042 COMMAND FAILURE
                                EXTRN   E106:NEAR               ; 106 ERROR CODE - CONVERTING LOGIC
                                EXTRN   E107:NEAR               ; 107 ERROR CODE - NMI ERROR
                                EXTRN   E108:NEAR               ; 108 ERROR CODE - TIMER BUS ERROR
                                EXTRN   E109:NEAR               ; 109 ERROR CODE - MEMORY SELECT ERROR
                                EXTRN   E161:NEAR               ; 161 ERROR CODE - BAD BATTERY
                                EXTRN   E162:NEAR               ; 162 ERROR CODE - CMOS CHECKSUM/CONFIG
                                EXTRN   E163:NEAR               ; 163 ERROR CODE - BAD REAL TIME CLOCK
                                EXTRN   E164:NEAR               ; 164 ERROR CODE - MEMORY SIZE WRONG
                                EXTRN   E201:NEAR               ; 201 ERROR CODE - MEMORY DATA ERROR
                                EXTRN   E202:NEAR               ; 202 ERROR CODE - MEMORY ADDRESS ERROR
                                EXTRN   E203:NEAR               ; 203 ERROR CODE - SEGMENT ADDRESS ERROR
                                EXTRN   E301:NEAR               ; 301 ERROR CODE - KEYBOARD ERROR
                                EXTRN   E302:NEAR               ; 302 ERROR CODE - LOCK IS ON
                                EXTRN   E303:NEAR               ; 303 ERROR CODE - KEYBOARD/PLANAR ERROR
                                EXTRN   E304:NEAR               ; 304 ERROR CODE - KEYBOARD/PLANAR ERROR
                                EXTRN   E401:NEAR               ; 401 ERROR CODE - MONOCHROME ADAPTER
                                EXTRN   E501:NEAR               ; 501 ERROR CODE - COLOR ADAPTER
                                EXTRN   E601:NEAR               ; 601 ERROR CODE - DISKETTE ADAPTER

                        ;--------------------------------------------------------
                        ; TEST.17                                              :
                        ;       8259 INTERRUPT CONTROLLER TEST                 :
                        ; DESCRIPTION                                          :
                        ;       READ/WRITE THE INTERRUPT MASK REGISTER (IMR)    :
                        ;       WITH ALL ONES AND ZEROES. ENABLE SYSTEM        :
                        ;       INTERRUPT MASK DEVICE INTERRUPTS OFF. CHECK    :
                        ;       FOR HOT INTERRUPTS (UNEXPECTED).               :
                        ;--------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA

0000                    POST2   PROC    NEAR

0000 B0 0A              C21:    MOV     AL,10                   ; LINE FEED ON DISPLAY
0002 E8 0000 E                  CALL    PRT_HEX
0005 E8 0000 E                  CALL    DDS                     ;SET DATA SEGMENT

                        ;-----  CLEAR ERROR FLAG REGISTER (BP) <=> 0 FLAGS ERROR

0008 2B ED                      SUB     BP,BP                   ; CLEAR (BP) REGISTER AS ERROR FLAG REG

                        ;-----  TEST THE INTERRUPT MASK REGISTER REGISTERS

000A FA                 C21A:   CLI                             ; TURN OFF INTERRUPTS
000B B0 00                      MOV     AL,0                    ; SET INTERRUPT MASK REGISTER TO ZERO
000D E6 21                      OUT     INTA01,AL
000F E6 A1                      OUT     INTB01,AL               ; SEND TO 2ND INTERRUPT CONTROLLER ALSO
0011 EB 00                      JMP     $+2
0013 E4 21                      IN      AL,INTA01               ; READ INTERRUPT MASK REGISTER
0015 8A E0                      MOV     AH,AL                   ; SAVE RESULTS
0017 E4 A1                      IN      AL,INTB01               ; READ 2ND INTERRUPT MASK REGISTER

0019 0A E0                      OR      AH,AL                   ; BOTH IMR = 0?
001B 75 2C                      JNZ     D6                      ; GO TO ERR ROUTINE IF NOT 0

001D B0 25                      MOV     AL,25H                  ;       <><><><><><><><><><>
001F E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  25 <><>
```

```
                                        ;-----  CHECK FOR HOT INTERRUPTS
                                        ;-----  INTERRUPTS ARE MASKED OFF.  CHECK THAT NO INTERRUPTS OCCUR.
0034 A2 006B R                                  MOV     @INTR_FLAG,AL           ; CLEAR INTERRUPT FLAG
0037 B0 26                                      MOV     AL,26H                  ;       <><><><><><><><><><><><>
0039 E6 80                                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  26 <><>
003B FB                                         STI                             ; ENABLE EXTERNAL INTERRUPTS
003C B9 19E4                                    MOV     CX,6628                 ; WAIT 100 MILLISECONDS FOR ANY
003F E8 0000 E                                  CALL    WAITF                   ;  INTERRUPTS THAT OCCUR
0042 80 3E 006B R 00                            CMP     @INTR_FLAG,00H          ; DID ANY INTERRUPTS OCCUR?
0047 74 0D                                      JZ      D7                      ; NO - GO TO NEXT TEST
0049 C6 06 0015 R 05    D6:             MOV     @MFG_ERR_FLAG,05H       ;       <><><><><><><><><><><><>
                                                                        ;       <><> CHECKPOINT   5 <><>
004E BE 0000 E                                  MOV     SI,OFFSET E101          ; DISPLAY 101 ERROR
0051 E8 0000 E          D6A:            CALL    E_MSG
0054 FA                                         CLI
0055 F4                                         HLT                             ; HALT THE SYSTEM
                                        ;-----  CHECK THE CONVERTING LOGIC
0056 B0 27              D7:             MOV     AL,27H                  ;       <><><><><><><><><><><><>
0058 E6 80                                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  27 <><>
005A B8 AA55                                    MOV     AX,0AA55H
005D E7 82                                      OUT     MFG_PORT+2,AX           ; WRITE A WORD
005F E4 82                                      IN      AL,MFG_PORT+2           ;  GET THE FIRST BYTE
0061 86 C4                                      XCHG    AL,AH                   ;  SAVE IT
0063 E4 83                                      IN      AL,MFG_PORT+3           ;  GET THE SECOND BYTE
0065 3D 55AA                                    CMP     AX,55AAH                ; IS IT OK?
0068 74 05                                      JZ      D7_A                    ; GO IF YES
006A BE 0000 E                                  MOV     SI,OFFSET E106          ; DISPLAY 106 ERROR
006D EB E2                                      JMP     D6A
                                        ;-----  CHECK FOR HOT NMI INTERRUPTS WITHOUT I/O-MEMORY PARITY ENABLED
006F                    D7_A:
006F B0 0D                                      MOV     AL,CMOS_REG_D           ; TURN ON NMI
0071 E6 70                                      OUT     CMOS_PORT,AL            ; ADDRESS DEFAULT READ ONLY REGISTER
0073 B9 0007                                    MOV     CX,7                    ; DELAY COUNT FOR 100 MICROSECONDS
0076 E8 0000 E                                  CALL    WAITF                   ; WAIT FOR HOT NMI TO PROCESS
0079 B0 8D                                      MOV     AL,CMOS_REG_D+NMI       ; TURN NMI ENABLE BACK OFF
007B E6 70                                      OUT     CMOS_PORT,AL
007D 80 3E 006B R 00                            CMP     @INTR_FLAG,00H          ; DID ANY INTERRUPTS OCCUR?
0082 74 09                                      JZ      D7_C                    ; CONTINUE IF NOT
0084 B0 28                                      MOV     AL,28H                  ;       <><><><><><><><><><><><>
0086 E6 80                                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  28 <><>
0088 BE 0000 E                                  MOV     SI,OFFSET E107          ; DISPLAY 107 ERROR
008B EB C4                                      JMP     D6A
                                        ;-----  TEST THE DATA BUS TO TIMER 2
008D B0 29              D7_C:           MOV     AL,29H                  ;       <><><><><><><><><><><><>
008F E6 80                                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  29 <><>
0091 E4 61                                      IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
0093 8A E0                                      MOV     AH,AL                   ; SAVE THAT SETTING
0095 24 FC                                      AND     AL,0FCH                 ; INSURE SPEAKER OFF
0097 E6 61                                      OUT     PORT_B,AL
0099 B0 B0                                      MOV     AL,10110000B            ; SELECT TIM 2,LSB,MSB,BINARY,MODE 0
009B E6 43                                      OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
009D EB 00                                      JMP     $+2                     ; I/O DELAY
009F B8 AA55                                    MOV     AX,0AA55H               ; WRITE AN AA55
00A2 E6 42                                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
00A4 EB 00                                      JMP     $+2                     ; I/O DELAY
00A6 8A C4                                      MOV     AL,AH
00A8 E6 42                                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
00AA EB 00                                      JMP     $+2                     ; I/O DELAY
00AC E4 42                                      IN      AL,TIMER+2              ; GET THE LSB
00AE 86 E0                                      XCHG    AH,AL                   ; SAVE IT
00B0 EB 00                                      JMP     $+2                     ; I/O DELAY
00B2 E4 42                                      IN      AL,TIMER+2              ; GET THE MSB
00B4 3D 55AA                                    CMP     AX,055AAH               ; BUS OK?
00B7 74 05                                      JZ      D7_D                    ; GO IF OK
00B9 BE 0000 E                                  MOV     SI,OFFSET E108          ; DISPLAY 108 ERROR
00BC EB 93                                      JMP     D6A
                                        ;--------------------------------------------------------
                                        ; TEST.18                                               :
                                        ;       8254 TIMER CHECKOUT                             :
                                        ; DESCRIPTION                                           :
                                        ;       VERIFY THAT THE SYSTEM TIMER (0) DOESN'T COUNT  :
                                        ;       TOO FAST OR TOO SLOW.                           :
                                        ;--------------------------------------------------------
00BE B0 2A              D7_D:           MOV     AL,2AH                  ;       <><><><><><><><><><><><>
00C0 E6 80                                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2A <><>
00C2 FA                                         CLI                             ;
00C3 B0 FE                                      MOV     AL,0FEH                 ; MASK ALL INTERRUPTS EXCEPT LEVEL 0
00C5 E6 21                                      OUT     INTA01,AL               ; WRITE THE 8259 IMR
00C7 B0 10                                      MOV     AL,00010000B            ; SELECT TIM 0, LSB, MODE 0, BINARY
00C9 E6 43                                      OUT     TIMER+3,AL              ; WRITE TIMER CONTROL MODE REGISTER
00CB B9 002C                                    MOV     CX,2CH                  ; SET PROGRAM LOOP COUNT
00CE EB 00                                      JMP     $+2                     ; I/O DELAY
```

```
00D0 8A C1                      MOV     AL,CL                   ; SET TIMER 0 COUNT REGISTER
00D2 E6 40                      OUT     TIMER+0,AL              ; WRITE TIMER 0 COUNT REGISTER
00D4 FB                         STI
00D5 F6 06 006B R 01    D8:     TEST    @INTR_FLAG,01H
                                                                ; DID TIMER 0 INTERRUPT OCCUR?
00DA 75 0D                      JNZ     D9                      ; CHECK TIMER OPERATION FOR SLOW TIME
00DC E2 F7                      LOOP    D8                      ; WAIT FOR INTERRUPT FOR SPECIFIED TIME

00DE C6 06 0015 R 02            MOV     @MFG_ERR_FLAG,02H       ;       <><><><><><><><><><><><><>
                                                                ;       <><> TIMER CHECKPOINT (2) <><>


00E3 BE 0000 E          D8_A:   MOV     SI,OFFSET E102          ; DISPLAY 102 ERROR
00E6 E9 0051 R                  JMP     D6A                     ; TIMER 0 INTERRUPT DID NOT OCCUR= ERROR


00E9 B0 2B              D9:     MOV     AL,2BH                  ;       <><><><><><><><><><><><><>
00EB E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2B <><>

00ED FA                         CLI
00EE B1 0C                      MOV     CL,12                   ; SET PROGRAM LOOP COUNT
00F0 B0 FF                      MOV     AL,0FFH                 ; WRITE TIMER 0 COUNT REGISTER
00F2 E6 40                      OUT     TIMER+0,AL
00F4 C6 06 006B R 00            MOV     @INTR_FLAG,0            ; RESET INTERRUPT RECEIVED FLAG
00F9 B0 FE                      MOV     AL,0FEH                 ; RE-ENABLE TIMER 0 INTERRUPTS
00FB E6 21                      OUT     INTA01,AL
00FD FB                         STI
00FE F6 06 006B R 01    D10:    TEST    @INTR_FLAG,01H          ; DID TIMER 0 INTERRUPT OCCUR?
0103 75 DE                      JNZ     D8_A                    ; YES - TIMER COUNTING TOO FAST, ERROR
0105 E2 F7                      LOOP    D10                     ; WAIT FOR INTERRUPT FOR SPECIFIED TIME


                        ;-----  WAIT FOR INTERRUPT

0107 2B C9                      SUB     CX,CX

0109 B0 2C                      MOV     AL,2CH                  ;       <><><><><><><><><><><><><>
010B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2C <><>
010D                    D110:
010D F6 06 006B R 01            TEST    @INTR_FLAG,01H          ; DID TIMER 0 INTERRUPT OCCUR?
0112 75 08                      JNZ     D12                     ; GO IF YES
0114 E2 F7                      LOOP    D110                    ; TRY AGAIN

0116 BE 0000 E                  MOV     SI,OFFSET E103          ; DISPLAY 103 ERROR
0119 E9 0051 R                  JMP     D6A                     ; ERROR IF NOT


                        ;-----  SETUP TIMER 0 TO MODE 3

011C FA                 D12:    CLI
011D B0 FF                      MOV     AL,0FFH                 ; DISABLE ALL DEVICE INTERRUPTS
011F E6 21                      OUT     INTA01,AL
0121 B0 36                      MOV     AL,36H                  ; SELECT TIMER 0,LSB,MSB,MODE 3
0123 E6 43                      OUT     TIMER+3,AL              ; WRITE TIMER MODE REGISTER
0125 EB 00                      JMP     $+2                     ; I/O DELAY
0127 B0 00                      MOV     AL,0
0129 E6 40                      OUT     TIMER+0,AL              ; WRITE LSB TO TIMER 0 REGISTER
012B EB 00                      JMP     $+2                     ; I/O DELAY
012D E6 40                      OUT     TIMER+0,AL              ; WRITE MSB TO TIMER 0 REGISTER


                        ;-----  CHECK 8042 FOR LAST COMMAND ACCEPTED

012F 2B C9                      SUB     CX,CX                   ; SET WAIT TIME
0131 B0 2D                      MOV     AL,2DH                  ;       <><><><><><><><><><><><><>
0133 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2D <><>
0135 E4 64              D13:    IN      AL,STATUS_PORT          ; GET THE 8042 STATUS
0137 A8 02                      TEST    AL,INPT_BUF_FULL        ; HAS THE LAST COMMAND BEEN ACCEPTED?
0139 74 08                      JZ      E19                     ; GO IF YES
013B E2 F8                      LOOP    D13                     ; TRY AGAIN


                        ;-----  ERROR EXIT (MESSAGE 105)

013D BE 0000 E                  MOV     SI,OFFSET E105          ; PRINT 105 ERROR
0140 E9 0051 R                  JMP     D6A                     ; GO ERROR HALT


                        ;--------------------------------------------------------------------------
                        ; TEST.19                                                                 :
                        ;       ADDITIONAL READ/WRITE STORAGE TEST                                :
                        ;       ++++ MUST RUN IN PROTECTED MODE ++++                              :
                        ; DESCRIPTION                                                             :
                        ;       WRITE/READ DATA PATTERNS TO ANY READ/WRITE STORAGE AFTER THE      :
                        ;       FIRST 64K.  STORAGE ADDRESSABILITY IS CHECKED.                    :
                        ;--------------------------------------------------------------------------


                                ASSUME  DS:DATA
0143                    E19:
0143 E8 0000 E                  CALL    DDS                     ; SET DATA SEGMENT
0146 B0 2F                      MOV     AL,2FH                  ;       <><><><><><><><><><><><><>
0148 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2F <><>

014A 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; WARM START?
0150 75 03                      JNE     E19A                    ; GO IF NOT
0152 E9 0420 R                  JMP     SHUT2                   ; GO TO NEXT TEST IF WARM START


                        ;-----  SET SHUTDOWN RETURN 2

0155 B0 30              E19A:   MOV     AL,30H                  ;       <><><><><><><><><><><><><>
0157 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  30 <><>

0159 B8 028F                    MOV     AX,2*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
015C E8 0000 E                  CALL    CMOS_WRITE              ; SECOND ENTRY IN SHUTDOWN TABLE


                        ;-----  ENABLE PROTECTED MODE

015F BC 0000                    MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
0162 8E D4                      MOV     SS,SP
0164 BC 8000                    MOV     SP,POST_SP

0167 E8 0000 E                  CALL    SYSINIT1                ; GO ENABLE PROTECTED MODE


016A B0 31                      MOV     AL,31H                  ;       <><><><><><><><><><><><><>
016C E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  31 <><>


                        ;-----  SET TEMPORARY STACK

016E 6A 08                      PUSH    BYTE PTR GDT_PTR
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```
0170 07                         POP     ES
0171 26: C7 06 005A 0000        MOV     ES:SS_TEMP.BASE_LO_WORD,0
0178 26: C6 06 005C 00          MOV     BYTE PTR ES:[SS_TEMP.BASE_HI_BYTE],0
017E BE 0058                    MOV     SI,SS_TEMP
0181 8E D6                      MOV     SS,SI
0183 BC FFFD                    MOV     SP,MAX_SEG_LEN-2

                        ;-----  DATA SEGMENT TO SYSTEM DATA AREA

0186 6A 18                      PUSH    BYTE PTR RSDA_PTR       ; POINT TO DATA AREA
0188 1F                         POP     DS

0189 B0 80                      MOV     AL,PARITY_CHECK         ; SET CHECK PARITY
018B E6 87                      OUT     DMA_PAGE+6,AL           ; SAVE WHICH CHECK TO USE

                        ;-----  PRINT 64 K BYTES OK

018D B8 0040                    MOV     AX,64                   ; STARTING AMOUNT OF MEMORY OK
0190 E8 099F R                  CALL    PRT_OK                  ; POST 65K OK MESSAGE

                        ;-----  GET THE MEMORY SIZE DETERMINED (PREPARE BX AND DX FOR BAD CMOS)

0193 B8 B0B1                    MOV     AX,(CMOS_U_M_S_LO+NMI)*H+CMOS_U_M_S_HI+NMI
0196 E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
0199 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
019B E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE
019E 8B 1E 0013 R               MOV     BX,@MEMORY_SIZE         ; LOAD THE BASE MEMORY SIZE
01A2 8B D3                      MOV     DX,BX                   ; SAVE BASE MEMORY SIZE
01A4 03 D8                      ADD     BX,AX                   ; SET TOTAL MEMORY SIZE

                        ;-----  IS CMOS GOOD?

01A6 B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; DETERMINE THE CONDITION OF CMOS
01A8 E8 0000 E                  CALL    CMOS_READ               ; GET THE CMOS STATUS

01AB A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; CMOS OK?
01AD 74 02                      JZ      E20B0                   ; GO IF YES
01AF EB 5B                      JMP     SHORT E20C              ; DEFAULT IF NOT

                        ;-----  GET THE BASE 0->640K MEMORY SIZE FROM CONFIGURATION IN CMOS

01B1                    E20B0:
01B1 B8 9596                    MOV     AX,(CMOS_B_M_S_LO+NMI)*H+CMOS_B_M_S_HI+NMI
01B4 E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
01B7 24 3F                      AND     AL,03FH                 ; MASK OFF THE MANUFACTURING TEST BITS
01B9 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
01BB E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE OF BASE MEMORY SIZE
01BE 3B D0                      CMP     DX,AX                   ; IS MEMORY SIZE GREATER THAN CONFIG?
01C0 74 13                      JZ      E20B1                   ; GO IF EQUAL

                        ;-----  SET MEMORY SIZE DETERMINE NOT EQUAL TO CONFIGURATION

01C2 50                         PUSH    AX                      ; SAVE AX
01C3 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS THE STATUS BYTE
01C6 E8 0000 E                  CALL    CMOS_READ               ; GET THE STATUS
01C9 0C 10                      OR      AL,W_MEM_SIZE           ; SET CMOS FLAG
01CB 86 C4                      XCHG    AL,AH                   ; SAVE AL AND GET ADDRESS
01CD E8 0000 E                  CALL    CMOS_WRITE              ; WRITE UPDATED STATUS
01D0 58                         POP     AX                      ; RESTORE AX
01D1 3B D0                      CMP     DX,AX                   ; IS MEMORY SIZE GREATER THAN CONFIG ?
01D3 77 37                      JA      E20C                    ; DEFAULT TO MEMORY SIZE DETERMINED ?
01D5                    E20B1:
01D5 8B D8                      MOV     BX,AX                   ; SET BASE MEMORY SIZE IN TOTAL REGISTER
01D7 8B D0                      MOV     DX,AX                   ; SAVE IN BASE SIZE REGISTER

                        ;-----  CHECK MEMORY SIZE ABOVE 640K FROM CONFIGURATION

01D9 B8 9798                    MOV     AX,(CMOS_E_M_S_LO+NMI)*H+(CMOS_E_M_S_HI+NMI)
01DC E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
01DF 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
01E1 E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE
01E4 8B C8                      MOV     CX,AX                   ; SAVE THE ABOVE 640K MEMORY SIZE
                        ;-----  ABOVE 640K SIZE FROM MEMORY SIZE DETERMINE
                        ;-----  CX=CONFIG  AX=MEMORY SIZE DETERMINE
01E6 B8 B0B1                    MOV     AX,(CMOS_U_M_S_LO+NMI)*H+(CMOS_U_M_S_HI+NMI)
01E9 E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
01EC 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
01EE E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE
                        ;------ WHICH IS GREATER - AX = MEMORY SIZE DETERMINE
                        ;------ CX = CONFIGURATION (ABOVE 640) BX = SIZE (BELOW 640)

01F1 3B C8                      CMP     CX,AX                   ; IS CONFIGURATION EQUAL TO DETERMINED?
01F3 74 0F                      JZ      SET_MEM1                ; GO IF EQUAL

                        ;-----  SET MEMORY SIZE DETERMINE NOT EQUAL TO CONFIGURATION

01F5 50                         PUSH    AX                      ; SAVE AX
01F6 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS THE STATUS BYTE
01F9 E8 0000 E                  CALL    CMOS_READ               ; GET THE STATUS
01FC 0C 10                      OR      AL,W_MEM_SIZE           ; SET CMOS FLAG
01FE 86 C4                      XCHG    AL,AH                   ; SAVE AL
0200 E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE STATUS BYTE
0203 58                         POP     AX                      ; RESTORE AX

0204                    SET_MEM1:
0204 3B C8                      CMP     CX,AX                   ; IS CONFIG GREATER THAN DETERMINED?
0206 77 02                      JA      SET_MEM                 ;  GO IF YES
0208 8B C8                      MOV     CX,AX                   ; USE MEMORY SIZE DETERMINE IF NOT
020A                    SET_MEM:
020A 03 D9                      ADD     BX,CX                   ; SET TOTAL MEMORY SIZE
020C                    E20C:
020C 81 FA 0201                 CMP     DX,513                  ; CHECK IF BASE MEMORY LESS 512K
0210 72 0D                      JB      NO_640                  ; GO IF YES

0212 B8 B3B3                    MOV     AX,X*(CMOS_INFO128+NMI) ; SET 640K BASE MEMORY BIT
0215 E8 0000 E                  CALL    CMOS_READ               ; GET THE CURRENT STATUS
0218 0C 80                      OR      AL,M640K                ; TURN ON 640K BIT IF NOT ALREADY ON
021A 86 C4                      XCHG    AL,AH                   ; SAVE THE CURRENT DIAGNOSTIC STATUS
021C E8 0000 E                  CALL    CMOS_WRITE              ; RESTORE THE STATUS
021F                    NO_640:
021F 89 1E 0017 R               MOV     WORD PTR @KB_FLAG,BX    ; SAVE TOTAL SIZE FOR LATER TESTING
0223 C1 EB 06                   SHR     BX,6                    ; DIVIDE BY 64
0226 4B                         DEC     BX                      ; 1ST 64K ALREADY DONE
0227 C1 EA 06                   SHR     DX,6                    ; DIVIDE BY 64 FOR BASE
```

```
                        ;-----  SAVE COUNTS IN STACK FOR BOTH MEMORY AND ADDRESSING TESTS

022A 52                         PUSH    DX                      ; SAVE BASE MEMORY SIZE COUNT
022B 6A 40                      PUSH    BYTE PTR 64             ; SAVE STARTING AMOUNT OF MEMORY OK
022D 53                         PUSH    BX                      ; SAVE COUNT OF 64K BLOCKS TO BE TESTED

022E 52                         PUSH    DX                      ; SAVE BASE MEMORY SIZE COUNT
022F 6A 40                      PUSH    BYTE PTR 64             ; SAVE STARTING AMOUNT OF MEMORY OK
0231 53                         PUSH    BX                      ; SAVE COUNT OF 64K BLOCKS TO BE TESTED

                        ;-----  MODIFY DESCRIPTOR TABLES

0232 6A 08                      PUSH    BYTE PTR GDT_PTR        ; MODIFY THE DESCRIPTOR TABLE
0234 07                         POP     ES

                        ;-----  SET TEMPORARY ES DESCRIPTOR 64K SEGMENT LIMIT STARTING AT 000000

0235 26: C7 06 0048 FFFF        MOV     ES:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
023C 26: C7 06 004A 0000        MOV     ES:ES_TEMP.BASE_LO_WORD,0
0243 26: C6 06 004C 00          MOV     BYTE PTR ES:(ES_TEMP.BASE_HI_BYTE),0            ; FIRST 65K
0249 26: C6 06 004D 93          MOV     BYTE PTR ES:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                        ;-----  SET TEMPORARY DS DESCRIPTOR 64K SEGMENT LIMIT AT FIRST 65K BLOCK

024F 26: C7 06 0060 FFFF        MOV     ES:DS_TEMP.SEG_LIMIT,MAX_SEG_LEN
0256 26: C7 06 0062 0000        MOV     ES:DS_TEMP.BASE_LO_WORD,0
025D 26: C6 06 0064 00          MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0
0263 26: C6 06 0065 93          MOV     BYTE PTR ES:(DS_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                        ;-----  TEMPORARY SEGMENT SAVE IN DMA PAGE REGISTER FOR SECOND 65K BLOCK

0269 2A C0                      SUB     AL,AL                   ; INITIALIZE VALUES TO 010000
026B E6 85                      OUT     DMA_PAGE+4,AL           ; HIGH BYTE OF LOW WORD OF SEGMENT
026D E6 86                      OUT     DMA_PAGE+5,AL           ; LOW BYTE OF LOW WORD OF SEGMENT
026F FE C0                      INC     AL                      ; SET HIGH BYTE OF SEGMENT WORD
0271 E6 84                      OUT     DMA_PAGE+3,AL           ; HIGH BYTE OF SEGMENT


                        ;-----  MEMORY TEST LOOP - POINT TO NEXT BLOCK OF 32K WORDS (64K)

0273                    E21:                                    ;       MEMORY TEST LOOP
0273 6A 08                      PUSH    BYTE PTR GDT_PTR        ; POINT TO START OF DESCRIPTOR TABLE
0275 1F                         POP     DS
0276 FE 06 0064                 INC     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE)      ; POINT TO NEXT BLOCK
027A FE 06 004C                 INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                        ;-----  CHECK FOR END OF 256K PLANAR MEMORY

027E 80 3E 0064 04              CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),04H
0283 72 04                      JB      E21_0                   ; GO IF STILL FIRST 256K OF BASE MEMORY

0285 B0 C0                      MOV     AL,PARITY_CHECK+IO_CHECK; CHECK FOR ANY TYPE OF PARITY ERROR
0287 E6 87                      OUT     DMA_PAGE+6,AL           ; AFTER FIRST 256K

                        ;-----  CHECK END OF FIRST 640K OR ABOVE (END OF MAXIMUM BASE MEMORY)
0289                    E21_0:
0289 80 3E 0064 0A              CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),0AH
028E 77 16                      JA      NEXT                    ; CONTINUE IF ABOVE 1 MEG

                        ;-----  CHECK FOR END OF BASE MEMORY TO BE TESTED

0290 59                         POP     CX                      ; GET COUNT
0291 5B                         POP     BX                      ; GET COUNT TESTED
0292 58                         POP     AX                      ; RECOVER COUNT OF BASE MEMORY BLOCKS
0293 50                         PUSH    AX                      ; SAVE BASE COUNT
0294 53                         PUSH    BX                      ; SAVE TESTED COUNT
0295 51                         PUSH    CX                      ; SAVE TOTAL COUNT
0296 38 06 0064                 CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),AL           ; MAX BASE COUNT
029A 72 0A                      JB      NEXT                    ; CONTINUE IF NOT DONE WITH BASE MEMORY

                        ;-----  DO ADDITIONAL STORAGE ABOVE 1 MEG

029C C6 06 0064 10              MOV     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),10H
02A1 C6 06 004C 10              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H

                        ;-----  SAVE BASE_HI_BYTE IN DMA PAGE REGISTERS 3

02A6 A0 0064            NEXT:   MOV     AL,BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE)
02A9 E6 84                      OUT     DMA_PAGE+3,AL           ; SAVE THE HIGH BYTE OF SEGMENT
                                                                ;  FOR POSSIBLE ERROR

                        ;-----  CHECK FOR TOP OF MEMORY (FE0000) 16 MEG

02AB 80 3E 004C FE              CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0FEH ; TOP OF MEMORY?
02B0 74 29                      JE      KB_LOOP3                                ; EXIT NEXT TEST IF DONE

                        ;-----  SET ES AND DS REGISTERS TO MEMORY BLOCK

02B2 6A 60                      PUSH    BYTE PTR DS_TEMP
02B4 1F                         POP     DS
02B5 6A 48                      PUSH    BYTE PTR ES_TEMP
02B7 07                         POP     ES

02B8 B0 31                      MOV     AL,31H                  ;       <><><><><><><><><><><><>
02BA E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  31 <><>

02BC B9 8000                    MOV     CX,8000H                ; SET COUNT FOR 32K WORDS
02BF E8 0000 E                  CALL    STGTST_CNT
02C2 74 03                      JZ      N1                      ; SKIP IF OK
02C4 E9 0367 R                  JMP     E21A                    ; GO PRINT ERROR
02C7                    N1:
02C7 59                         POP     CX                      ; POP CX TO GET AX
02C8 58                         POP     AX                      ; RECOVER TESTED MEMORY

                        ;-----  WRITE THE CURRENT SIZE FOR (ADDRESS LINE 23-17 TEST) USED LATER

02C9 2B FF                      SUB     DI,DI                   ; POINT TO BEGINNING OR A BLOCK
02CB AB                         STOSW                           ; WRITE THE CURRENT SIZE
                                                                ;  AT THE STARTING ADDRESS
02CC 05 0040                    ADD     AX,64                   ; ADVANCE COUNT TO NEXT BLOCK
02CF 50                         PUSH    AX                      ; SAVE TESTED MEMORY
02D0 51                         PUSH    CX                      ; SAVE LOOP COUNT

02D1 E8 099F R                  CALL    PRT_OK                  ; DISPLAY "0XXXX OK" MESSAGE
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                        POP     CX                      ; RECOVER 64K BLOCK COUNT
                        DEC     CX                      ; DECREMENT BLOCK COUNT FOR LOOP
                        JCXZ    KB_LOOP3                ; CONTINUE TO NEXT TEST IF DONE

                        PUSH    CX                      ; SAVE LOOP COUNT
                        JMP     E21                     ; LOOP TILL ALL MEMORY CHECKED

                KB_LOOP3:                               ;       END MAIN TEST LOOP
                        POP     AX                      ; CLEAR MAXIMUM BLOCK COUNT
                        POP     AX                      ; CLEAR BASE SIZE COUNT FROM STACK
                                                        ; ADDRESS TEST VALUES ARE IN STACK
                ;-----  ADDRESS LINE 16-23 TEST
                                                        ;       LET FIRST PASS BE SEEN
                        MOV     CX,16571                ; COUNT FOR 250 MS FIXED TIME DELAY
                        CALL    WAITF                   ; ALLOW SIX DISPLAY REFRESH CYCLES

                ;-----  INITIALIZE DS DESCRIPTOR

                        PUSH    BYTE PTR GDT_PTR
                        POP     ES
                        MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0
                        MOV     ES:DS_TEMP.BASE_LO_WORD,0

                ;-----  TEMPORARY SEGMENT SAVE IN DMA PAGE REGISTER

                        SUB     AL,AL
                        OUT     DMA_PAGE+4,AL           ; HIGH BYTE OF LOW WORD OF SEGMENT
                        OUT     DMA_PAGE+5,AL           ; LOW BYTE OF LOW WORD OF SEGMENT
                        MOV     AL,01H                  ; SET HIGH BYTE OF SEGMENT WORD
                        OUT     DMA_PAGE+3,AL           ; HIGH BYTE OF SEGMENT

                ;-----  POINT TO NEXT BLOCK OF 64K

                E21_A:
                        MOV     AL,33H                  ;       <><><><><><><><><><>
                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  33 <><>
                        ADD     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),01

                ;-----  CHECK FOR END OF BASE MEMORY TO BE TESTED

                        CMP     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0AH
                        JA      NEXT_A                  ; CONTINUE IF ABOVE 1 MEG

                        POP     CX                      ; GET COUNT
                        POP     BX                      ; GET COUNT TESTED
                        POP     AX                      ; RECOVER COUNT OF BASE MEMORY BLOCKS
                        PUSH    AX                      ; SAVE BASE COUNT
                        PUSH    BX                      ; SAVE TESTED COUNT
                        PUSH    CX                      ; SAVE TOTAL COUNT
                        CMP     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),AL           ; MAX BASE COUNT
                        JB      NEXT_A                  ; CONTINUE IF NOT DONE WITH BASE MEMORY

                ;-----  DO ADDITIONAL STORAGE ABOVE 1 MEG

                NEXT_A2:
                        MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),10H
                NEXT_A:
                        MOV     AL,BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE)

                ;-----  DMA PAGE REGISTERS 3
                                                        ; SAVE THE HIGH BYTE OF SEGMENT
                        OUT     DMA_PAGE+3,AL           ;  FOR POSSIBLE ERROR

                ;-----  CHECK FOR TOP OF MEMORY (FE0000) 16 MEG

                        CMP     AL,0FEH                 ; TOP OF MEMORY?
                        JZ      KB_LOOP_3               ; GO NEXT TEST IF IT IS

                ;-----  SET DS REGISTER

                        PUSH    BYTE PTR DS_TEMP
                        POP     DS
                        SUB     DI,DI                   ; POINT TO START OF BLOCK
                        MOV     DX,DS:[DI]              ; GET THE VALUE OF THIS BLOCK
                        MOV     SI,DI                   ; SET SI FOR POSSIBLE ERROR
                        SUB     AX,AX                   ; CLEAR MEMORY LOCATION
                        MOV     [DI],AX

                ;-----  ALLOW DISPLAY TIME TO DISPLAY MESSAGE AND REFRESH TO RUN

                        MOV     CX,6761                 ; COUNT FOR 102 MS FIXED TIME DELAY
                        CALL    WAITF                   ; ALLOW FIVE DISPLAY REFRESH CYCLES
                        POP     CX                      ; GET THE LOOP COUNT
                        POP     AX                      ; RECOVER TESTED MEMORY
                        PUSH    AX                      ; SAVE TESTED MEMORY
                        PUSH    CX                      ; SAVE LOOP COUNT
                        CMP     AX,DX                   ; DOES THE BLOCK ID MATCH
                        MOV     AX,DX                   ; GET THE BLOCK ID FOR POSSIBLE ERROR
                        JNZ     E21A                    ; GO PRINT ERROR

                ;-----  CHECK FOR CHECK PARITY

                        IN      AL,PORT_B               ; CHECK FOR I/O OR PARITY CHECK
                        AND     AL,PARITY_ERR           ; STRIP UNWANTED BITS
                        JNZ     E21A                    ; EXIT IF PARITY ERROR

                        POP     CX                      ; POP CX TO GET AX
                        POP     AX                      ; RECOVER TESTED MEMORY
                        ADD     AX,64                   ; 64K INCREMENTS
                        PUSH    AX                      ; SAVE TESTED MEMORY
                        PUSH    CX                      ; SAVE LOOP COUNT
                        CALL    PRT_OK                  ; DISPLAY OK MESSAGE
                        POP     CX                      ; RECOVER 64K BLOCK COUNT
                        DEC     CX                      ; LOOP TILL ALL MEMORY CHECKED
                        JCXZ    KB_LOOP_3               ; CONTINUE

                        PUSH    CX                      ; SAVE LOOP COUNT
                        JMP     E21_A                   ; CONTINUE TILL DONE

                ;-----  BACK TO REAL MODE - MEMORY TESTS DONE

                KB_LOOP_3:
                        MOV     AL,34H                  ;       <><><><><><><><><><>
                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  34 <><>
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                                                        ; BACK TO REAL MODE
0364 E9 0000 E                  JMP     PROC_SHUTDOWN   ; NEXT TEST VIA JUMP TABLE (SHUT2)


                        ;-----  PRINT FAILING ADDRESS AND XOR'ED PATTERN IF DATA COMPARE ERROR
                        ;-----  USE DMA PAGE REGISTERS AS TEMPORARY SAVE AREA FOR ERROR
                        ;       SET SHUTDOWN 3

0367 E6 82              E21A:   OUT     DMA_PAGE+1,AL   ; SAVE FAILING BIT PATTERN (LOW BYTE)
0369 8A C4                      MOV     AL,AH           ; SAVE HIGH BYTE
036B E6 83                      OUT     DMA_PAGE+2,AL
036D 8B C6                      MOV     AX,SI           ; GET THE FAILING OFFSET
036F E6 86                      OUT     DMA_PAGE+5,AL
0371 86 E0                      XCHG    AH,AL
0373 E6 85                      OUT     DMA_PAGE+4,AL

                        ;-----  CLEAR I/O CHANNEL CHECK OR R/W PARITY CHECK

0375 2B F6                      SUB     SI,SI           ; WRITE TO FAILING BLOCK
0377 AB                         STOSW
0378 E4 61                      IN      AL,PORT_B       ; GET PARITY CHECK LATCHES
037A E6 88                      OUT     DMA_PAGE+7,AL   ; SAVE FOR ERROR HANDLER
037C 0C 0C                      OR      AL,RAM_PAR_OFF  ; TOGGLE I/O-PARITY CHECK ENABLE
037E E6 61                      OUT     PORT_B,AL       ;  TO RESET CHECKS
0380 24 F3                      AND     AL,RAM_PAR_ON
0382 E6 61                      OUT     PORT_B,AL

                        ;-----  GET THE LAST OF GOOD MEMORY

0384 58                         POP     AX              ; CLEAR BLOCK COUNT
0385 58                         POP     AX              ; GET THE LAST OF GOOD MEMORY
0386 5B                         POP     BX              ; GET BASE MEMORY COUNTER
0387 C1 E3 06                   SHL     BX,6            ; CONVERT TO MEMORY SIZE COUNTS
038A 2B C3                      SUB     AX,BX           ; COMPARE LAST GOOD MEMORY WITH BASE
038C 73 17                      JAE     E211            ; IF ABOVE OR EQUAL, USE REMAINDER IN
                                                        ;  CMOS_U_M_S_(H/L)
                        ;-----  ELSE SET BASE MEMORY SIZE

038E 6A 18                      PUSH    BYTE PTR RSDA_PTR       ; SET THE DATA SEGMENT
0390 1F                         POP     DS              ; IN PROTECTED MODE

0391 03 C3                      ADD     AX,BX           ; CONVERT BACK TO LAST WORKING MEMORY
0393 A3 0013 R                  MOV     @MEMORY_SIZE,AX ; TO INDICATE HOW MUCH MEMORY WORKING

                        ;-----  RESET 512K --> 640K OPTION IF SET

0396 B8 B3B3                    MOV     AX,X*(CMOS_INFO128+NMI) ; ADDRESS OPTIONS INFORMATION BYTE
0399 E8 0000 E                  CALL    CMOS_READ       ; READ THE MEMORY INFORMATION FLAG
039C 24 7F                      AND     AL,NOT M640K    ; SET 640K OPTION OFF
039E 86 C4                      XCHG    AL,AH           ; MOVE TO WORK REGISTER
03A0 E8 0000 E                  CALL    CMOS_WRITE      ; UPDATE STATUS IF IT WAS ON
03A3 33 C0                      XOR     AX,AX           ; CLEAR VALUE FOR EXTENSION MEMORY
03A5                    E211:
03A5 8B C8                      MOV     CX,AX           ; SAVE ADJUSTED MEMORY SIZE
03A7 B0 B1                      MOV     AL,CMOS_U_M_S_HI+NMI
03A9 E8 0000 E                  CALL    CMOS_WRITE      ; SAVE THE HIGH BYTE MEMORY SIZE
03AC 8A E1                      MOV     AH,CL           ; GET THE LOW BYTE
03AE B0 B0                      MOV     AL,CMOS_U_M_S_LO+NMI    ; DO THE LOW BYTE
03B0 E8 0000 E                  CALL    CMOS_WRITE      ; WRITE IT

                        ;-----  SET SHUTDOWN 3

03B3 B8 038F                    MOV     AX,3*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN RETURN
03B6 E8 0000 E                  CALL    CMOS_WRITE      ; SET RETURN 3

                        ;-----  SHUTDOWN

03B9 E9 0000 E                  JMP     PROC_SHUTDOWN
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                        PAGE
                        ;--------------------------------------------------------------------
                        ; MEMORY ERROR REPORTING          (R/W/ MEMORY OR PARITY ERRORS)     :
                        ;                                                                    :
                        ; DESCRIPTION FOR ERRORS 201 (CMP ERROR OR PARITY)                   :
                        ;                        OR 202 (ADDRESS LINE 0-15 ERROR)            :
                        ;                                                                    :
                        ;       "AABBCC DDEE 201" (OR 202)                                   :
                        ;                          AA=HIGH BYTE OF 24 BIT ADDRESS            :
                        ;                          BB=MIDDLE BYTE OF 24 BIT ADDRESS          :
                        ;                          CC=LOW BYTE OF 24 BIT ADDRESS             :
                        ;                          DD=HIGH BYTE OF XOR FAILING BIT PATTERN   :
                        ;                          EE=LOW BYTE OF XOR FAILING BIT PATTERN    :
                        ;                                                                    :
                        ; DESCRIPTION FOR ERROR 202 (ADDRESS LINE 00-15)                     :
                        ;       A WORD OF FFFF IS WRITTEN AT THE FIRST WORD AND LAST WORD    :
                        ;       OF EACH 64K BLOCK WITH ZEROS AT ALL OTHER LOCATIONS OF THE   :
                        ;       BLOCK.  A SCAN OF THE BLOCK IS MADE TO INSURE ADDRESS LINE   :
                        ;       0-15 ARE FUNCTIONING.                                        :
                        ;                                                                    :
                        ; DESCRIPTION FOR ERROR 203 (ADDRESS LINE 16-23)                     :
                        ;       AT THE LAST PASS OF THE STORAGE TEST, FOR EACH BLOCK OF      :
                        ;       64K, THE CURRENT STORAGE SIZE (ID) IS WRITTEN AT THE FIRST   :
                        ;       WORD OF EACH BLOCK. IT IS USED TO FIND ADDRESSING FAILURES.  :
                        ;                                                                    :
                        ;       "AABBCC DDEE 203"                                            :
                        ;                          SAME AS ABOVE EXCEPT FOR DDEE             :
                        ;                                                                    :
                        ; GENERAL DESCRIPTION FOR BLOCK ID (DDEE WILL NOW CONTAINED THE ID)  :
                        ;       DD=HIGH BYTE OF BLOCK ID                                     :
                        ;       EE=LOW BYTE OF BLOCK ID                                      :
                        ;                                                                    :
                        ;       BLOCK ID        ADDRESS RANGE                                :
                        ;       0000            000000 --> 00FFFF                            :
                        ;       0040            010000 --> 01FFFF                            :
                        ;       //                                                           :
                        ;       0200            090000 --> 09FFFF (512->576K) IF 640K BASE   :
                        ;                       100000 --> 10FFFF (1024->1088K) IF 512K BASE :
                        ;                                                                    :
                        ; EXAMPLE (640K BASE MEMORY + 512K I/O MEMORY = 1152K TOTAL)         :
                        ;       NOTE: THE CORRECT BLOCK ID FOR THIS FAILURE IS 0280 HEX.     :
                        ;             DUE TO AN ADDRESS FAILURE THE BLOCK ID+128K OVERLAYED  :
                        ;             THE CORRECT BLOCK ID.                                  :
                        ;                                                                    :
                        ;       00640K OK          <-- LAST OK MEMORY                        :
                        ;       10000 0300 202     <-- ERROR DUE TO ADDRESS FAILURE          :
                        ;                                                                    :
                        ; IF A PARITY LATCH WAS SET THE CORRESPONDING MESSAGE WILL DISPLAY.  :
                        ;                                                                    :
                        ;       "PARITY CHECK 1" (OR 2)                                      :
                        ;                                                                    :
                        ; DMA PAGE REGISTERS ARE USED AS TEMPORARY SAVE AREAS FOR SEGMENT     :
                        ; DESCRIPTOR VALUES.                                                 :
                        ;--------------------------------------------------------------------

 03BC                   SHUT3:                                  ;       ENTRY FROM PROCESSOR SHUTDOWN 3
 03BC E8 0000 E                 CALL    DDS                     ; SET REAL MODE DATA SEGMENT

                                                                ;       <><> MEMORY FAILED  <><>
 03BF C6 06 0016 R 01           MOV     @MFG_ERR_FLAG+1,MEM_FAIL; CLEAR AND SET MANUFACTURING ERROR FLAG
 03C4 B0 0D                     MOV     AL,CR                   ; CARRIAGE RETURN
 03C6 E8 0000 E                 CALL    PRT_HEX
 03C9 B0 0A                     MOV     AL,LF                   ; LINE FEED
 03CB E8 0000 E                 CALL    PRT_HEX
 03CE E4 84                     IN      AL,DMA_PAGE+3           ; GET THE HIGH BYTE OF 24 BIT ADDRESS
 03D0 E8 0000 E                 CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
 03D3 E4 85                     IN      AL,DMA_PAGE+4           ; GET THE MIDDLE BYTE OF 24 BIT ADDRESS
 03D5 E8 0000 E                 CALL    XPC_BYTE
 03D8 E4 86                     IN      AL,DMA_PAGE+5           ; GET THE LOW BYTE OF 24 BIT ADDRESS
 03DA E8 0000 E                 CALL    XPC_BYTE
 03DD B0 20                     MOV     AL,' '                  ; SPACE TO MESSAGE
 03DF E8 0000 E                 CALL    PRT_HEX
 03E2 E4 83                     IN      AL,DMA_PAGE+2           ; GET HIGH BYTE FAILING BIT PATTERN
 03E4 E8 0000 E                 CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
 03E7 E4 82                     IN      AL,DMA_PAGE+1           ; GET LOW BYTE FAILING BIT PATTERN
 03E9 E8 0000 E                 CALL    XPC_BYTE                ; CONVERT AND PRINT CODE

                        ;-----  CHECK FOR ADDRESS ERROR

 03EC E4 80                     IN      AL,MFG_PORT             ; GET THE CHECKPOINT
 03EE 3C 33                     CMP     AL,33H                  ; IS IT AN ADDRESS FAILURE?
 03F0 BE 0000 E                 MOV     SI,OFFSET E203          ; LOAD ADDRESS ERROR 16->23
 03F3 74 0A                     JZ      ERR2                    ; GO IF YES

 03F5 BE 0000 E                 MOV     SI,OFFSET E202          ; LOAD ADDRESS ERROR 00->15
 03F8 3C 32                     CMP     AL,32H                  ; GO IF YES
 03FA 74 03                     JZ      ERR2

 03FC BE 0000 E                 MOV     SI,OFFSET E201          ; SETUP ADDRESS OF ERROR MESSAGE
 03FF                   ERR2:
 03FF E8 0000 E                 CALL    E_MSG                   ; PRINT ERROR MESSAGE
 0402 E4 88                     IN      AL,DMA_PAGE+7           ; GET THE PORT_B VALUE

                        ;-----  DISPLAY "PARITY CHECK ?" ERROR MESSAGES

 0404 A8 80                     TEST    AL,PARITY_CHECK         ; CHECK FOR PLANAR ERROR
 0406 74 0B                     JZ      NMI_M1                  ; SKIP IF NOT

 0408 50                        PUSH    AX                      ; SAVE STATUS
 0409 E8 098F R                 CALL    PADING                  ; INSERT BLANKS
 040C BE 0000 E                 MOV     SI,OFFSET D1            ; PLANAR ERROR, ADDRESS "PARITY CHECK 1"
 040F E8 0000 E                 CALL    P_MSG                   ; DISPLAY "PARITY CHECK 1" MESSAGE
 0412 58                        POP     AX                      ; AND RECOVER STATUS
 0413                   NMI_M1:
 0413 A8 40                     TEST    AL,IO_CHECK             ; I/O PARITY CHECK ?
 0415 74 09                     JZ      NMI_M2                  ; SKIP IF CORRECT ERROR DISPLAYED

 0417 E8 098F R                 CALL    PADING                  ; INSERT BLANKS
 041A BE 0000 E                 MOV     SI,OFFSET D2            ; ADDRESS OF "PARITY CHECK 2" MESSAGE
 041D E8 0000 E                 CALL    P_MSG                   ; DISPLAY "PARITY CHECK 2" ERROR
 0420                   NMI_M2:
                                                                ; CONTINUE TESTING SYSTEM ....
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SECTION 5

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                        PAGE
                        ;-----  ENTRY FROM SHUTDOWN

0420                    SHUT2:

                        ;--------------------------------------------------------
                        ; TEST.20                                               :
                        ;       ADDITIONAL PROTECTED (VIRTUAL MODE) TEST        :
                        ; DESCRIPTION                                          :
                        ;       THE PROCESSOR IS PUT IN PROTECTED MODE AND      :
                        ;       THE FOLLOWING FUNCTIONS ARE VERIFIED            :
                        ;                                                       :
                        ;       1. VERIFY PROTECTED MODE                        :
                        ;          THE MACHINE STATUS IS CHECK FOR VIRTUAL MODE :
                        ;       2. PROGRAMMED INTERRUPT TEST                    :
                        ;          AN PROGRAMMED INTERRUPT 32 IS ISSUED AND     :
                        ;          AND VERIFIED                                 :
                        ;       3. EXCEPTION INTERRUPT 13 TEST                  :
                        ;          A DESCRIPTOR SEGMENT LIMIT IS SET TO ZERO    :
                        ;          AND A WRITE TO THAT SEGMENT IS ATTEMPTED     :
                        ;          AN EXCEPTION 13 IS EXPECTED AND VERIFIED     :
                        ;       4. LDT/SDT LTR/STR TEST                         :
                        ;          LOAD LDT REGISTER AND VERIFY CORRECT         :
                        ;          LOAD TASK REGISTER AND VERIFY CORRECT        :
                        ;          THEY ARE VERIFIED VIA THE STORE INSTRUCTION  :
                        ;       5. THE CONTROL FLAGS OF THE 286 FOR DIRECTION   :
                        ;          ARE VERIFIED VIA THE STD AND CLD COMMANDS     :
                        ;          IN PROTECTED MODE                            :
                        ;       6. BOUND INSTRUCTION TEST (EXCEPTION INT 5)     :
                        ;          CREATE A SIGNED ARRAY INDEX WITHIN AND       :
                        ;          OUTSIDE THE LIMITS.  CHECK THAT NO EXC INT   :
                        ;          IF WITHIN LIMIT AND THAT AN EXC INT 5        :
                        ;          OCCURS IF OUTSIDE THE LIMITS.                :
                        ;       7. PUSH ALL POP ALL TEST                        :
                        ;          SET GENERAL PURPOSE REGISTERS TO DIFFERENT   :
                        ;          VALUES, ISSUE A PUSH ALL, CLEAR THE REGISTERS:
                        ;          THEN ISSUE A POP ALL AND VERIFY CORRECT.     :
                        ;       8. CHECK THE VERR/VERW INSTRUCTIONS             :
                        ;          THE ACCESS BYTE IS SET TO READ ONLY THEN TO  :
                        ;          A WRITE ONLY AND THE VERR/VERW INSTRUCTIONS   :
                        ;          ARE VERIFIED.                                :
                        ;       9. CAUSE AN INTERRUPT 13 VIA A WRITE TO A       :
                        ;          READ ONLY SEGMENT                            :
                        ;      10. VERIFY THE ARPL INSTRUCTION FUNCTIONS        :
                        ;          SET THE RPL FIELD OF A SELECTOR AND          :
                        ;          VERIFY THAT CURRENT SELECTOR RPL IS SET      :
                        ;          CORRECTLY.                                   :
                        ;      11. VERIFY THE LAR INSTRUCTION FUNCTIONS         :
                        ;      12. VERIFY THE LSL INSTRUCTION FUNCTIONS         :
                        ;      13. LOW MEG CHIP SELECT TEST                     :
                        ;--------------------------------------------------------

0420 E9 0000 E                  JMP     POST3                   ; GO TEST THE 286 PROTECTED MODE

                        ;-----  FAILURE ENTRY FROM A SHUTDOWN

0423 E8 0000 E          SHUT7:  CALL    DDS                     ; ESTABLISH THE DATA SEGMENT
0426 E4 80                      IN      AL,MFG_PORT             ; CHECK FOR CHIP SELECT ERROR
0428 3C 35                      CMP     AL,35H
042A BE 0000 E                  MOV     SI,OFFSET E109          ; PRINT ERROR 109
042D 74 0D                      JZ      SHUT7B                  ; GO IF NOT
042F BE 0000 E          SHUT7A: MOV     SI,OFFSET E104          ; PROTECTED MODE FAILED

0432 80 0E 0016 R 02            OR      @MFG_ERR_FLAG+1,PRO_FAIL;       <><><><><><><><><><><><><><><>
                                                                ;       <><> VIRTUAL MODE FAILED  <><>

0437 E8 0000 E                  CALL    E_MSG                   ; PRINT MESSAGE
043A EB 08                      JMP     SHORT SHUT6
043C E8 0000 E          SHUT7B: CALL    E_MSG                   ; PRINT MESSAGE

043F 80 0E 0016 R 04            OR      @MFG_ERR_FLAG+1,LMCS_FAIL;      <><><><><><><><><><><><><><><>
                                                                ;       <><> LOW MEG CHIP SELECT  <><>

                        ;-----  PROTECTED MODE TEST PASSED ENTRY FROM A SHUTDOWN

0444 E8 0000 E          SHUT6:  CALL    DDS                     ; PROTECTED MODE TEST PASSED
0447 2B C0                      SUB     AX,AX                   ; CLEAR KEYBOARD STATE FLAGS
0449 A3 0017 R                  MOV     WORD PTR @KB_FLAG,AX
044C B9 000E                    MOV     CX,0EH                  ; CLEAR PAGE REGISTERS
044F BA 0082                    MOV     DX,DMA_PAGE+1
0452                    CLR_LOOP:
0452 2A C0                      SUB     AL,AL
0454 EE                         OUT     DX,AL
0455 42                         INC     DX
0456 E2 FA                      LOOP    CLR_LOOP

                        ;--------------------------------------------
                        ; TEST.21                                   :
                        ;       KEYBOARD TEST                       :
                        ; DESCRIPTION                              :
                        ;       RESET THE KEYBOARD AND CHECK THAT SCAN  :
                        ;       CODE "AA" IS RETURNED TO THE PROCESSOR. :
                        ;       CHECK FOR STUCK KEYS.               :
                        ;--------------------------------------------

0458 B0 35                      MOV     AL,35H                  ;       <><><><><><><><><><>
045A E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  35 <><>

045C F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; MANUFACTURING BURN IN TEST MODE?
0461 75 03                      JNZ     F7_A
0463 E9 0516 R                  JMP     F7
0466 80 3E 0072 R 64    F7_A:   CMP     BYTE PTR @RESET_FLAG,064H ; MANUFACTURING RUN IN MODE?
046B 75 03                      JNZ     F7_B
046D E9 0516 R                  JMP     F7                      ; YES - SKIP KEYBOARD TEST
0470 B0 36              F7_B:   MOV     AL,36H                  ;       <><><><><><><><><><>
0472 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  36 <><>
0474 FA                         CLI
0475 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; SOFT RESET?
047B 74 17                      JZ      G10
047D 80 3E 0072 R AA            CMP     BYTE PTR @RESET_FLAG,KB_OK ; CHECK FOR AA ALREADY RECEIVED
0482 74 10                      JZ      G10                     ; GO IF YES
0484 B0 AE                      MOV     AL,ENA_KBD
0486 E8 0000 E                  CALL    C8042                   ; ENABLE KEYBOARD
0489 B7 04                      MOV     BH,4                    ; TRY 4 TIMES
```

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                                ;-----  CHECK FOR OUTPUT BUFFER FULL
048B E8 0000 E          LOOP1:  CALL    OBF_42                  ; CHECK FOR OUTPUT BUFFER FULL
048E 75 04                      JNZ     G10                     ; GO IF BUFFER FULL
0490 FE CF                      DEC     BH
0492 75 F7                      JNZ     LOOP1
0494 B0 AD              G10:    MOV     AL,DIS_KBD              ; DISABLE KEYBOARD
0496 E8 0000 E                  CALL    C8042
0499 E4 60                      IN      AL,PORT_A               ; FLUSH
049B B0 E0                      MOV     AL,KYBD_CLK_DATA        ; GET THE CLOCK AND DATA LINES
049D E8 0000 E                  CALL    C8042
04A0 E8 0000 E                  CALL    OBF_42                  ; WAIT FOR OUTPUT BUFFER FULL
04A3 E4 60                      IN      AL,PORT_A               ; GET THE RESULTS
04A5 A8 01                      TEST    AL,KYBD_CLK             ; KEYBOARD CLOCK MUST BE LOW
04A7 74 0A                      JZ      G11

04A9 80 0E 0016 R 08            OR      @MFG_ERR_FLAG+1,KYCLK_FAIL ;    <><><><><><><><><><><><><>
                                                                ;       <><> KEYBOARD CLOCK HIGH  <><>
04AE BE 0000 E                  MOV     SI,OFFSET E304          ; DISPLAY 304 ERROR
04B1 EB 60                      JMP     SHORT F6D               ; REPORT ERROR
04B3 E8 0000 E          G11:    CALL    KBD_RESET               ; ISSUE RESET TO KEYBOARD
04B6 E3 29                      JCXZ    F6                      ; PRINT ERROR MESSAGE IF NO INTERRUPT
04B8 B0 37                      MOV     AL,37H                  ;       <><><><><><><><><><><><>
04BA E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  37 <><>
04BC 80 FB AA                   CMP     BL,KB_OK                ; SCAN CODE AS EXPECTED?
04BF 75 20                      JNE     F6                      ; NO - DISPLAY ERROR MESSAGE

                                ;-----  CHECK FOR STUCK KEYS

04C1 B0 38                      MOV     AL,38H                  ;       <><><><><><><><><><><><>
04C3 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  38 <><>

04C5 B0 AE                      MOV     AL,ENA_KBD              ; ASSURE KEYBOARD ENABLED
04C7 E8 0000 E                  CALL    C8042                   ; ISSUE THE COMMAND
04CA B9 19E4                    MOV     CX,6628                 ; COUNT FOR 100 MILLISECONDS
04CD E8 0000 E                  CALL    WAITF                   ; DELAY FOR A WHILE
04D0 E4 64                      IN      AL,STATUS_PORT          ; CHECK FOR STUCK KEYS
04D2 A8 01                      TEST    AL,OUT_BUF_FULL         ; OUT BUFFER FULL?
04D4 74 40                      JE      F7                      ; YES - CONTINUE TESTING

04D6 B0 39                      MOV     AL,39H                  ;       <><><><><><><><><><><><>
04D8 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  39 <><>

04DA E4 60                      IN      AL,PORT_A               ; GET THE SCAN CODE
04DC E8 0000 E                  CALL    XPC_BYTE                ; CONVERT AND PRINT
04DF EB 2A                      JMP     SHORT F6C               ; CONTINUE

                                ;-----  KEYBOARD ERROR TRY TO DETERMINE IF 8042 INTERFACE IS WORKING

04E1 FA                 F6:     CLI
04E2 B0 AB                      MOV     AL,INTR_FACE_CK         ; COMMAND TO 8042
04E4 E6 64                      OUT     STATUS_PORT,AL
04E6 2B C9                      SUB     CX,CX
04E8 B7 05                      MOV     BH,05                   ; WAIT FOR OUTPUT BUFFER FULL
04EA E4 64              F6A:    IN      AL,STATUS_PORT
04EC A8 01                      TEST    AL,OUT_BUF_FULL         ; 8042 FINISHED TEST?
04EE E1 FA                      LOOPZ   F6A
04F0 75 09                      JNZ     F6B                     ; GO CHECK RESULTS
04F2 FE CF                      DEC     BH
04F4 75 F4                      JNZ     F6A                     ; TRY AGAIN
04F6 BE 0000 E                  MOV     SI,OFFSET E303          ; INDICATE PLANAR FAILURE
04F9 EB 18                      JMP     SHORT F6D               ;   (REMOVE KEYBOARD TRY AGAIN)
04FB E4 60              F6B:    IN      AL,PORT_A               ; GET THE RESULTS OF INTERFACE TEST
04FD 3C 00                      CMP     AL,0                    ; IS THE INTERFACE OK?
04FF 74 0A                      JZ      F6C
0501 80 0E 0016 R 10            OR      @MFG_ERR_FLAG+1,KY_SYS_FAIL ;   <><><><><><><><><><>
                                                                ;       <><> KEYBOARD/SYSTEM  <><>
0506 BE 0000 E                  MOV     SI,OFFSET E303          ; PLANAR FAILURE
0509 EB 08                      JMP     SHORT F6D               ; GO IF YES
050B BE 0000 E          F6C:    MOV     SI,OFFSET E301          ; GET MESSAGE ADDRESS

050E 80 0E 0016 R 20            OR      @MFG_ERR_FLAG+1,KYBD_FAIL;      <><><><><><><><><><><><>
                                                                ;       <><> KEYBOARD FAILED  <><>

0513 E8 0000 E          F6D:    CALL    E_MSG                   ; PRINT MESSAGE ON SCREEN

                                ;-----  INITIALIZE 8042 TO HONOR KEY LOCK

0516 B0 3A              F7:     MOV     AL,3AH                  ;       <><><><><><><><><><><><>
0518 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3A <><>

051A B0 FF                      MOV     AL,0FFH                 ; DISABLE INTERRUPTS
051C E6 21                      OUT     INTA01,AL
051E FA                         CLI
051F B0 60                      MOV     AL,WRITE_8042_LOC       ; WRITE 8042 MEMORY COMMAND
0521 E8 0000 E                  CALL    C8042                   ; ISSUE THE COMMAND
0524 B0 45                      MOV     AL,45H                  ; SET SYSTEM FLAG - OUTBUF INTERRUPT -
0526 E6 60                      OUT     PORT_A,AL               ; PC I COMPATIBILITY
                                                                ; RESET INHIBIT OVER RIDE

                                ;-----  DEGATE ADDRESS LINE 20

0528 B4 DD                      MOV     AH,DISABLE_BIT20        ; SET COMMAND IN AH
052A E8 0000 E                  CALL    GATE_A20                ; ISSUE THE COMMAND

                                ;-----  SETUP HARDWARE INTERRUPT VECTOR TABLE LEVEL 0-7

052D 2B C0                      SUB     AX,AX
052F 8E C0                      MOV     ES,AX
0531 B9 0008                    MOV     CX,08                   ; GET VECTOR COUNT
0534 0E                         PUSH    CS                      ; SETUP DS SEGMENT REGISTER
0535 1F                         POP     DS
0536 BE 0000 E                  MOV     SI,OFFSET VECTOR_TABLE
0539 BF 0020 R                  MOV     DI,OFFSET @INT_PTR
053C A5                 F7A:    MOVSW
053D 47                         INC     DI                      ; SKIP OVER SEGMENT
053E 47                         INC     DI
053F E2 FB                      LOOP    F7A

                                ;-----  SETUP HARDWARE INTERRUPT VECTORS LEVEL 8-15 (VECTORS START AT INT 70H)

                                ASSUME  ES:ABS0
0541 2B C0                      SUB     AX,AX
0543 8E C0                      MOV     ES,AX
0545 B9 0008                    MOV     CX,08                   ; GET VECTOR COUNT
0548 0E                         PUSH    CS                      ; SETUP DS SEGMENT REGISTER
0549 1F                         POP     DS
```

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                                MOV     SI,OFFSET SLAVE_VECTOR_TABLE
                                MOV     DI,OFFSET @SLAVE_INT_PTR
                        F7A1:   MOVSW
                                INC     DI                      ; SKIP OVER SEGMENT
                                INC     DI
                                LOOP    F7A1

                        ;-----  SET UP OTHER INTERRUPTS AS NECESSARY

                                ASSUME  DS:ABS0
                                SUB     AX,AX                   ; DS=0
                                MOV     DS,AX
                                MOV     WORD PTR @NMI_PTR,OFFSET NMI_INT ; NMI INTERRUPT
                                MOV     WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN   ; PRINT SCREEN
                                MOV     WORD PTR @BASIC_PTR+2,0F600H     ; SEGMENT FOR CASSETTE BASIC

                        ;-----  ZERO RESERVED VECTORS

                                MOV     DI,60H*4                ; FILL INTERRUPT 60 THRU 67 WITH ZERO
                                MOV     CX,16                   ; CLEAR 16 WORDS
                        F7A2:   MOV     WORD PTR DS:[DI],0
                                ADD     DI,2                    ; POINT TO NEXT LOCATION
                                LOOP    F7A2

                        ;-----  SETUP TIMER 0 TO BLINK LED IF MANUFACTURING TEST MODE

                                ASSUME  DS:DATA
                                CALL    DDS                     ; ESTABLISH DATA SEGMENT

                                TEST    @MFG_TST,MFG_LOOP       ; MFG. TEST MODE?
                                JNZ     F9
                                MOV     WORD PTR ES:@INT_PTR,OFFSET BLINK_INT ; SETUP TIMER TO BLINK LED
                                MOV     AL,0FEH                 ; ENABLE TIMER INTERRUPT
                                OUT     INTA01,AL
                        F9:     STI                             ; ALLOW INTERRUPTS

                        ;-----  ISSUE A RESET TO THE HARD FILE IF SOFT RESET

                                CMP     @RESET_FLAG,1234H       ; SOFT RESET?
                                JNZ     F9A                     ; CONTINUE IF NOT
                                MOV     CX,0FFH
                                MOV     DX,03F6H
                                MOV     AL,04H                  ; RESET
                                OUT     DX,AL
                        F9_A:   LOOP    F9_A                    ; HOLD RESET
                                SUB     AL,AL
                                OUT     DX,AL                   ; REMOVE RESET

                        ;--------------------------------------------------------------
                        ; TEST.23                                                     :
                        ;       DISKETTE ATTACHMENT TEST                              :
                        ; DESCRIPTION                                                 :
                        ;       CHECK IF IPL DISKETTE DRIVE IS ATTACHED TO SYSTEM.  IF  :
                        ;       ATTACHED, VERIFY STATUS OF NEC FDC AFTER A RESET. ISSUE :
                        ;       A RECALIBRATE AND SEEK COMMAND TO FDC AND CHECK STATUS. :
                        ;       COMPLETE SYSTEM INITIALIZATION THEN PASS CONTROL TO THE :
                        ;       BOOT LOADER PROGRAM.                                  :
                        ;--------------------------------------------------------------

                        F9A:    MOV     AL,3CH                  ;       <><><><><><><><><><><><>
                                OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3C <><>

                                MOV     AL,02H                  ; SET DATA RATE TO 250 K BITS PER SECOND
                                MOV     DX,3F7H
                                OUT     DX,AL
                                TEST    BYTE PTR @EQUIP_FLAG,1H ; DISKETTE PRESENT?
                                JZ      F15
                                TEST    @MFG_TST,MFG_LOOP       ; MFG JUMPER INSTALLED?
                                JZ      F15                     ; GO IF YES
                        F10:                                    ; DISK_TEST:
                                IN      AL,INTA01
                                JMP     $+2                     ; I/O DELAY
                                AND     AL,0BFH                 ; ENABLE DISKETTE INTERRUPTS
                                OUT     INTA01,AL
                                MOV     AH,0                    ; RESET NEC FDC
                                MOV     DL,AH                   ; SET FOR DRIVE 0
                                INT     13H                     ; VERIFY STATUS AFTER RESET
                                TEST    AH,0FFH                 ; STATUS OK?
                                JNZ     F13                     ; NO - FDC FAILED

                        ;-----  TURN DRIVE 0 MOTOR ON

                                MOV     DX,03F2H                ; GET ADDRESS OF FDC CARD
                                MOV     AL,1CH                  ; TURN MOTOR ON, ENABLE DMA, INTERRUPTS
                                OUT     DX,AL                   ; WRITE FDC CONTROL REGISTER
                                SUB     CX,CX                   ; WAITF COUNT FOR 0.988 SECONDS
                                CALL    WAITF                   ; WAIT 1 SECOND FOR MOTOR

                                XOR     DI,DI                   ; SELECT DRIVE 0
                                MOV     CH,1                    ; SELECT TRACK 1
                                MOV     @SEEK_STATUS,0          ; INSURE RECALIBRATE
                                OR      @RTC_WAIT_FLAG,01       ; NO REAL TIME CLOCK, USE WAIT LOOP
                                CALL    SEEK                    ; RECALIBRATE DISKETTE
                                JC      F13                     ; GO TO ERR SUBROUTINE IF ERR
                                MOV     CH,34                   ; SELECT TRACK 34
                                CALL    SEEK                    ; SEEK TO TRACK 34
                                JNC     F14                     ; OK, TURN MOTOR OFF
                        F13:                                    ; DSK_ERR:
                                OR      @MFG_ERR_FLAG+1,DSK_FAIL;       <><><><><><><><><><><><><>
                                                                ;       <><> DISKETTE FAILED  <><>
                                MOV     SI,OFFSET E601          ; GET ADDRESS OF MESSAGE
                                CALL    E_MSG                   ; GO PRINT ERROR MESSAGE

                        ;-----  TURN DRIVE 0 MOTOR OFF

                        F14:                                    ; DR0_OFF:
                                AND     @RTC_WAIT_FLAG,0FEH     ; ALLOW FOR RTC WAIT
                                MOV     AL,0CH                  ; TURN DRIVE 0 MOTOR OFF
                                MOV     DX,03F2H                ; FDC CONTROLLER ADDRESS
                                OUT     DX,AL

                        ;-----  SETUP KEYBOARD PARAMETERS

                        F15:    MOV     @INTR_FLAG,00H          ; SET STRAY INTERRUPT FLAG = 00
```

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                        MOV     SI,OFFSET @KB_BUFFER    ; SETUP KEYBOARD PARAMETERS
                        MOV     @BUFFER_HEAD,SI
                        MOV     @BUFFER_TAIL,SI
                        MOV     @BUFFER_START,SI
                        ADD     SI,32                   ; DEFAULT BUFFER OF 32 BYTES
                        MOV     @BUFFER_END,SI

                ;-----  SET PRINTER TIMEOUT DEFAULT

                        MOV     DI,OFFSET @PRINT_TIM_OUT; SET DEFAULT PRINTER TIMEOUT
                        PUSH    DS
                        POP     ES
                        MOV     AX,1414H                ; DEFAULT=20
                        STOSW
                        STOSW

                ;-----  SET RS232 DEFAULT

                        MOV     AX,0101H                ; RS232 DEFAULT=01
                        STOSW
                        STOSW

                ;-----  ENABLE TIMER INTERRUPTS

                        IN      AL,INTA01
                        AND     AL,0FEH                 ; ENABLE TIMER INTERRUPTS
                        JMP     $+2                     ; I/O DELAY
                        OUT     INTA01,AL

                ;-----  CHECK CMOS BATTERY AND CHECKSUM

                        TEST    @MFG_TST,MFG_LOOP       ; MFG JUMPER?
                        JNZ     B1_OK                   ; GO IF NOT
                        JMP     F15C                    ; BYPASS IF YES
                B1_OK:
                        MOV     AL,CMOS_DIAG+NMI        ; ADDRESS DIAGNOSTIC STATUS BYTE
                        CALL    CMOS_READ               ; READ IT FROM CMOS

                        MOV     SI,OFFSET E161          ; LOAD BAD BATTERY MESSAGE 161
                        TEST    AL,BAD_BAT              ; BATTERY BAD?
                        JNZ     B1_ER                   ; DISPLAY ERROR IF BAD

                        MOV     SI,OFFSET E162          ; LOAD CHECKSUM BAD MESSAGE 162
                        TEST    AL,BAD_CKSUM+BAD_CONFIG ; CHECK FOR CHECKSUM OR NO DISKETTE
                        JZ      C_OK                    ; SKIP AND CONTINUE TESTING CMOS CLOCK
                B1_ER:
                        CALL    E_MSG                   ; ELSE DISPLAY ERROR MESSAGE
                        OR      BP,08000H               ; FLAG "SET SYSTEM OPTIONS" DISPLAYED
                        JMP     SHORT H_OK1A            ; SKIP CLOCK TESTING IF ERROR

                ;-----  TEST CLOCK UPDATING

                C_OK:   MOV     BL,04H                  ; OUTER LOOP COUNT
                D_OK:   SUB     CX,CX                   ; INNER LOOP COUNT
                E_OK:   MOV     AL,CMOS_REG_A+NMI       ; GET THE CLOCK UPDATE BYTE
                        CALL    CMOS_READ
                        TEST    AL,80H                  ; CHECK FOR UPDATE IN PROGRESS
                        JNZ     G_OK                    ; GO IF YES
                        LOOP    E_OK                    ; TRY AGAIN
                        DEC     BL                      ; DEC OUTER LOOP
                        JNZ     D_OK                    ; TRY AGAIN
                F_OK:   MOV     SI,OFFSET E163          ; PRINT MESSAGE
                        CALL    E_MSG

                ;-----  SET CMOS DIAGNOSTIC STATUS TO 04 (CLOCK ERROR)

                        MOV     AX,X*CMOS_DIAG+NMI      ; SET CLOCK ERROR
                        CALL    CMOS_READ               ; GET THE CURRENT STATUS
                        OR      AL,CMOS_CLK_FAIL        ; SET NEW STATUS
                        XCHG    AL,AH                   ; GET STATUS ADDRESS AND SAVE NEW STATUS
                        CALL    CMOS_WRITE              ; MOVE NEW DIAGNOSTIC STATUS TO CMOS
                        JMP     SHORT H_OK              ; CONTINUE

                ;-----  CHECK CLOCK UPDATE

                G_OK:   MOV     CX,800                  ; LOOP COUNT
                I_OK:   MOV     AL,CMOS_REG_A+NMI       ; CHECK FOR OPPOSITE STATE
                        CALL    CMOS_READ
                        TEST    AL,80H
                        LOOPNZ  I_OK                    ; TRY AGAIN
                        JCXZ    F_OK                    ; PRINT ERROR IF TIMEOUT

                ;-----  CHECK MEMORY SIZE DETERMINED = CONFIGURATION

                H_OK:
                        MOV     AL,CMOS_DIAG+NMI        ; GET THE STATUS BYTE
                        CALL    CMOS_READ
                        TEST    AL,W_MEM_SIZE           ; WAS THE CONFIG= MEM_SIZE_DETERMINED?
                        JZ      H_OK1A                  ; GO IF YES

                ;-----  MEMORY SIZE ERROR

                        MOV     SI,OFFSET E164          ; PRINT SIZE ERROR
                        CALL    E_MSG                   ; DISPLAY ERROR

                ;-----  CHECK FOR CRT ADAPTER ERROR

                H_OK1A: CMP     @MFG_ERR_FLAG,0CH       ; CHECK FOR MONOCHROME CRT ERROR
                        MOV     SI,OFFSET E401          ; LOAD MONOCHROME CRT ERROR
                        JZ      H_OK1B                  ; GO IF YES

                        CMP     @MFG_ERR_FLAG,0DH       ; CHECK FOR COLOR CRT ADAPTER ERROR
                        JNZ     J_OK                    ; CONTINUE IF NOT
                        MOV     SI,OFFSET E501          ; CRT ADAPTER ERROR MESSAGE
                H_OK1B:
                        CALL    E_MSG

                ;-----  CHECK FOR MULTIPLE DATA RATE CAPABILITY

                J_OK:
                        MOV     DX,03F1H                ; D/S/P DIAGNOSTIC REGISTER
                        IN      AL,DX                   ; READ D/S/P TYPE CODE
                        AND     AL,11111000B            ; KEEP ONLY UNIQUE CODE FOR D/S/P
                        CMP     AL,01010000B            ; D/S/P CARD - MULTIPLE DATA RATE ?
```

```
06C8 74 46                      JZ      J_OK3                   ; IF SO JUMP
                                
06CA BA 05F7                    MOV     DX,05F7H                ; FIXED DISK DIAGNOSTIC REGISTER
06CD EC                         IN      AL,DX                   ; READ FIXED DISK TYPE CODE
06CE 24 F0                      AND     AL,11110000B            ; KEEP ONLY UNIQUE CODE FOR F/D
06D0 3C A0                      CMP     AL,10100000B            ; FIXED DISK ADAPTER ?
06D2 74 2F                      JZ      J_FAIL                  ; MUST BE COMBO ELSE ERROR
                                
06D4 B3 0F                      MOV     BL,0FH                  ; OUTER LOOP COUNT WAIT FOR BUSY OFF
06D6 2B C9                      SUB     CX,CX
06D8 BA 01F7                    MOV     DX,01F7H                ; HARD FILE STATUS PORT
06DB                    J_OK1:
06DB EC                         IN      AL,DX                   ; GET THE STATUS
06DC A8 80                      TEST    AL,080H                 ; IS THE CONTROLLER BUSY?
06DE 74 0C                      JZ      J_OK2                   ; CONTINUE IF NOT
06E0 E2 F9                      LOOP    J_OK1                   ; TRY AGAIN
06E2 FE CB                      DEC     BL                      ; DECREMENT OUTER LOOP
06E4 75 F5                      JNZ     J_OK1                   ; TRY AGAIN IF NOT ZERO
06E6 24 0C                      AND     AL,0CH                  ; BITS 2 & 3 = 0 IF MULTI DATA CAPABLE
06E8 74 26                      JZ      J_OK3                   ; GO IF YES
06EA EB 17                      JMP     SHORT J_FAIL            ; NO MULTIPLE DATA RATE CAPABILITY
06EC                    J_OK2:
06EC BA 01F4                    MOV     DX,1F4H                 ; VERIFY MULTIPLE DATA RATE CAPABLE
06EF B0 55                      MOV     AL,055H                 ;  WRITE TO THE CYLINDER BYTE
06F1 EE                         OUT     DX,AL
06F2 EB 00                      JMP     $+2                     ; I/O DELAY
06F4 EC                         IN      AL,DX                   ; CHECK DATA WRITTEN = DATA READ
06F5 3C 55                      CMP     AL,055H
06F7 75 0A                      JNZ     J_FAIL                  ; GO IF NOT
06F9 B0 AA                      MOV     AL,0AAH                 ; WRITE ANOTHER PATTERN
06FB EE                         OUT     DX,AL
06FC EB 00                      JMP     $+2                     ; I/O DELAY
06FE EC                         IN      AL,DX
06FF 3C AA                      CMP     AL,0AAH                 ; IS DATA PATTERN THE SAME?
0701 74 0D                      JZ      J_OK3                   ; GO IF SO
                                
0703                    J_FAIL:
0703 80 0E 0016 R 40            OR      @MFG_ERR_FLAG+1,DSK_FAIL;       <><><><><><><><><><><><><>
                                                                ;       <><> DISKETTE FAILED  <><>
0708 BE 0000 E                  MOV     SI,OFFSET E601          ; GET ADDRESS OF MESSAGE
070B E8 0000 E                  CALL    E_MSG                   ; GO PRINT ERROR MESSAGE
070E EB 1E                      JMP     SHORT F15C              ; SKIP SETUP IF ERROR
                                
0710                    J_OK3:
0710 80 0E 008B R 01            OR      @LASTRATE,DUAL          ; TURN ON DSP/COMBO FLAG
                                
                                ;-----  INITIALIZE FLOPPY FOR DRIVE TYPE
                                
0715 B0 3D                      MOV     AL,3DH                  ;       <><><><><><><><><><><><>
0717 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3D <><>
0719 E8 0000 E                  CALL    DSKETTE_SETUP           ; INITIALIZE FLOPPY
                                
                                ;-----  CHECK FOR 2ND DISKETTE DRIVE
                                
071C E8 0000 E                  CALL    DDS                     ; INSURE DATA SEGMENT
071F 8A 26 0091 R               MOV     AH,@DSK_STATE+1         ; GET STATE OF SECOND DRIVE
0723 0A E4                      OR      AH,AH                   ; IS THERE A DRIVE 2 ATTACHED?
0725 74 07                      JZ      F15C                    ; SKIP IF NOT
0727 80 0E 0010 R 40            OR      BYTE PTR @EQUIP_FLAG,40H; ELSE SET SECOND DRIVE INSTALLED
072C B4 FF                      MOV     AH,0FFH                 ; SET TEST MASK FOR DRIVE PRESENT
072E                    F15C:
072E B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; GET THE CMOS DIAGNOSTIC STATUS
0730 E8 0000 E                  CALL    CMOS_READ
0733 A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; BATTERY/CHECKSUM OK
0735 75 22                      JNZ     ROM_SCAN1               ; BYPASS DISK SETUP IF NOT
                                
0737 B0 90                      MOV     AL,CMOS_DISKETTE+NMI    ; ADDRESS DISKETTE TYPE BYTE
0739 E8 0000 E                  CALL    CMOS_READ               ; GET DISKETTE TYPES
073C 24 0F                      AND     AL,00FH                 ; LOOK AT SECOND DRIVE TYPE DEFINED
073E 3A C4                      CMP     AL,AH                   ; ARE BOTH INDICATORS ZERO
0740 74 07                      JE      F15D                    ; SKIP IF NO SECOND DRIVE
                                
0742 22 C4                      AND     AL,AH                   ; ARE BOTH INDICATORS NON-ZERO
0744 75 03                      JNZ     F15D                    ; SKIP IF DRIVE FOUND AND DEFINED
                                
0746 E8 0000 E                  CALL    CONFIG_BAD              ; SET BAD_CONFIG IN CMOS_DIAG
                                
                                ;-----  INITIALIZE HARD FILE
0749                    F15D:
0749 B0 3E                      MOV     AL,3EH                  ;       <><><><><><><><><><><><>
074B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3E <><>
                                
074D B0 92                      MOV     AL,CMOS_DISK+NMI        ; INSURE CMOS DEFINES TYPE OF FIXED DISK
074F E8 0000 E                  CALL    CMOS_READ
0752 3C 00                      CMP     AL,0H                   ; INSURE TYPE IS DEFINED
0754 74 03                      JZ      ROM_SCAN1               ; BYPASS DISK SETUP IF NOT
                                
0756 E8 0000 E                  CALL    DISK_SETUP              ; INITIALIZE HARD FILE(S)
                                
                                ;--------------------------------------------------------
                                ; TEST.22                                              :
                                ; CHECK FOR OPTIONAL ROM FROM C800->E000 IN 2K BLOCKS  :
                                ;       (A VALID MODULE HAS '55AA' IN THE FIRST 2 LOCATIONS:
                                ;       LENGTH INDICATOR (LENGTH/512) IN THE 3RD LOCATION  :
                                ;       AND TEST/INIT. CODE STARTING IN THE 4TH LOCATION)  :
                                ;--------------------------------------------------------
0759                    ROM_SCAN1:
0759 FB                         STI                             ; ALLOW INTERRUPTS
075A B0 3B                      MOV     AL,3BH                  ;       <><><><><><><><><><><><>
075C E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3B <><>
075E E8 0000 E                  CALL    DDS                     ; SET REAL MODE DATA SEGMENT
0761 B0 0A                      MOV     AL,10                   ; LINE FEED ON DISPLAY
0763 E8 0000 E                  CALL    PRT_HEX
0766                    ROM_SCAN:
                                
                                ;-----  SET DMA MASK AND REQUEST REGISTERS
                                
0766 2A C0                      SUB     AL,AL
0768 E6 D2                      OUT     DMA18+2,AL              ; SEND ZERO TO MASK REGISTER
076A EB 00                      JMP     $+2
076C E6 D4                      OUT     DMA18+4,AL              ; SEND ZERO TO REQUEST REGISTER
076E BA C800                    MOV     DX,0C800H               ; SET BEGINNING ADDRESS
0771                    ROM_SCAN2:
0771 8E DA                      MOV     DS,DX
```

```
                        PUSH    DI                      ; SAVE WORK REGISTER
                        MOV     DI,0AA55H               ; GET TEST PATTERN
                        SUB     BX,BX                   ; SET BX=0000
                        MOV     AX,[BX]                 ; GET 1ST WORD FROM MODULE
                        CMP     AX,DI                   ; = TO ID WORD?
                        POP     DI                      ; RECOVER WORK REGISTER
                        JNZ     NEXT_ROM                ; PROCEED TO NEXT ROM IF NOT
                        CALL    ROM_CHECK               ; GO CHECK OUT MODULE
                        JMP     SHORT ARE_WE_DONE       ; CHECK FOR END OF ROM SPACE
                NEXT_ROM:
                        ADD     DX,0080H                ; POINT TO NEXT 2K ADDRESS
                ARE_WE_DONE:
                        CMP     DX,0E000H               ; AT E0000 YET?
                        JL      ROM_SCAN2               ; GO CHECK ANOTHER ADD. IF NOT

                ;-----  TEST FOR KEYBOARD LOCKED

                        CALL    DDS                     ; SET DATA SEGMENT
                        IN      AL,STATUS_PORT          ; IS KEYBOARD UNLOCKED?
                        AND     AL,KYBD_INH
                        JZ      KEY1                    ; NO - SET ERROR FLAGS AND PRINT MESSAGE
                        JMP     SHORT KEY10             ; GO IF OFF
                KEY1:
                        OR      @MFG_ERR_FLAG+1,KEY_FAIL;       <><><><><><><><><><><><><><>
                                                        ;       <><> KEYBOARD IS LOCKED <><>
                        ASSUME  DS:DATA
                        MOV     SI,OFFSET E302          ; PRINT LOCKED MESSAGE  (302)
                        CALL    E_MSG
                KEY10:
                        ;====================
                ;-----  SETUP @PRINTER_BASE
                        ;====================

                        MOV     DI,OFFSET F4            ; OFFSET OF PRINTER ADDRESS TABLE
                        MOV     SI,0
                F16:
                        MOV     DX,CS:[DI]              ; GET PRINTER BASE ADDRESS
                        MOV     AL,0AAH                 ; WRITE DATA TO PORT A
                        OUT     DX,AL
                        JMP     $+2                     ; I/O DELAY
                        PUSH    DS                      ; BUS SETTLING
                        IN      AL,DX                   ; READ PORT A
                        POP     DS
                        CMP     AL,0AAH                 ; DATA PATTERN SAME
                        JNE     F17                     ; NO - CHECK NEXT PRINTER CARD
                        MOV     @PRINTER_BASE[SI],DX    ; YES - STORE PRINTER BASE ADDRESS
                        INC     SI                      ; INCREMENT TO NEXT WORD
                        INC     SI
                F17:
                        INC     DI                      ; POINT TO NEXT BASE ADDRESS
                        INC     DI
                        CMP     DI,OFFSET F4E           ; ALL POSSIBLE ADDRESSES CHECKED?
                        JNE     F16                     ; PRT_BASE
                        ;=============
                ;-----  SETUP RS232
                        ;=============
                        MOV     BX,0                    ; POINTER TO RS232 TABLE
                        MOV     DX,3FAH                 ; CHECK IF RS232 CARD 1 ATTACHED ?
                        IN      AL,DX                   ; READ INTERRUPT ID REGISTER
                        TEST    AL,0F8H
                        JNZ     F18
                        MOV     @RS232_BASE[BX],3F8H    ; SETUP RS232 CARD #1 ADDRESS
                        INC     BX
                        INC     BX
                F18:    MOV     DX,2FAH                 ; CHECK IF RS232 CARD 2 ATTACHED
                        IN      AL,DX                   ; READ INTERRUPT ID REGISTER
                        TEST    AL,0F8H
                        JNZ     F19                     ; BASE_END
                        MOV     @RS232_BASE[BX],2F8H    ; SETUP RS232 CARD #2
                        INC     BX
                        INC     BX
                        ;--------------------------------------------------------------
                ;-----  SET UP @EQUIP_FLAG TO INDICATE NUMBER OF PRINTERS AND RS232 CARDS
                        ;--------------------------------------------------------------------------
                F19:                                    ; BASE_END:
                        MOV     AX,SI                   ; SI HAS 2* NUMBER OF RS232
                        MOV     CL,3                    ; SHIFT COUNT
                        ROR     AL,CL                   ; ROTATE RIGHT 3 POSITIONS
                        OR      AL,BL                   ; OR IN THE PRINTER COUNT
                        MOV     BYTE PTR @EQUIP_FLAG+1,AL       ; STORE AS SECOND BYTE

                ;-----  INSURE CMOS CLOCK HAS VALID HOURS.MINUTES.SECONDS

                        CALL    SET_TOD                 ; INSURE CMOS CLOCK IS VALID

                ;-----  ENABLE HARDWARE INTERRUPT IF MATH PROCESSOR (80287)

                        MOV     AL,40H                  ;       <><><><><><><><><><><><>
                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  40 <><>

                        MOV     DI,OFFSET @IO_ROM_INIT  ; ADDRESS WORK STORAGE LOCATION
                        XOR     AX,AX                   ; CLEAR WORK REGISTER  (AH)= 0 (NO 287)
                        MOV     WORD PTR [DI],AX        ; CLEAR THE WORK LOCATION
                        FNINIT                          ; INITIALIZE THE 80287 WITH NO WAIT
                        JMP     $+2                     ; DELAY
                        FNSTCW  WORD PTR [DI]           ; WRITE THE CURRENT 80287 CONTROL WORD
                        PUSHA                           ; TIME FOR 80287 TO RESPOND
                        POPA
                        AND     WORD PTR [DI],01F3FH    ; CLEAR UNUSED 80287 BITS
                        CMP     WORD PTR [DI],0033FH    ; IS THE 80287 INSTALLED?
                        JNE     NO_287                  ; GO IF MATH PROCESSOR IS NOT INSTALLED

                        FSTSW   WORD PTR [DI]           ; STORE THE STATUS WORD (WITH WAIT)
                        PUSHA                           ; TIME FOR 80287 TO RESPOND
                        POPA
                        TEST    WORD PTR [DI],0B8BFH    ; ALL BITS SHOULD BE OFF (OR ERROR)
                        JNZ     NO_287                  ; GO IF NOT INSTALLED

                        IN      AL,INTB01               ; GET THE SLAVE INTERRUPT MASK
                        AND     AL,0DFH                 ; ENABLE 80287 INTERRUPTS
                        MOV     AH,002H                 ; SET WORK REGISTER FOR 80287 FOUND
                        OUT     INTB01,AL
                NO_287:
                        MOV     AL,BYTE PTR @EQUIP_FLAG ; GET LOW EQUIPMENT FLAG
```

SECTION 5

```
082C 24 02                      AND     AL,002H                 ; STRIP OFF OTHER BITS
082E 3A C4                      CMP     AL,AH                   ; DOES CMOS MATCH HARDWARE ?
0830 74 08                      JE      OK_287                  ; SKIP IF EQUIPMENT FLAG CORRECT

0832 80 36 0010 R 02            XOR     BYTE PTR @EQUIP_FLAG,2H ; ELSE SET 80287 BIT TO CORRECT VALUE
0837 E8 0000 E                  CALL    CONFIG_BAD              ; AND SET THE CONFIGURATION ERROR FLAG
083A                    OK_287:
                        ;-----  SET KEYBOARD STATE FLAGS

083A C7 06 0017 R 0000          MOV     WORD PTR @KB_FLAG,0     ; RESET ALL KEYBOARD STATUS FLAGS

                        ;-----  ENABLE KEYBOARD/TIMER INTERRUPTS

0840 E4 21                      IN      AL,INTA01
0842 24 FC                      AND     AL,0FCH                 ; ENABLE TIMER AND KEYBOARD INTERRUPTS
0844 EB 00                      JMP     $+2                     ; I/O DELAY
0846 E6 21                      OUT     INTA01,AL
0848 C6 06 0015 R 00            MOV     @MFG_ERR_FLAG,0         ; CLEAR MFG ERROR FLAG

                        ;-----  READ KEYBOARD ID TO INITIALIZE KEYBOARD TYPE AND NUM LOCK STATE

084D C6 06 0096 R A0            MOV     @KB_FLAG_3,RD_ID+SET_NUM_LK     ; SET READ ID COMMAND FOR KBX
0852 B0 F2                      MOV     AL,KB_READ_ID           ; GET THIS SYSTEMS KEYBOARD ID REQUEST
0854 E8 0000 E                  CALL    SND_DATA                ; USE KEYBOARD TRANSMISSION ROUTINE
0857 B9 067A                    MOV     CX,T658                 ; SET DELAY COUNT TO 25 MILLISECONDS
085A E8 0000 E                  CALL    WAITF                   ; WAIT FOR READ ID RESPONSE (20 MS)
085D 80 26 0096 R 1F            AND     @KB_FLAG_3,NOT RD_ID+LC_AB+SET_NUM_LK   ; RESET READ ID COMMAND

                        ;-----  CHECK FOR SECOND FIXED DISK PRESENT BUT NOT DEFINED

0862 80 3E 0075 R 02            CMP     @HF_NUM,2               ; CHECK FOR TWO DRIVES DEFINED BY CMOS
0867 74 13                      JE      F15G                    ; SKIP TEST IF TWO DRIVES DEFINED

0869 B4 10                      MOV     AH,010H                 ; GET TEST DRIVE READY COMMAND
086B B2 81                      MOV     DL,081H                 ; POINT TO SECOND FIXED DISK
086D FE 06 0075 R               INC     @HF_NUM                 ; TELL BIOS IT HAS TWO DRIVES
0871 CD 13                      INT     13H                     ; CHECK READY THROUGH BIOS
0873 FE 0E 0075 R               DEC     @HF_NUM                 ; RESTORE CORRECT COUNT (RETAIN CY)
0877 72 03                      JC      F15G                    ; SKIP IF SECOND DRIVE NOT READY
                                                                ;       SECOND DRIVE NOT DEFINED
0879 E8 0000 E                  CALL    CONFIG_BAD              ; SET CONFIGURATION BAD
087C                    F15G:
                        ;---------------------------------------
                        ;   TEST FOR ANY ERRORS (BP NOT ZERO)   :
                        ;---------------------------------------

087C 0B ED                      OR      BP,BP                   ; CHECK (BP)= NON-ZERO  (ERROR HAPPENED)
087E 74 55                      JE      F15A_0                  ; SKIP PAUSE IF NO ERROR

0880 80 3E 0072 R 64            CMP     BYTE PTR @RESET_FLAG,64H; MFG RUN IN MODE?
0885 BA 0002                    MOV     DX,2                    ; 2 SHORT BEEP COUNT FOR ERROR(S)
0888 75 0E                      JNZ     ERR_WAIT                ; GO IF NOT

                        ;-----  MFG RUN IN MODE -> SET ERROR FLAG

088A C6 06 0015 R AA            MOV     @MFG_ERR_FLAG,0AAH      ; INDICATE ERROR
088F E4 64                      IN      AL,STATUS_PORT          ; CHECK KEY LOCK STATUS
0891 24 10                      AND     AL,KYBD_INH             ; IS THE KEYBOARD LOCKED
0893 75 40                      JNZ     F15A_0                  ; CONTINUE MFG MODE IF NOT LOCKED
                                                                ;  ELSE
0895 BA 0005                    MOV     DX,5                    ; 5 SHORT BEEPS FOR MFG SETUP ERROR
0898                    ERR_WAIT:
0898 E8 0000 E                  CALL    ERR_BEEP                ; BEEPS FOR ERROR(S)
089B B0 0E                      MOV     AL,CMOS_DIAG            ; ADDRESS CMOS
089D E8 0000 E                  CALL    CMOS_READ               ; GET THE DIAGNOSTIC STATUS BYTE
08A0 A8 20                      TEST    AL,BAD_CONFIG           ; CHECK FOR BAD HARDWARE CONFIGURATION
08A2 74 0C                      JZ      ERR_WKEY                ; SKIP IF NOT SET

08A4 F7 C5 8000                 TEST    BP,08000H               ; ELSE CHECK FOR E161/E162 POSTED
08A8 75 06                      JNZ     ERR_WKEY                ; SKIP IF DISPLAYED BEFORE NOW

08AA BE 0000 E                  MOV     SI,OFFSET E162          ; ELSE DISPLAY "OPTIONS NOT SET"
08AD E8 0000 E                  CALL    P_MSG                   ; WITH NON HALTING ROUTINE

                        ;-----  CHECK FOR "UNLOCK SYSTEM UNIT KEYLOCK" MESSAGE REQUIRED

08B0                    ERR_WKEY:
08B0 E4 64                      IN      AL,STATUS_PORT          ; CHECK IF RESUME MESSAGE NEEDED
08B2 24 10                      AND     AL,KYBD_INH             ; IS THE KEYBOARD LOCKED
08B4 75 06                      JNZ     ERR_WAIT2               ; SKIP LOCK MESSAGE IF NOT

08B6 BE 0000 E                  MOV     SI,OFFSET F3D1          ; ERROR MESSAGE FOR KEYBOARD LOCKED
08B9 E8 0000 E                  CALL    P_MSG

                        ;-----  DISPLAY '(RESUME = "F1" KEY)' FOR ERRORS

08BC                    ERR_WAIT2:
08BC BE 0000 E                  MOV     SI,OFFSET F3D           ; RESUME ERROR MESSAGE
08BF E8 0000 E                  CALL    P_MSG

                        ;-----  INITIALIZE PRINTER  (ALTERNATE DISPLAY DEVICE)

08C2 B4 01                      MOV     AH,1                    ;
08C4 2B D2                      SUB     DX,DX                   ; FIRST PRINTER
08C6 CD 17                      INT     17H                     ;
08C8                    ERR_WAIT1:
08C8 B0 3F                      MOV     AL,3FH                  ;       <><><><><><><><><><><><>
08CA E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3F <><>
08CC B4 00                      MOV     AH,00
08CE CD 16                      INT     16H                     ; WAIT FOR 'F1' KEY
08D0 80 FC 3B                   CMP     AH,3BH
08D3 75 F3                      JNE     ERR_WAIT1
08D5                    F15A_0:
08D5 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; MFG BURN IN MODE
08DA 75 03                      JNZ     F15A                    ; GO IF NOT
08DC E9 0000 E                  JMP     START_1                 ; GO LOOP POST
08DF 80 3E 0072 R 64    F15A:   CMP     BYTE PTR @RESET_FLAG,64H; MFG RUN IN?
08E4 74 06                      JZ      F15B                    ; BYPASS BEEP IF YES

08E6 BA 0001                    MOV     DX,1                    ; 1 SHORT BEEP (NO ERRORS)
08E9 E8 0000 E                  CALL    ERR_BEEP
                                ;===============
                        ;-----  SET TIME OF DAY
                                ;===============
```

```
                                ;-----  CLEAR DISPLAY SCREEN

08EF 2A E4                              SUB     AH,AH                   ; CLEAR FLAGS
08F1 A0 0049 R                          MOV     AL,@CRT_MODE
08F4 CD 10                              INT     10H                     ; CLEAR SCREEN

                                ;-----  CLEAR DESCRIPTOR TABLES

08F6 B9 01F4                    F20:    MOV     CX,0500                 ; CLEAR 1K
08F9 BF D0A0                            MOV     DI,SYS_IDT_LOC          ; POINT ES TO START OF DESCRIPTORS
08FC 2B C0                              SUB     AX,AX
08FE 8E C0                              MOV     ES,AX
0900 26: 89 05                  F20_A:  MOV     ES:[DI],AX              ; CLEAR
0903 83 C7 02                           ADD     DI,2                    ; POINT TO NEXT LOCATION
0906 E2 F8                              LOOP    F20_A                   ; CONTINUE TILL DONE

                                ;-----  SET POST SYSTEM STACK

0908 B8 ---- R                          MOV     AX,ABS0                 ; GET THE POST STACK SEGMENT
090B 8E D0                              MOV     SS,AX
090D BC 0400 R                          MOV     SP,OFFSET @TOS

                                ;-----  ENSURE THAT MASTER LEVEL 2 ENABLED

0910 E4 21                              IN      AL,INTA01               ; GET THE CURRENT MASK
0912 24 FB                              AND     AL,0FBH
0914 EB 00                              JMP     $+2                     ; I/O DELAY
0916 E6 21                              OUT     INTA01,AL

                                ;-----  TEST FOR MFG RUN-IN TEST

0918 80 3E 0072 R 64                    CMP     BYTE PTR @RESET_FLAG,64H; IS THE THE MFG RUN-IN TEST?
091D 75 02                              JNZ     END_287                 ; GO IF NOT
091F EB 5C                              JMP     SHORT SHUT4             ; BOOT LOAD IF YES

                                ;-----  UNMASK SLAVE HARDWARE INTERRUPT 9 (LEVEL 71)
0921                            END_287:
0921 E4 A1                              IN      AL,INTB01               ; GET THE CURRENT MASK
0923 24 FD                              AND     AL,0FDH
0925 EB 00                              JMP     $+2                     ; I/O DELAY
0927 E6 A1                              OUT     INTB01,AL               ; SET NEW MASK

                                ;-------------------------------------------------------------------
                                ; TEST FOR SYSTEM CODE AT SEGMENT E000:0
                                ;   FIRST WORD = AA55H
                                ;   LAST BYTE = CHECKSUM
                                ;   ENTRY POINT = FIRST BYTE + 3
                                ; IF TEST IS SUCCESSFUL A CALL FAR TO THE ENTRY POINT IS EXECUTED
                                ;-------------------------------------------------------------------
0929 B0 41                              MOV     AL,41H                  ;       <><><><><><><><><><>
092B E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  41 <><>

092D B0 8D                              MOV     AL,CMOS_REG_D+NMI       ; INSURE NMI OFF AND CMOS AT DEFAULT
092F E6 70                              OUT     CMOS_PORT,AL

                                ENDIF

0931 C6 06 0072 R 00                    MOV     BYTE PTR @RESET_FLAG,0  ; CLEAR FLAG
0936 B8 E000                            MOV     AX,0E000H               ; SEGMENT OF SYSTEM CODE
0939 8E C0                              MOV     ES,AX
093B 2B FF                              SUB     DI,DI
093D 26: 8B 05                          MOV     AX,ES:[DI]              ; CHECK FOR AA55
0940 53                                 PUSH    BX                      ; BUS SETTLE
0941 5B                                 POP     BX
0942 3D AA55                            CMP     AX,0AA55H
0945 9C                                 PUSHF                           ; SAVE FLAGS
0946 26: 89 05                          MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY CHECK
0949 E4 61                              IN      AL,PORT_B
094B 0C 0C                              OR      AL,RAM_PAR_OFF          ; TOGGLE I/O-PARITY CHECK ENABLES
094D E6 61                              OUT     PORT_B,AL
094F 24 F3                              AND     AL,RAM_PAR_ON
0951 E6 61                              OUT     PORT_B,AL
0953 9D                                 POPF                            ; RESTORE FLAGS
0954 75 27                              JNZ     SHUT4                   ; CONTINUE

                                ;-----  CHECKSUM SYSTEM CODE

0956 1E                                 PUSH    DS
0957 06                                 PUSH    ES                      ; SET SEGMENT TO TEST
0958 1F                                 POP     DS
0959 2B DB                              SUB     BX,BX                   ; STARTING OFFSET
095B E8 0000 E                          CALL    ROM_CHECKSUM
095E 1F                                 POP     DS                      ; RESTORE DATA SEGMENT
095F 75 1C                              JNZ     SHUT4                   ; GO IF CHECKSUM NOT OK

                                ;-----  ENABLE NMI AND I/O-MEMORY PARITY CHECKS

0961 B0 0D                              MOV     AL,CMOS_REG_D           ; ENABLE NMI AND SET DEFAULT ADDRESS
0963 E6 70                              OUT     CMOS_PORT,AL

0965 E4 61                              IN      AL,PORT_B               ; ENABLE PARITY
0967 24 F3                              AND     AL,RAM_PAR_ON           ; ENABLE MEMORY PARITY CHECK / I/O CHECK
0969 E6 61                              OUT     PORT_B,AL

096B C7 06 0067 R 0003                  MOV     @IO_ROM_INIT,0003H      ; SET THE OFFSET
0971 8C 06 0069 R                       MOV     @IO_ROM_SEG,ES          ; SET THE SEGMENT

0975 B0 42                              MOV     AL,42H                  ;       <><><><><><><><><><>
0977 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  42 <><>

                                ;-----  EXIT TO SYSTEM CODE

0979 FF 1E 0067 R                       CALL    DWORD PTR @IO_ROM_INIT  ; GO TO SYSTEM CODE
                                                                        ; VIA CALL THROUGH DATA AREA LOCATION

                                ;-----  ENABLE NMI INTERRUPTS + ENTRY FROM SHUTDOWN WITH BOOT REQUEST

097D B0 0D                      SHUT4:  MOV     AL,CMOS_REG_D           ; ENABLE NMI AND SET DEFAULT ADDRESS
097F E6 70                              OUT     CMOS_PORT,AL
0981 E4 61                              IN      AL,PORT_B               ; ENABLE PARITY
0983 24 F3                              AND     AL,RAM_PAR_ON           ; ENABLE MEMORY PARITY CHECK / I/O CHECK
```

SECTION 5

```
                        OUT     PORT_B,AL

                        MOV     AL,43H                  ;       <><><><><><><><><><><><><>
                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  43 <><>
                        STI                             ; ENABLE INTERRUPTS IF DISABLED

                        INT     19H                     ; GO TO BOOT LOADER

                        HLT

PADING                  PROC    NEAR                    ;       INSERT PADDING
                        MOV     CX,15                   ; GET BLANK CHARACTER COUNT
PAD1:
                        MOV     AL,' '                  ; GET FILL SPACE
                        CALL    PRT_HEX                 ; WRITE A SPACE
                        LOOP    PADT                    ; LOOP TILL INSERT DONE
                        MOV     AL,'-'                  ; GET DASH CHARACTER
                        CALL    PRT_HEX                 ; WRITE TO DISPLAY
                        RET
PADING                  ENDP

PRT_OK                  PROC    NEAR                    ;       PRINT "00000 KB OK"
                        PUSH    AX                      ; SAVE WORK REGISTER
                        MOV     BX,10                   ; SET DECIMAL CONVERT

                ;-----  CONVERT AND SAVE

                        MOV     CX,5                    ; OF 5 NIBBLES XX,XXX KB
                        SUB     DI,DI                   ; DISPLAY REGEN BUFFER POSITION
PRT_DIV:
                        XOR     DX,DX
                        DIV     BX                      ; DIVIDE BY 10
                        OR      DL,30H                  ; MAKE INTO ASCII
                        PUSH    DX                      ; SAVE
                        LOOP    PRT_DIV

                ;-----  DISPLAY LAST OK MEMORY

                        MOV     CX,5
PRT_DEC:
                        POP     AX                      ; RECOVER A NUMBER
                        CALL    PROT_PRT_HEX
                        INC     DI                      ; POINT TO DISPLAY REGEN BUFFER
                        LOOP    PRT_DEC
                        MOV     CX,OFFSET F3B_PAD-OFFSET F3B    ; LOAD MESSAGE LENGTH
                        MOV     SI,OFFSET F3B           ; POINT TO PRINT ' KB OK','     ' MESSAGE
PRT_LOOP:
                        MOV     AL,CS:[SI]
                        INC     SI
                        CALL    PROT_PRT_HEX
                        INC     DI                      ; INCREMENT BUFF PTR
                        LOOP    PRT_LOOP
                        POP     AX                      ; RECOVER WORK REGISTERS
                        RET

F3B     DB      ' KB OK'                ; OK MESSAGE
F3B_OK  DB      ' '                     ; PAD A SPACE
F3B_PAD EQU     $
        .LIST
PRT_OK  ENDP

                ;-------------------------
                ;       PRINTER TABLE   :
                ;-------------------------

                        DW      03BCH                   ; ADDRESS OF MONOCHROME PARALLEL ADAPTER
                        DW      0378H                   ; BASE ADDRESS STANDARD PARALLEL ADAPTER
                        DW      0278H                   ; ADDRESS OF ALTERNATE PARALLEL ADAPTER
F4E                     LABEL   WORD

POST2                   ENDP
CODE                    ENDS
                        END
```

```
                        PAGE 118,121
                        TITLE TEST3 ---- 06/10/85  POST EXCEPTION INTERRUPT TESTS
                        .286C
                        .LIST
                        ;--------------------------------------------------------
                        ; TEST.20                                               :
                        ;       ADDITIONAL PROTECTED (VIRTUAL MODE) TEST        :
                        ; DESCRIPTION                                           :
                        ;       THE PROCESSOR IS PUT IN PROTECTED MODE AND      :
                        ;       THE FOLLOWING FUNCTIONS ARE VERIFIED            :
                        ;                                                       :
                        ;       1. VERIFY PROTECTED MODE                        :
                        ;          THE MACHINE STATUS IS CHECK FOR VIRTUAL MODE :
                        ;       2. PROGRAMMED INTERRUPT TEST                    :
                        ;          AN PROGRAMMED INTERRUPT 32 IS ISSUED AND     :
                        ;          AND VERIFIED                                 :
                        ;       3. EXCEPTION INTERRUPT 13 TEST                  :
                        ;          A DESCRIPTOR SEGMENT LIMIT IS SET TO ZERO    :
                        ;          AND A WRITE TO THAT SEGMENT IS ATTEMPTED     :
                        ;          AN EXCEPTION 13 IS EXPECTED AND VERIFIED     :
                        ;       4. LDT/SDT LTR/STR TEST                         :
                        ;          LOAD LDT REGISTER AND VERIFY CORRECT         :
                        ;          LOAD TASK REGISTER AND VERIFY CORRECT        :
                        ;          THEY ARE VERIFIED VIA THE STORE INSTRUCTION  :
                        ;       5. THE CONTROL FLAGS OF THE 286 FOR DIRECTION   :
                        ;          ARE VERIFIED VIA THE STD AND CLD COMMANDS    :
                        ;          IN PROTECTED MODE                            :
                        ;       6. BOUND INSTRUCTION TEST (EXCEPTION INT 5)     :
                        ;          CREATE A SIGNED ARRAY INDEX WITHIN AND       :
                        ;          OUTSIDE THE LIMITS.  CHECK THAT NO EXC INT   :
                        ;          IF WITHIN LIMIT AND THAT AN EXC INT 5        :
                        ;          OCCURS IF OUTSIDE THE LIMITS.                :
                        ;       7. PUSH ALL POP ALL TEST                        :
                        ;          SET GENERAL PURPOSE REGISTERS TO DIFFERENT   :
                        ;          VALUES ISSUE A PUSH ALL, CLEAR THE REGISTERS :
                        ;          ISSUE A POP ALL AND VERIFY CORRECT.          :
                        ;       8. CHECK THE VERR/VERW INSTRUCTIONS             :
                        ;          THE ACCESS BYTE IS SET TO READ ONLY THEN TO  :
                        ;          A WRITE ONLY AND THE VERR/VERW INSTRUCTIONS   :
                        ;          ARE VERIFIED.                                :
                        ;       9. CAUSE AN INTERRUPT 13 VIA A WRITE TO A       :
                        ;          READ ONLY SEGMENT                            :
                        ;      10. VERIFY THE ARPL INSTRUCTION FUNCTIONS        :
                        ;          SET THE RPL FIELD OF A SELECTOR AND          :
                        ;          VERIFY THAT CURRENT SELECTOR RPL IS SET      :
                        ;          CORRECTLY.                                   :
                        ;      11. VERIFY THE LAR INSTRUCTION FUNCTIONS         :
                        ;      12. VERIFY THE LSL INSTRUCTION FUNCTIONS         :
                        ;      13. LOW MEG CHIP SELECT TEST                     :
                        ;--------------------------------------------------------
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  POST3

                                EXTRN   CMOS_WRITE:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   PROC_SHUTDOWN:NEAR
                                EXTRN   SYSINIT1:NEAR

                                ASSUME  CS:CODE
0000                    POST3   PROC
0000 E8 0000 E                  CALL    DDS                     ; SET DATA SEGMENT
0003 B0 F0                      MOV     AL,0F0H                 ;       <><><><><><><><><><><><>
0005 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F0 <><>

                        ;-----  SET SHUTDOWN RETURN 7

0007 B8 078F                    MOV     AX,7*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
000A E8 0000 E                  CALL    CMOS_WRITE              ; SET ERROR EXIT (DOUBLE EXCEPTION?)

                        ;-----  ENABLE PROTECTED MODE

000D BC 0000                    MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
0010 8E D4                      MOV     SS,SP
0012 BC 8000                    MOV     SP,POST_SP
0015 E8 0000 E                  CALL    SYSINIT1                ; GO ENABLE PROTECTED MODE

                        ;-----  SET TEMPORARY STACK

0018 B8 0008                    MOV     AX,GDT_PTR
001B 8E C0                      MOV     ES,AX
001D 8E D8                      MOV     DS,AX
001F 26: C7 06 005A 0000        MOV     ES:SS_TEMP.BASE_LO_WORD,0
0026 26: C6 06 005C 00          MOV     BYTE PTR ES:(SS_TEMP.BASE_HI_BYTE),0
002C BE 0058                    MOV     SI,SS_TEMP
002F 8E D6                      MOV     SS,SI
0031 BC FFFD                    MOV     SP,MAX_SEG_LEN-2

                        ;-----  VERIFY PROTECTED MODE

                                SMSW    AX                      ; GET THE MACHINE STATUS WORD
0034 0F 01 E0           +       DB      00FH,001H,0E0H
0037 A9 0001                    TEST    AX,VIRTUAL_ENABLE       ; ARE WE IN PROTECTED MODE
003A 75 03                      JNZ     T7_1
003C E9 02CD R                  JMP     ERROR_EXIT              ; ERROR IF NOT

003F B0 F1              T7_1:   MOV     AL,0F1H                 ;       <><><><><><><><><><><><>
0041 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F1 <><>

                        ;-----  INTERRUPT TEST (PROGRAMMED INTERRUPT 32)

0043 B0 B0                      MOV     AL,0B0H                 ; SET EXCEPTION FLAG
0045 E6 8B                      OUT     DMA_PAGE+0AH,AL         ;   FOR INTERRUPT 10
0047 CD 20                      INT     32                      ; INTERRUPT
0049 2B C9                      SUB     CX,CX                   ; WAIT FOR INTERRUPT
004B E4 8B              LOOP1:  IN      AL,DMA_PAGE+0AH
004D 22 C0                      AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
004F E0 FA                      LOOPNZ  LOOP1
0051 74 03                      JZ      T7_2
0053 E9 02CD R                  JMP     ERROR_EXIT              ; MISSING INTERRUPT

                        ;-----  CAUSE AN EXCEPTION INTERRUPT (GENERAL PROTECTION INTERRUPT 13D)

0056 B0 F2              T7_2:   MOV     AL,0F2H                 ;       <><><><><><><><><><><><>
```

```
0058 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F2 <><>
005A B0 9D                      MOV     AL,9DH                  ; SET INTERRUPT 13 FLAG
005C E6 8B                      OUT     DMA_PAGE+0AH,AL         ; FOR THE INTERRUPT HANDLER

                        ;-----  MODIFY DESCRIPTOR TABLES
                        ;-----   SET TEMPORARY ES DESCRIPTOR TO SEGMENT LIMIT

005E C7 06 0048 0000            MOV     DS:ES_TEMP.SEG_LIMIT,0  ; SET SEGMENT TO 0

                        ;-----  CPL0, DATA ACCESS RIGHTS

0064 C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
0069 C6 06 004C 01              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),01  ; DO ALL TESTS ON 2ND 64K
006E C7 06 004A 0000            MOV     WORD PTR DS:(ES_TEMP.BASE_LO_WORD),0

                        ;-----  SET ES REGISTER

0074 6A 48                      PUSH    BYTE PTR ES_TEMP        ; LOAD ES
0076 07                         POP     ES

                        ;-----  CAUSE AN EXCEPTION 13 INTERRUPT

0077 2B FF                      SUB     DI,DI
0079 26: 8B 05                  MOV     AX,ES:[DI]              ; THIS SHOULD CAUSE AND EXCEPTION
007C 2B C9                      SUB     CX,CX                   ; WAIT FOR INTERRUPT
007E E4 8B              LOOP2:  IN      AL,DMA_PAGE+0AH
0080 22 C0                      AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
0082 E0 FA                      LOOPNZ  LOOP2
0084 74 03                      JZ      T7_3                    ; CONTINUE IF INTERRUPT
0086 E9 02CD R                  JMP     ERROR_EXIT              ; MISSING INTERRUPT


                        ;---------------------------------------
                        ;                                       :
                        ;       VERIFY 286 LDT/SDT LTR/STR      :
                        ;       INSTRUCTIONS                    :
                        ; DESCRIPTION                           :
                        ;       LOAD LDT  REGISTERS WITH A      :
                        ;       DESCRIPTOR AND VERIFY CORRECT   :
                        ;---------------------------------------

                        ;-----  WRITE TO 286 LDT REGISTER
0089                    T7_3:
0089 B0 F3                      MOV     AL,0F3H                 ;       <><><><><><><><><><><><>
008B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F3 <><>
008D BF 0078                    MOV     DI,POST_LDTR
                                LLDT    DI                      ; REGISTER FROM THIS AREA
0090 0F                 +       DB      00FH
0091                    + ??0000 LABEL  BYTE
0091 8B D7              +       MOV     DX,DI
0093                    + ??0001 LABEL  BYTE
0091                    +       ORG     OFFSET CS:??0000
0091 00                 +       DB      000H
0093                    +       ORG     OFFSET CS:??0001

                        ;-----  READ AND VERIFY 286 LDT SELECTOR

0093 2B C0                      SUB     AX,AX                   ; CLEAR AX
                                SLDT    AX                      ; GET THE LDT SELECTOR
0095 0F                 +       DB      00FH
0096                    + ??0002 LABEL  BYTE
0096 03 C0              +       ADD     AX,AX
0098                    + ??0003 LABEL  BYTE
0096                    +       ORG     OFFSET CS:??0002
0096 00                 +       DB      000H
0098                    +       ORG     OFFSET CS:??0003
0098 25 00F8                    AND     AX,0F8H                 ; STRIP TI/RPL
009B 3D 0078                    CMP     AX,POST_LDTR            ; CORRECT SELECTOR?
009E 75 1B                      JNZ     ERROR                   ; GO IF NOT

                        ;-----  WRITE TO 286 TR

00A0 BF 0068                    MOV     DI,POST_TR
                                LTR     DI                      ; REGISTER FROM THIS AREA
00A3 0F                 +       DB      00FH
00A4                    + ??0004 LABEL  BYTE
00A4 8B DF              +       MOV     BX,DI
00A6                    + ??0005 LABEL  BYTE
00A4                    +       ORG     OFFSET CS:??0004
00A4 00                 +       DB      000H
00A6                    +       ORG     OFFSET CS:??0005

                        ;-----  VERIFY 286 TR REGISTERS

00A6 2B C0                      SUB     AX,AX
                                STR     AX                      ; GET THE TR  REGISTER
00A8 0F                 +       DB      00FH
00A9                    + ??0006 LABEL  BYTE
00A9 8B C8              +       MOV     CX,AX
00AB                    + ??0007 LABEL  BYTE
00A9                    +       ORG     OFFSET CS:??0006
00A9 00                 +       DB      000H
00AB                    +       ORG     OFFSET CS:??0007
00AB 25 00F8                    AND     AX,0F8H
00AE 3D 0068                    CMP     AX,POST_TR              ; CORRECT SELECTOR?
00B1 75 08                      JNZ     ERROR

                        ;-----  TEST 286 CONTROL FLAGS

00B3 FD                         STD                             ; SET DIRECTION FLAG FOR DECREMENT
00B4 9C                         PUSHF                           ; GET THE FLAGS
00B5 58                         POP     AX
00B6 A9 0200                    TEST    AX,0200H                ; INTERRUPT FLAG SHOULD BE OFF
00B9 74 03                      JZ      T7_4                    ; CONTINUE IF OFF
00BB E9 02CD R          ERROR:  JMP     ERROR_EXIT              ; GO IF NOT
00BE                    T7_4:
00BE A9 0400                    TEST    AX,0400H                ; CHECK DIRECTION FLAG
00C1 75 03                      JNZ     T7_5
00C3 E9 02CD R                  JMP     ERROR_EXIT              ; GO IF NOT SET
00C6                    T7_5:
00C6 FC                         CLD                             ; CLEAR DIRECTION FLAG
00C7 9C                         PUSHF                           ; INSURE DIRECTION FLAG IS RESET
00C8 58                         POP     AX
00C9 A9 0400                    TEST    AX,0400H
00CC 74 03                      JZ      T7_6
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00CE E9 02CD R                  JMP     ERROR_EXIT              ; GO IF NOT
                        ;-----------------------------------------
                        ;       VERIFY 286 BOUND INSTRUCTION    :
                        ; DESCRIPTION                           :
                        ;       CREATE A SIGNED ARRAY INDEX     :
                        ;       WITHIN AND OUTSIDE THE LIMITS   :
                        ;       (EXPECT INT 5)                  :
                        ;-----------------------------------------
00D1                    T7_6:
00D1 B0 F4                      MOV     AL,0F4H                 ;       <><><><><><><><><><><><>
00D3 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F4 <><>
00D5 6A 48                      PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER
00D7 07                         POP     ES
                        ;-----  CHECK BOUND FUNCTIONS CORRECTLY
00D8 2B FF                      SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
00DA 26: C7 05 0000             MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO ZERO
00DF 26: C7 45 02 7FFF          MOV     WORD PTR ES:[DI+2],07FFFH ; SET SECOND TO 07FFFH
00E5 B0 95                      MOV     AL,095H                 ; SET INTERRUPT 5 FLAG
00E7 E6 8B                      OUT     DMA_PAGE+0AH,AL
00E9 B8 1000                    MOV     AX,1000H                ; SET AX WITHIN BOUNDS
00EC 26: 62 05                  BOUND   AX,DWORD PTR ES:[DI]    ; USE THE ES SEGMENT POINTER
00EF 2B C9                      SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
00F1 E2 FE                LOOPA:LOOP    LOOPA
00F3 E4 8B                      IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
00F5 3C 00                      CMP     AL,0                    ; DID AN INTERRUPT OCCUR?
00F7 75 03                      JNZ     T7_7                    ; CONTINUE IF NOT
00F9 E9 02CD R                  JMP     ERROR_EXIT              ; GO IF YES
                        ;-----  CHECK LOW BOUND WORD CAUSES INTERRUPT 5
00FC                    T7_7:
00FC 2B FF                      SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
00FE 26: C7 05 3FF0             MOV     WORD PTR ES:[DI],03FF0H ; SET FIRST WORD TO 03FF0H
0103 B8 1000                    MOV     AX,1000H                ; SET AX OUT OF BOUNDS
0106 26: 62 05                  BOUND   AX,DWORD PTR ES:[DI]
0109 2B C9                      SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
010B                    LOOPB:
010B E4 8B                      IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
010D 3C 00                      CMP     AL,0H                   ; DID AN INTERRUPT OCCUR?
010F E0 FA                      LOOPNZ  LOOPB                   ; TRY AGAIN
0111 74 03                      JZ      T7_8                    ; CONTINUE IF INTERRUPT
0113 E9 02CD R                  JMP     ERROR_EXIT              ; GO IF NO INTERRUPT
                        ;-----  CHECK HIGH BOUND WORD CAUSES INTERRUPT 5
0116 B0 95              T7_8:   MOV     AL,95H                  ; SET FLAG FOR INTERRUPT
0118 E6 8B                      OUT     DMA_PAGE+0AH,AL
011A 2B FF                      SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
011C 26: C7 05 0000             MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO 0
0121 26: C7 45 02 0FFF          MOV     WORD PTR ES:[DI+2],0FFFH; SET SECOND TO 0FFFH
0127 B8 1000                    MOV     AX,1000H                ; SET AX OUT OF BOUNDS
012A 26: 62 05                  BOUND   AX,DWORD PTR ES:[DI]
012D 2B C9                      SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
012F                    LOOPC:
012F E4 8B                      IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
0131 3C 00                      CMP     AL,0H                   ; DID AN INTERRUPT OCCUR?
0133 E0 FA                      LOOPNZ  LOOPC                   ; TRY AGAIN
0135 74 03                      JZ      T7_9
0137 E9 02CD R                  JMP     ERROR_EXIT              ; GO IF NO INTERRUPT
                        ;-----------------------------------------------
                        ;       VERIFY PUSH ALL AND POP ALL INSTRUCTIONS:
                        ; DESCRIPTION                                   :
                        ;       SET REGISTERS TO A KNOWN VALUE AND      :
                        ;       PUSH ALL.  RESET THE REGISTERS, POP ALL :
                        ;       AND VERIFY                              :
                        ;-----------------------------------------------
013A                    T7_9:
013A B0 F5                      MOV     AL,0F5H                 ;       <><><><><><><><><><><><>
013C E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F5 <><>
013E B8 0001                    MOV     AX,01                   ; SET AX=1
0141 8B D8                      MOV     BX,AX                   ; SET BX=2
0143 43                         INC     BX
0144 8B CB                      MOV     CX,BX                   ; SET CX=3
0146 41                         INC     CX
0147 8B D1                      MOV     DX,CX
0149 42                         INC     DX                      ; SET DX=4
014A 8B FA                      MOV     DI,DX
014C 47                         INC     DI                      ; SET DI=5
014D 8B F7                      MOV     SI,DI
014F 46                         INC     SI                      ; SET SI=6
0150 55                         PUSH    BP                      ; SAVE THE (BP) ERROR FLAG REGISTER
0151 8B EE                      MOV     BP,SI                   ; SET BP=7
0153 45                         INC     BP
0154 60                         PUSHA                           ; ISSUE THE PUSH ALL COMMAND
0155 2B C0                      SUB     AX,AX                   ; CLEAR ALL REGISTERS
0157 8B D8                      MOV     BX,AX
0159 8B C8                      MOV     CX,AX
015B 8B D0                      MOV     DX,AX
015D 8B F8                      MOV     DI,AX
015F 8B F0                      MOV     SI,AX
0161 8B E8                      MOV     BP,AX
0163 61                         POPA                            ; GET THE REGISTERS BACK
0164 83 FD 07                   CMP     BP,07                   ; BP SHOULD BE 7
0167 5D                         POP     BP                      ; RESTORE (BP) ERROR FLAG REGISTER
0168 75 1E                      JNZ     ERROR_EXIT1             ; GO IF NOT
016A 3D 0001                    CMP     AX,01                   ; AX SHOULD BE 1
016D 75 19                      JNZ     ERROR_EXIT1             ; GO IF NOT
016F 83 FB 02                   CMP     BX,02                   ; BX SHOULD BE 2
0172 75 14                      JNZ     ERROR_EXIT1             ; GO IF NOT
0174 83 F9 03                   CMP     CX,03                   ; CX SHOULD BE 3
0177 75 0F                      JNZ     ERROR_EXIT1             ; GO IF NOT
0179 83 FA 04                   CMP     DX,04                   ; DX SHOULD BE 4
017C 75 0A                      JNZ     ERROR_EXIT1             ; GO IF NOT
017E 83 FF 05                   CMP     DI,05                   ; DI SHOULD BE 5
0181 75 05                      JNZ     ERROR_EXIT1             ; GO IF NOT
0183 83 FE 06                   CMP     SI,06                   ; SI SHOULD BE 6
0186 74 03                      JZ      T7_10                   ; CONTINUE IF IT IS
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                        ;-----  ERROR EXIT
                        ERROR_EXIT1:
0188 E9 02CD R                  JMP     ERROR_EXIT
                        ;--------------------------------------------------
                        ;       VERIFY ACCESS RIGHTS FUNCTION CORRECTLY :
                        ; DESCRIPTION                                   :
                        ;       SET ACCESS RIGHTS OF DESCRIPTOR TO      :
                        ;       READ ONLY.  VERIFY THE VERW/VERR INSTR  :
                        ;       ACCESS A READ ONLY WITH A WRITE AND     :
                        ;       VERIFY AN EXCEPTION INTERRUPT 13        :
                        ;--------------------------------------------------
018B B0 F6              T7_10:  MOV     AL,0F6H                 ;       <><><><><><><><><><><><>
018D E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F6 <><>
018F C7 06 0048 FFFF            MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN        ; SET SEGMENT TO 0FFFFH
0195 C6 06 004C 00              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0    ; SET THE ADDRESS
019A C7 06 004A F000            MOV     DS:ES_TEMP.BASE_LO_WORD,0F000H
01A0 B8 0048                    MOV     AX,ES_TEMP              ; LOAD ES REGISTER
01A3 8E C0                      MOV     ES,AX                   ; THIS SEGMENT SHOULD BE WRITEABLE

                        ;-----  INSURE ACCESS RIGHTS MAY BE WRITTEN

                                SEGOV   DS                      ; SET SEGMENT OVERRIDE TO START OF TABLE
01A5 3E                 +       DB      03EH
                                VERW    AX                      ; CHECK THE ACCESS RIGHTS OF ES_TEMP
01A6 0F                 +       DB      00FH
01A7                    + ??0009        LABEL   BYTE
01A7 8B E8              +       MOV     BP,AX
01A9                    + ??000A        LABEL   BYTE
01A7                    +       ORG     OFFSET CS:??0009
01A7 00                 +       DB      000H
01A9                    +       ORG     OFFSET CS:??000A
01A9 75 DD                      JNZ     ERROR_EXIT1             ; ERROR IF SEGMENT CAN NOT WRITE

                        ;-----  SET ACCESS RIGHTS TO READ ONLY

01AB C6 06 004D 91              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),91H
01B0 B8 0048                    MOV     AX,ES_TEMP              ; LOAD ES REGISTER
01B3 8E C0                      MOV     ES,AX
                                SEGOV   DS                      ; SET SEGMENT OVERRIDE TO START OF TABLE
01B5 3E                 +       DB      03EH
                                VERW    AX                      ; CHECK THE ACCESS RIGHTS OF ES_TEMP
01B6 0F                 +       DB      00FH
01B7                    + ??000C        LABEL   BYTE
01B7 8B E8              +       MOV     BP,AX
01B9                    + ??000D        LABEL   BYTE
01B7                    +       ORG     OFFSET CS:??000C
01B7 00                 +       DB      000H
01B9                    +       ORG     OFFSET CS:??000D
01B9 74 CD                      JZ      ERROR_EXIT1             ; ERROR IF SEGMENT IS WRITEABLE

01BB B8 0048                    MOV     AX,ES_TEMP              ; INSURE THAT SEGMENT IS READABLE
                                SEGOV   DS
01BE 3E                 +       DB      03EH
                                VERR    AX
01BF 0F                 +       DB      00FH
01C0                    + ??000F        LABEL   BYTE
01C0 8B E0              +       MOV     SP,AX
01C2                    + ??0010        LABEL   BYTE
01C0                    +       ORG     OFFSET CS:??000F
01C0 00                 +       DB      000H
01C2                    +       ORG     OFFSET CS:??0010
01C2 75 C4                      JNZ     ERROR_EXIT1             ; GO IF SEGMENT NOT READABLE

                        ;-----  CAUSE AN EXCEPTION 13 INTERRUPT

01C4 B0 9D                      MOV     AL,09DH                 ; SET EXCEPTION FLAG
01C6 E6 8B                      OUT     DMA_PAGE+0AH,AL         ;   FOR INTERRUPT 13
01C8 2B F6                      SUB     SI,SI
01CA 26: C6 04 00               MOV     BYTE PTR ES:[SI],00     ; WRITE A BYTE THAT SHOULD
01CE 2B C9                      SUB     CX,CX                   ; WAIT FOR INTERRUPT
01D0 E4 8B              LOOPD:  IN      AL,DMA_PAGE+0AH
01D2 22 C0                      AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
01D4 E0 FA                      LOOPNZ  LOOPD
01D6 75 B0                      JNZ     ERROR_EXIT1             ; MISSING INTERRUPT

                        ;-----  RESTORE THE ACCESS RIGHTS BYTE

01D8 C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                        ;--------------------------------------------------
                        ;       VERIFY ADJUST RPL FIELD OF SELECTOR      :
                        ;       INSTRUCTION (ARPL) FUNCTIONS             :
                        ; DESCRIPTION                                    :
                        ;       SET THE RPL FIELD OF A SELECTOR          :
                        ;       AND VERIFY THAT THE ZERO FLAG IS SET     :
                        ;       CORRECTLY AND THAT THE SELECTOR RPL      :
                        ;       FIELD IS SET CORRECTLY                   :
                        ;--------------------------------------------------

01DD B0 F7                      MOV     AL,0F7H                 ;       <><><><><><><><><><><><>
01DF E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F7 <><>
01E1 B8 0048                    MOV     AX,ES_TEMP              ; PUT A SELECTOR IN AX
01E4 BB 0060                    MOV     BX,DS_TEMP              ; PUT A SELECTOR IN BX
01E7 0D 0003                    OR      AX,03H                  ; MAKE ACCESS OF AX < BX

                        ;-----  NOTE BX = FIRST OPERAND  AX = SECOND OPERAND

                                ARPL    AX,BX                   ; ISSUE THE RPL COMMAND
01EA                    + ??0011        LABEL   BYTE
01EA 8B C3              +       MOV     AX,BX
01EC                    + ??0012        LABEL   BYTE
01EA                    +       ORG     OFFSET CS:??0011
01EA 63                 +       DB      063H
01EC                    +       ORG     OFFSET CS:??0012
01EC 75 9A                      JNZ     ERROR_EXIT1             ; GO IF RPL WAS NOT CHANGED
01EE 80 E3 03                   AND     BL,03H                  ; STRIP UNWANTED BITS
01F1 80 FB 03                   CMP     BL,03H                  ; AS EXPECTED?
01F4 75 92                      JNZ     ERROR_EXIT1             ; GO IF NOT

                        ;-----  CHECK THAT ACCESS RIGHTS DO NOT CHANGE
```

```
01F6 BB 0060                    MOV     BX,DS_TEMP              ; PUT A SELECTOR IN BX
01F9 B8 0048                    MOV     AX,ES_TEMP              ; PUT A SELECTOR IN AX
01FC 80 CB 03                   OR      BL,03H                  ; MAKE ACCESS OF BX < AX

                        ;-----  NOTE BX = FIRST OPERAND  AX = SECOND OPERAND

                                ARPL    AX,BX                   ; ISSUE THE RPL COMMAND
01FF                    + ??0013 LABEL  BYTE
01FF 8B C3              +       MOV     AX,BX
0201                    + ??0014 LABEL  BYTE
01FF                    +       ORG     OFFSET CS:??0013
01FF 63                 +       DB      063H
0201                    +       ORG     OFFSET CS:??0014
0201 74 85                      JZ      ERROR_EXIT1             ; GO IF RPL WAS NOT CHANGED
0203 80 E3 03                   AND     BL,03H                  ; STRIP UNWANTED BITS
0206 80 FB 03                   CMP     BL,03H                  ; AS EXPECTED?
0209 75 2F                      JNZ     ERROR_EXIT2             ; GO IF NOT

                        ;-----  VERIFY LOAD SEGMENT LIMIT (LSL)
                        ;-----  AND LOAD ACCESS RIGHTS (LAR) INSTRUCTION

                        ;-----   CHECK THE LAR INSTRUCTION

020B B0 F8                      MOV     AL,0F8H                 ;       <><><><><><><><><><>
020D E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F8 <><>

                        ;-----  SET THE DESCRIPTOR TO LEVEL 3

020F C6 06 004D F3              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL3_DATA_ACCESS
0214 BB 0048                    MOV     BX,ES_TEMP
0217 2B C0                      SUB     AX,AX                   ; CLEAR AX

                        ;-----  GET THE CURRENT DESCRIPTORS ACCESS RIGHTS

                                LAR     AX,BX                   ; ISSUE THE LAR COMMAND
0219 0F                 +       DB      00FH
021A                    + ??0015 LABEL  BYTE
021A 8B C3              +       MOV     AX,BX
021C                    + ??0016 LABEL  BYTE
021A                    +       ORG     OFFSET CS:??0015
021A 02                 +       DB      002H
021C                    +       ORG     OFFSET CS:??0016

                        ;-----  INSURE THE DESCRIPTOR WAS VISIBLE

021C 75 1C                      JNZ     ERROR_EXIT2             ; GO IF LAR WAS NOT CHANGED

                        ;-----  THE DESCRIPTORS ACCESS RIGHTS MUST BE 3

021E 80 FC F3                   CMP     AH,CPL3_DATA_ACCESS     ; AS EXPECTED?
0221 75 17                      JNZ     ERROR_EXIT2             ; GO IF NOT

                        ;-----  CHECK THE LSL (LOAD SEGMENT LIMITS)

0223 B0 F9                      MOV     AL,0F9H                 ;       <><><><><><><><><><>
0225 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F9 <><>
0227 C7 06 0048 AAAA            MOV     DS:ES_TEMP.SEG_LIMIT,0AAAAH     ; SET SEGMENT LIMIT TO 0AAAAH

022D C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
0232 B8 0048                    MOV     AX,ES_TEMP              ; LOAD ES REGISTER
                                LSL     BX,AX                   ; GET THE DESCRIPTOR SEGMENT LIMIT
0235 0F                 +       DB      00FH
0236                    + ??0017 LABEL  BYTE
0236 8B D8              +       MOV     BX,AX
0238                    + ??0018 LABEL  BYTE
0236                    +       ORG     OFFSET CS:??0017
0236 03                 +       DB      003H
0238                    +       ORG     OFFSET CS:??0018
0238 74 03                      JZ      R07                     ; GO IF OK

023A                    ERROR_EXIT2:
023A E9 02CD R                  JMP     ERROR_EXIT              ; GO IF NOT SUCCESSFUL

023D 81 FB AAAA         R07:    CMP     BX,0AAAAH               ; INSURE CORRECT SEGMENT LIMIT
0241 C7 06 0048 5555            MOV     DS:ES_TEMP.SEG_LIMIT,05555H     ;SET THE SEGMENT LIMIT TO 05555H
0247 B8 0048                    MOV     AX,ES_TEMP
                                LSL     BX,AX                   ; GET THE DESCRIPTOR SEGMENT LIMIT
024A 0F                 +       DB      00FH
024B                    + ??0019 LABEL  BYTE
024B 8B D8              +       MOV     BX,AX
024D                    + ??001A LABEL  BYTE
024B                    +       ORG     OFFSET CS:??0019
024B 03                 +       DB      003H
024D                    +       ORG     OFFSET CS:??001A
024D 75 EB                      JNZ     ERROR_EXIT2             ; GO IF NOT SUCCESSFUL

024F 81 FB 5555                 CMP     BX,05555H               ; INSURE CORRECT SEGMENT LIMIT
0253 75 E5                      JNZ     ERROR_EXIT2             ; GO IF NOT

                        ;-------------------------------------------------------
                        ; LOW MEG CHIP SELECT TEST                             :
                        ;  TEST THAT A WRITE TO ADDRESS 1B0000 DOES NOT WRITE   :
                        ;  TO B000:0, OR 1B8000 DOES NOT WRITE TO B800:0         :
                        ;-------------------------------------------------------

0255 B0 FA                      MOV     AL,0FAH                 ;       <><><><><><><><><><>
0257 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  FA <><>
0259 6A 08                      PUSH    BYTE PTR GDT_PTR        ; MODIFY THE DESCRIPTOR TABLE
025B 1F                         POP     DS

                        ;-----  SET TEMPORARY ES DESCRIPTOR 64K SEGMENT LIMIT/CPL0 DATA ACCESS

025C C7 06 0048 FFFF            MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
0262 C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                        ;-----  START WITH SEGMENT 1B0000

0267 C6 06 004C 1B              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),1BH
026C C7 06 004A 0000            MOV     DS:ES_TEMP.BASE_LO_WORD,0
0272 6A 48                      PUSH    BYTE PTR  ES_TEMP       ; LOAD ES REGISTER
0274 07                         POP     ES
0275 2B FF                      SUB     DI,DI                   ; POINT TO FIRST LOCATION
0277 26: C7 05 AA55             MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN
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                        ;-----  DO FOR SEGMENT 1B8000
                        
027C C7 06 004A 8000            MOV     DS:ES_TEMP.BASE_LO_WORD,8000H
0282 6A 48                      PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER
0284 07                         POP     ES
0285 26: C7 05 AA55             MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN
                        
                        ;-----  DO FOR SEGMENT 1A0000
                        
028A C6 06 004C 1A              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),1AH
028F C7 06 004A 0000            MOV     DS:ES_TEMP.BASE_LO_WORD,0
0295 6A 48                      PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER
0297 07                         POP     ES
0298 26: C7 05 AA55             MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN
                        
                        ;-----  B/W VIDEO CARD
                        
029D 6A 20                      PUSH    BYTE PTR  C_BWCRT_PTR
029F 1F                         POP     DS                      ; SET DS TO B/W DISPLAY REGEN BUFFER
02A0 8B 05                      MOV     AX,DS:[DI]              ; GET THE WORD FROM B/W VIDEO
                        
                        ;-----  COMPATIBLE COLOR
                        
02A2 6A 28                      PUSH    BYTE PTR C_CCRT_PTR     ; SET DS TO COMPATIBLE COLOR MEMORY
02A4 1F                         POP     DS
02A5 8B 1D                      MOV     BX,DS:[DI]              ; GET THE WORD FROM COLOR MEMORY
                        
                        ;-----  EGA COLOR
                        
02A7 6A 30                      PUSH    BYTE PTR E_CCRT_PTR             ; EGA COLOR CRT POINTER LOW 64K
02A9 1F                         POP     DS
02AA 8B 0D                      MOV     CX,DS:[DI]
                        
                        ;-----  TEST FOR ERROR
                        
02AC 50                         PUSH    AX                      ; SAVE RESULTS
02AD B0 35                      MOV     AL,35H                  ;       <><><><><><><><><><><><><>
02AF E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  35 <><>
02B1 58                         POP     AX
02B2 3D AA55                    CMP     AX,0AA55H
02B5 74 16                      JZ      ERROR_EXIT
02B7 81 FB AA55                 CMP     BX,0AA55H
02BB 74 10                      JZ      ERROR_EXIT
02BD 81 F9 AA55                 CMP     CX,0AA55H
02C1 74 0A                      JZ      ERROR_EXIT
02C3 B0 34                      MOV     AL,34H                  ; RESTORE CHECKPOINT
02C5 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  34 <><>
                        
                        ;-----  SHUTDOWN
                        
02C7                    NORMAL_EXIT:
02C7 B8 068F                    MOV     AX,6*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
02CA E8 0000 E                  CALL    CMOS_WRITE                      ; SET GOOD ENDING
02CD                    ERROR_EXIT:
02CD E9 0000 E                  JMP     PROC_SHUTDOWN
                        
02D0                    POST3   ENDP
                        
02D0                    CODE    ENDS
                                END
```

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                        PAGE 118,121
                        TITLE TEST4 ---- 06/10/85  POST AND BIOS UTILITY ROUTINES
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  BEEP
                                PUBLIC  BLINK_INT
                                PUBLIC  CMOS_READ
                                PUBLIC  CMOS_WRITE
                                PUBLIC  CONFTG_BAD
                                PUBLIC  D11
                                PUBLIC  DDS
                                PUBLIC  DUMMY_RETURN_1
                                PUBLIC  ERR_BEEP
                                PUBLIC  E_MSG
                                PUBLIC  INT_287
                                PUBLIC  KBD_RESET
                                PUBLIC  POST4
                                PUBLIC  PROT_PRT_HEX
                                PUBLIC  PROC_SHUTDOWN
                                PUBLIC  PRT_HEX
                                PUBLIC  PRT_SEG
                                PUBLIC  P_MSG
                                PUBLIC  RE_DIRECT
                                PUBLIC  ROM_CHECK
                                PUBLIC  ROM_CHECKSUM
                                PUBLIC  SET_TOD
                                PUBLIC  WAITF
                                PUBLIC  XPC_BYTE

                                EXTRN   E163:NEAR
                                EXTRN   OBF_42:NEAR
                                EXTRN   ROM_ERR:NEAR
                                EXTRN   XMIT_8042:NEAR

                                ASSUME  CS:CODE,DS:DATA
0000                    POST4:
                        ;--- CMOS_READ ------------------------------------------------------------
                        ;                       READ BYTE FROM CMOS SYSTEM CLOCK CONFIGURATION TABLE            :
                        ;                                                                                       :
                        ; INPUT: (AL)=  CMOS TABLE ADDRESS TO BE READ                                          :
                        ;               BIT     7 = 0 FOR NMI ENABLED AND 1 FOR NMI DISABLED ON EXIT            :
                        ;               BITS 6-0 = ADDRESS OF TABLE LOCATION TO READ                            :
                        ;                                                                                       :
                        ; OUTPUT: (AL)  VALUE AT LOCATION (AL) MOVED INTO (AL).  IF BIT 7 OF (AL) WAS           :
                        ;               ON THEN NMI LEFT DISABLED.  DURING THE CMOS READ BOTH NMI AND           :
                        ;               NORMAL INTERRUPTS ARE DISABLED TO PROTECT CMOS DATA INTEGRITY.          :
                        ;               THE CMOS ADDRESS REGISTER IS POINTED TO A DEFAULT VALUE AND             :
                        ;               THE INTERRUPT FLAG RESTORED TO THE ENTRY STATE ON RETURN.               :
                        ;               ONLY THE (AL) REGISTER AND THE NMI STATE IS CHANGED.                    :
                        ;-----------------------------------------------------------------------------------------

0000                    CMOS_READ       PROC    NEAR                    ;       READ LOCATION (AL) INTO (AL)
0000 9C                         PUSHF                                   ; SAVE INTERRUPT ENABLE STATUS AND FLAGS
0001 D0 C0                      ROL     AL,1                            ; MOVE NMI BIT TO LOW POSITION
0003 F9                         STC                                     ; FORCE NMI BIT ON IN CARRY FLAG
0004 D0 D8                      RCR     AL,1                            ; HIGH BIT ON TO DISABLE NMI - OLD IN CY
0006 FA                         CLI                                     ; DISABLE INTERRUPTS
0007 E6 70                      OUT     CMOS_PORT,AL                    ; ADDRESS LOCATION AND DISABLE NMI
0009 90                         NOP                                     ; I/O DELAY
000A E4 71                      IN      AL,CMOS_DATA                    ; READ THE REQUESTED CMOS LOCATION
000C 50                         PUSH    AX                              ; SAVE (AH) REGISTER VALUE AND CMOS BYTE
000D B0 1A                      MOV     AL,CMOS_REG_D*2                 ; GET ADDRESS OF DEFAULT LOCATION
000F D0 D8                      RCR     AL,1                            ; PUT ORIGINAL NMI MASK BIT INTO ADDRESS
0011 E6 70                      OUT     CMOS_PORT,AL                    ; SET DEFAULT TO READ ONLY REGISTER
0013 58                         POP     AX                              ; RESTORE (AH) AND (AL)= CMOS BYTE
0014 0E                         PUSH    CS                              ; *PLACE CODE SEGMENT IN STACK AND
0015 E8 0019 R                  CALL    CMOS_POPF                       ; *HANDLE POPF FOR B- LEVEL 80286
0018 C3                         RET                                     ; RETURN WITH FLAGS RESTORED

0019                    CMOS_READ       ENDP

0019                    CMOS_POPF       PROC    NEAR                    ;       POPF FOR LEVEL B- PARTS
0019 CF                         IRET                                    ; RETURN FAR AND RESTORE FLAGS

001A                    CMOS_POPF       ENDP

                        ;--- CMOS_WRITE -----------------------------------------------------------
                        ;                       WRITE BYTE TO CMOS SYSTEM CLOCK CONFIGURATION TABLE             :
                        ;                                                                                       :
                        ; INPUT: (AL)=  CMOS TABLE ADDRESS TO BE WRITTEN TO                                     :
                        ;               BIT     7 = 0 FOR NMI ENABLED AND 1 FOR NMI DISABLED ON EXIT            :
                        ;               BITS 6-0 = ADDRESS OF TABLE LOCATION TO WRITE                           :
                        ;        (AH)=  NEW VALUE TO BE PLACED IN THE ADDRESSED TABLE LOCATION                  :
                        ;                                                                                       :
                        ; OUTPUT:       VALUE IN (AH) PLACED IN LOCATION (AL) WITH NMI LEFT DISABLED            :
                        ;               IF BIT 7 OF (AL) IS ON.  DURING THE CMOS UPDATE BOTH NMI AND            :
                        ;               NORMAL INTERRUPTS ARE DISABLED TO PROTECT CMOS DATA INTEGRITY.          :
                        ;               THE CMOS ADDRESS REGISTER IS POINTED TO A DEFAULT VALUE AND             :
                        ;               THE INTERRUPT FLAG RESTORED TO THE ENTRY STATE ON RETURN.               :
                        ;               ONLY THE CMOS LOCATION AND THE NMI STATE IS CHANGED.                    :
                        ;-----------------------------------------------------------------------------------------

001A                    CMOS_WRITE      PROC    NEAR                    ;       WRITE (AH) TO LOCATION (AL)
001A 9C                         PUSHF                                   ; SAVE INTERRUPT ENABLE STATUS AND FLAGS
001B 50                         PUSH    AX                              ; SAVE WORK REGISTER VALUES
001C D0 C0                      ROL     AL,1                            ; MOVE NMI BIT TO LOW POSITION
001E F9                         STC                                     ; FORCE NMI BIT ON IN CARRY FLAG
001F D0 D8                      RCR     AL,1                            ; HIGH BIT ON TO DISABLE NMI - OLD IN CY
0021 FA                         CLI                                     ; DISABLE INTERRUPTS
0022 E6 70                      OUT     CMOS_PORT,AL                    ; ADDRESS LOCATION AND DISABLE NMI
0024 8A C4                      MOV     AL,AH                           ; GET THE DATA BYTE TO WRITE
0026 E6 71                      OUT     CMOS_DATA,AL                    ; PLACE IN REQUESTED CMOS LOCATION
0028 B0 1A                      MOV     AL,CMOS_REG_D*2                 ; GET ADDRESS OF DEFAULT LOCATION
002A D0 D8                      RCR     AL,1                            ; PUT ORIGINAL NMI MASK BIT INTO ADDRESS
002C E6 70                      OUT     CMOS_PORT,AL                    ; SET DEFAULT TO READ ONLY REGISTER
002E 58                         POP     AX                              ; RESTORE WORK REGISTERS
002F 0E                         PUSH    CS                              ; *PLACE CODE SEGMENT IN STACK AND
0030 E8 0019 R                  CALL    CMOS_POPF                       ; *HANDLE POPF FOR B- LEVEL 80286
0033 C3                         RET

0034                    CMOS_WRITE      ENDP
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                        PAGE
0034                    DDS     PROC    NEAR                    ;       LOAD (DS) TO DATA AREA
0034 2E: 8E 1E 003A R           MOV     DS,CS:DDSDATA           ; PUT SEGMENT VALUE OF DATA AREA INTO DS
0039 C3                         RET                             ; RETURN TO USER WITH (DS)= DATA

003A ---- R            DDSDATA DW      DATA                    ; SEGMENT SELECTOR VALUE FOR DATA AREA

003C                    DDS     ENDP

                        ;--- E_MSG -- P_MSG ------------------------------------------------------
                        ;       THIS SUBROUTINE WILL PRINT A MESSAGE ON THE DISPLAY             :
                        ;                                                                       :
                        ; ENTRY REQUIREMENTS:                                                   :
                        ;       SI = OFFSET(ADDRESS) OF MESSAGE BUFFER                          :
                        ;       CX = MESSAGE BYTE COUNT                                         :
                        ;            MAXIMUM MESSAGE LENGTH IS 36 CHARACTERS                    :
                        ;       BP = BIT 0=E161/E162, BIT 1=CONFIG_BAD, 2-15= FIRST MSG OFFSET  :
                        ;-----------------------------------------------------------------------

003C                    E_MSG   PROC    NEAR
003C F7 C5 3FFF                 TEST    BP,03FFFH               ; CHECK FOR NOT FIRST ERROR MESSAGE
0040 75 08                      JNZ     E_MSG1                  ; SKIP IF NOT FIRST ERROR MESSAGE

0042 56                         PUSH    SI                      ; SAVE MESSAGE POINTER
0043 81 E6 3FFF                 AND     SI,03FFFH               ; USE LOW 14 BITS OF MESSAGE OFFSET
0047 0B EE                      OR      BP,SI                   ;  AS FIRST ERROR MESSAGE FLAG
0049 5E                         POP     SI                      ; (BIT 0 = E161/E162, BIT 1 = BAD_CONFIG
004A                    E_MSG1:
004A E8 0063 R                  CALL    P_MSG                   ; PRINT MESSAGE
004D 1E                         PUSH    DS                      ; SAVE CALLERS (DS)
004E E8 0034 R                  CALL    DDS                     ; POINT TO POST/BIOS DATA SEGMENT
0051 F6 06 0010 R 01            TEST    BYTE PTR @EQUIP_FLAG,01H; LOOP/HALT ON ERROR SWITCH ON ?
0056 74 02                      JZ      MFG_HALT                ; YES - THEN GO TO MANUFACTURING HALT

0058 1F                         POP     DS                      ; RESTORE CALLERS (DS)
0059 C3                         RET

005A                    MFG_HALT:                               ; MANUFACTURING LOOP MODE ERROR TRAP
005A FA                         CLI                             ; DISABLE INTERRUPTS
005B A0 0015 R                  MOV     AL,@MFG_ERR_FLAG        ; RECOVER ERROR INDICATOR
005E E6 80                      OUT     MFG_PORT,AL             ; SET INTO MANUFACTURING PORT
0060 F4                         HLT                             ; HALT SYSTEM
0061 EB F7                      JMP     MFG_HALT                ; HOT NMI TRAP

0063                    E_MSG   ENDP

0063                    P_MSG   PROC    NEAR                    ;       DISPLAY STRING FROM (CS:)
0063 2E: 8A 04                  MOV     AL,CS:[SI]              ; PUT CHARACTER IN (AL)
0066 46                         INC     SI                      ; POINT TO NEXT CHARACTER
0067 50                         PUSH    AX                      ; SAVE PRINT CHARACTER
0068 E8 0128 R                  CALL    PRT_HEX                 ; CALL VIDEO_IO
006B 58                         POP     AX                      ; RECOVER PRINT CHARACTER
006C 3C 0A                      CMP     AL,LF                   ; WAS IT LINE FEED?
006E 75 F3                      JNE     P_MSG                   ; NO, KEEP PRINTING STRING
0070 C3                         RET

0071                    P_MSG   ENDP

                        ;--- ERR_BEEP ------------------------------------------------------------
                        ;       THIS PROCEDURE WILL ISSUE LONG TONES (1-3/4 SECONDS) AND ONE OR  :
                        ;       MORE SHORT TONES (9/32 SECOND) TO INDICATE A FAILURE ON THE      :
                        ;       PLANAR BOARD, A BAD MEMORY MODULE, OR A PROBLEM WITH THE CRT.    :
                        ; ENTRY PARAMETERS:                                                      :
                        ;       DH = NUMBER OF LONG TONES TO BEEP.                               :
                        ;       DL = NUMBER OF SHORT TONES TO BEEP.                              :
                        ;-----------------------------------------------------------------------

0071                    ERR_BEEP        PROC    NEAR
0071 9C                         PUSHF                           ; SAVE FLAGS
0072 FA                         CLI                             ; DISABLE SYSTEM INTERRUPTS
0073 0A F6                      OR      DH,DH                   ; ANY LONG ONES TO BEEP
0075 74 1E                      JZ      G3                      ; NO, DO THE SHORT ONES
0077                    G1:                                     ;       LONG BEEPS
0077 B3 70                      MOV     BL,112                  ; COUNTER FOR LONG BEEPS (1-3/4 SECONDS)
0079 B9 0500                    MOV     CX,1280                 ; DIVISOR FOR 932 HZ
007C E8 00AF R                  CALL    BEEP                    ; DO THE BEEP
007F B9 C233                    MOV     CX,49715                ; 2/3 SECOND DELAY AFTER LONG BEEP
0082 E8 00F5 R                  CALL    WAITF                   ; DELAY BETWEEN BEEPS
0085 FE CE                      DEC     DH                      ; ANY MORE LONG BEEPS TO DO
0087 75 EE                      JNZ     G1                      ; LOOP TILL DONE

0089 1E                         PUSH    DS                      ; SAVE DS REGISTER CONTENTS
008A E8 0034 R                  CALL    DDS
008D 80 3E 0012 R 01            CMP     @MFG_TST,01H            ; MANUFACTURING TEST MODE?
0092 1F                         POP     DS                      ; RESTORE ORIGINAL CONTENTS OF (DS)
0093 74 C5                      JE      MFG_HALT                ; YES - STOP BLINKING LED

0095                    G3:                                     ;       SHORT BEEPS
0095 B3 12                      MOV     BL,18                   ; COUNTER FOR A SHORT BEEP (9/32)
0097 B9 04B8                    MOV     CX,1208                 ; DIVISOR FOR 987 HZ
009A E8 00AF R                  CALL    BEEP                    ; DO THE SOUND
009D B9 8178                    MOV     CX,33144                ; 1/2 SECOND DELAY AFTER SHORT BEEP
00A0 E8 00F5 R                  CALL    WAITF                   ; DELAY BETWEEN BEEPS
00A3 FE CA                      DEC     DL                      ; DONE WITH SHORT BEEPS COUNT
00A5 75 EE                      JNZ     G3                      ; LOOP TILL DONE

00A7 B9 8178                    MOV     CX,33144                ; 1/2 SECOND DELAY AFTER LAST BEEP
00AA E8 00F5 R                  CALL    WAITF                   ; MAKE IT ONE SECOND DELAY BEFORE RETURN
00AD 9D                         POPF                            ; RESTORE FLAGS TO ORIGINAL SETTINGS
00AE C3                         RET                             ; RETURN TO CALLER

00AF                    ERR_BEEP        ENDP
```

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                        PAGE
                        ;--- BEEP ------------------------------------------------------------------
                        ;       ROUTINE TO SOUND THE BEEPER USING TIMER 2 FOR TONE                :
                        ; ENTRY:                                                                  :
                        ;       (BL) = DURATION COUNTER  ( 1 FOR 1/64 SECOND )                    :
                        ;       (CX) = FREQUENCY DIVISOR (1193180/FREQUENCY) (1331 FOR 886 HZ)    :
                        ; EXIT:                                                                   :
                        ;       (AX),(BL),(CX) MODIFIED.                                          :
                        ;-------------------------------------------------------------------------

00AF                    BEEP    PROC    NEAR                    ;       SETUP TIMER 2
00AF 9C                         PUSHF                           ; SAVE INTERRUPT STATUS
00B0 FA                         CLI                             ; BLOCK INTERRUPTS DURING UPDATE
00B1 B0 B6                      MOV     AL,10110110B            ; SELECT TIMER 2,LSB,MSB,BINARY
00B3 E6 43                      OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
00B5 EB 00                      JMP     $+2                     ; I/O DELAY
00B7 8A C1                      MOV     AL,CL                   ; DIVISOR FOR HZ (LOW)
00B9 E6 42                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
00BB EB 00                      JMP     $+2                     ; I/O DELAY
00BD 8A C5                      MOV     AL,CH                   ; DIVISOR FOR HZ (HIGH)
00BF E6 42                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
00C1 E4 61                      IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
00C3 8A E0                      MOV     AH,AL                   ; SAVE THAT SETTING
00C5 0C 03                      OR      AL,GATE2+SPK2           ; GATE TIMER 2 AND TURN SPEAKER ON
00C7 E6 61                      OUT     PORT_B,AL               ; AND RESTORE INTERRUPT STATUS
00C9 9D                         POPF
00CA                    G7:                                     ;       1/64 SECOND PER COUNT (BL)
00CA B9 040B                    MOV     CX,1035                 ; DELAY COUNT FOR 1/64 OF A SECOND
00CD E8 00F5 R                  CALL    WAITF                   ; GO TO BEEP DELAY 1/64 COUNT
00D0 FE CB                      DEC     BL                      ; (BL) LENGTH COUNT EXPIRED?
00D2 75 F6                      JNZ     G7                      ; NO - CONTINUE BEEPING SPEAKER

00D4 9C                         PUSHF                           ; SAVE INTERRUPT STATUS
00D5 FA                         CLI                             ; BLOCK INTERRUPTS DURING UPDATE
00D6 E4 61                      IN      AL,PORT_B               ; GET CURRENT PORT VALUE
00D8 0C FC                      OR      AL,NOT (GATE2+SPK2)     ; ISOLATE CURRENT SPEAKER BITS IN CASE
00DA 22 E0                      AND     AH,AL                   ;  SOMEONE TURNED THEM OFF DURING BEEP
00DC 8A C4                      MOV     AL,AH                   ; RECOVER VALUE OF PORT
00DE 24 FC                      AND     AL,NOT (GATE2+SPK2)     ; FORCE SPEAKER DATA OFF
00E0 E6 61                      OUT     PORT_B,AL               ; AND STOP SPEAKER TIMER
00E2 9D                         POPF                            ; RESTORE INTERRUPT FLAG STATE
00E3 B9 040B                    MOV     CX,1035                 ; FORCE 1/64 SECOND DELAY (SHORT)
00E6 E8 00F5 R                  CALL    WAITF                   ; MINIMUM DELAY BETWEEN ALL BEEPS
00E9 9C                         PUSHF                           ; SAVE INTERRUPT STATUS
00EA FA                         CLI                             ; BLOCK INTERRUPTS DURING UPDATE
00EB E4 61                      IN      AL,PORT_B               ; GET CURRENT PORT VALUE IN CASE
00ED 24 03                      AND     AL,GATE2+SPK2           ;  SOMEONE TURNED THEM ON
00EF 0A C4                      OR      AL,AH                   ; RECOVER VALUE OF PORT_B
00F1 E6 61                      OUT     PORT_B,AL               ; RESTORE SPEAKER STATUS
00F3 9D                         POPF                            ; RESTORE INTERRUPT FLAG STATE
00F4 C3                         RET

00F5                    BEEP    ENDP

                        ;--- WAITF -----------------------------------------------------------------
                        ;       FIXED TIME WAIT ROUTINE (HARDWARE CONTROLLED - NOT PROCESSOR)     :
                        ;                                                                         :
                        ; ENTRY:                                                                  :
                        ;       (CX) = COUNT OF 15.085737 MICROSECOND INTERVALS TO WAIT           :
                        ;              MEMORY REFRESH TIMER 1 OUTPUT USED AS REFERENCE            :
                        ; EXIT:                                                                   :
                        ;              AFTER (CX) TIME COUNT (PLUS OR MINUS 16 MICROSECONDS)      :
                        ;       (CX) = 0                                                          :
                        ;-------------------------------------------------------------------------

00F5                    WAITF   PROC    NEAR                    ;       DELAY FOR  (CX)*15.085737 US
00F5 50                         PUSH    AX                      ; SAVE WORK REGISTER (AH)

00F6                    WAITF1:                                 ;       USE TIMER 1 OUTPUT BITS
00F6 E4 61                      IN      AL,PORT_B               ; READ CURRENT COUNTER OUTPUT STATUS
00F8 24 10                      AND     AL,REFRESH_BIT          ; MASK FOR REFRESH DETERMINE BIT
00FA 3A C4                      CMP     AL,AH                   ; DID IT JUST CHANGE
00FC 74 F8                      JE      WAITF1                  ; WAIT FOR A CHANGE IN OUTPUT LINE

00FE 8A E0                      MOV     AH,AL                   ; SAVE NEW FLAG STATE
0100 E2 F4                      LOOP    WAITF1                  ; DECREMENT HALF CYCLES TILL COUNT END

0102 58                         POP     AX                      ; RESTORE (AH)
0103 C3                         RET                             ; RETURN  (CX)= 0

0104                    WAITF   ENDP

                        ;--- CONFIG_BAD ------------------------------------------------------------
                        ;       SET CMOS_DIAG WITH CONFIG ERROR BIT (WITH NMI DISABLED)           :
                        ;       (BP) BIT 14 SET ON TO INDICATE CONFIGURATION ERROR                :
                        ;-------------------------------------------------------------------------

0104                    CONFIG_BAD      PROC    NEAR
0104 50                         PUSH    AX
0105 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS CMOS DIAGNOSTIC STATUS BYTE
0108 E8 0000 R                  CALL    CMOS_READ               ; GET CURRENT VALUE
010B 0C 20                      OR      AL,BAD_CONFIG           ; SET BAD CONFIGURATION BIT
010D 86 E0                      XCHG    AH,AL                   ; SETUP FOR WRITE
010F E8 001A R                  CALL    CMOS_WRITE              ; UPDATE CMOS WITH BAD CONFIGURATION
0112 58                         POP     AX
0113 81 CD 4000                 OR      BP,04000H               ; SET CONFIGURATION BAD FLAG IN (BP)
0117 C3                         RET

0118                    CONFIG_BAD      ENDP
```

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                        PAGE
                        ;--- XPC_BYTE -- XLATE_PR -- PRT_HEX ------------------------------
                        ;                                                               :
                        ;       CONVERT AND PRINT ASCII CODE CHARACTERS                 :
                        ;                                                               :
                        ;       AL CONTAINS NUMBER TO BE CONVERTED.                     :
                        ;       AX AND BX DESTROYED.                                    :
                        ;---------------------------------------------------------------
                        
0118                    XPC_BYTE        PROC    NEAR                    ;       DISPLAY TWO HEX DIGITS
0118 50                         PUSH    AX                              ; SAVE FOR LOW NIBBLE DISPLAY
0119 C0 E8 04                   SHR     AL,4                            ; NIBBLE SWAP
011C E8 0122 R                  CALL    XLAT_PR                         ; DO THE HIGH NIBBLE DISPLAY
011F 58                         POP     AX                              ; RECOVER THE NIBBLE
0120 24 0F                      AND     AL,0FH                          ; ISOLATE TO LOW NIBBLE
                                                                        ; FALL INTO LOW NIBBLE CONVERSION
                        
0122                    XLAT_PR PROC    NEAR                    ;       CONVERT 00-0F TO ASCII CHARACTER
0122 04 90                      ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
0124 27                         DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
0125 14 40                      ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
0127 27                         DAA                             ; ADJUST HIGH NIBBLE TO ASCII RANGE
                        
0128                    PRT_HEX PROC    NEAR
0128 B4 0E                      MOV     AH,0EH                  ; DISPLAY CHARACTER IN (AL) COMMAND
012A B7 00                      MOV     BH,0
012C CD 10                      INT     10H                     ; CALL VIDEO_IO
012E C3                         RET
                        
012F                    PRT_HEX ENDP
012F                    XLAT_PR ENDP
012F                    XPC_BYTE        ENDP
                        
                        ;--- PRT_SEG ------------------------------------------------
                        ;       PRINT A SEGMENT VALUE TO LOOK LIKE A 21 BIT ADDRESS     :
                        ;       DX MUST CONTAIN SEGMENT VALUE TO BE PRINTED             :
                        ;---------------------------------------------------------------
                        
012F                    PRT_SEG PROC    NEAR
012F 8A C6                      MOV     AL,DH                   ; GET MSB
0131 E8 0118 R                  CALL    XPC_BYTE                ; DISPLAY SEGMENT HIGH BYTE
0134 8A C2                      MOV     AL,DL                   ; LSB
0136 E8 0118 R                  CALL    XPC_BYTE                ; DISPLAY SEGMENT LOW BYTE
0139 B0 30                      MOV     AL,'0'                  ; PRINT A '0 '
013B E8 0128 R                  CALL    PRT_HEX                 ;  TO MAKE LOOK LIKE ADDRESS
013E B0 20                      MOV     AL,' '                  ; ADD ENDING SPACE
0140 E8 0128 R                  CALL    PRT_HEX
0143 C3                         RET
                        
0144                    PRT_SEG ENDP
                        
                        ;--- PROT_PRT_HEX -------------------------------------------------
                        ;                                                               :
                        ;       PUT A CHARACTER TO THE DISPLAY BUFFERS WHEN IN PROTECTED MODE    :
                        ;                                                               :
                        ;       (AL)= ASCII CHARACTER                                   :
                        ;       (DI)= DISPLAY REGEN BUFFER POSITION                     :
                        ;---------------------------------------------------------------
                        
0144                    PROT_PRT_HEX    PROC    NEAR
0144 06                         PUSH    ES                      ; SAVE CURRENT SEGMENT REGISTERS
0145 57                         PUSH    DI
0146 D1 E7                      SAL     DI,1                    ; MULTIPLY OFFSET BY TWO
                        
                        ;-----  MONOCHROME VIDEO CARD
                        
0148 6A 20                      PUSH    BYTE PTR C_BWCRT_PTR    ; GET MONOCHROME BUFFER SEGMENT SELECTOR
014A 07                         POP     ES                      ; SET (ES) TO B/W DISPLAY BUFFER
014B AA                         STOSB                           ; PLACE CHARACTER IN BUFFER
014C 4F                         DEC     DI                      ; ADJUST POINTER BACK
                        
                        ;-----  ENHANCED GRAPHICS ADAPTER
                        
014D 6A 30                      PUSH    BYTE PTR E_CCRT_PTR     ; ENHANCED COLOR DISPLAY POINTER LOW 64K
014F 07                         POP     ES                      ; LOAD SEGMENT SELECTOR
0150 AA                         STOSB                           ; PLACE CHARACTER IN BUFFER
0151 4F                         DEC     DI                      ; ADJUST POINTER BACK
0152 6A 38                      PUSH    BYTE PTR E_CCRT_PTR2    ; ENHANCED COLOR DISPLAY POINTER HI 64K
0154 07                         POP     ES                      ; LOAD SEGMENT SELECTOR
0155 AA                         STOSB                           ; PLACE CHARACTER IN BUFFER
0156 4F                         DEC     DI                      ; ADJUST POINTER BACK
                        
                        ;-----  COMPATIBLE COLOR
                        
0157 6A 28                      PUSH    BYTE PTR C_CCRT_PTR     ; SET (DS) TO COMPATIBLE COLOR MEMORY
0159 07                         POP     ES
015A 53                         PUSH    BX                      ; SAVE WORK REGISTERS
015B 52                         PUSH    DX
015C 51                         PUSH    CX
015D 33 C9                      XOR     CX,CX                   ; TIMEOUT LOOP FOR "BAD" HARDWARE
015F BA 03DA                    MOV     DX,03DAH                ; STATUS ADDRESS OF COLOR CARD
0162 93                         XCHG    AX,BX                   ; SAVE IN (BX) REGISTER
0163                    PROT_S:
0163 EC                         IN      AL,DX                   ; GET COLOR CARD STATUS
0164 A8 09                      TEST    AL,RVRT+RHRZ            ; CHECK FOR VERTICAL RETRACE (OR HORZ)
0166 E1 FB                      LOOPZ   PROT_S                  ; TIMEOUT LOOP TILL FOUND
0168 93                         XCHG    AX,BX                   ; RECOVER CHARACTERS
0169 AA                         STOSB                           ; PLACE CHARACTER IN BUFFER
                        
016A 59                         POP     CX                      ; RESTORE REGISTERS
016B 5A                         POP     DX
016C 5B                         POP     BX
016D 5F                         POP     DI
016E 07                         POP     ES
016F C3                         RET
                        
0170                    PROT_PRT_HEX    ENDP
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                        PAGE
                        ;--------------------------------------
                        ;       ROM CHECKSUM SUBROUTINE        :
                        ;--------------------------------------

0170                    ROM_CHECKSUM    PROC    NEAR
0170 2B C9                      SUB     CX,CX                   ; NUMBER OF BYTES TO ADD IS 64K

0172                    ROM_CHECKSUM_CNT:                       ; ENTRY FOR OPTIONAL ROM TEST
0172 32 C0                      XOR     AL,AL
0174                    ROM_L:
0174 02 07                      ADD     AL,[BX]                 ; GET (DS:BX)
0176 43                         INC     BX                      ; POINT TO NEXT BYTE
0177 E2 FB                      LOOP    ROM_L                   ; ADD ALL BYTES IN ROM MODULE

0179 0A C0                      OR      AL,AL                   ; SUM = 0?
017B C3                         RET

017C                    ROM_CHECKSUM    ENDP

                        ;-------------------------------------------------------------------------
                        ;       THIS ROUTINE CHECKSUMS OPTIONAL ROM MODULES AND                  :
                        ;       IF CHECKSUM IS OK, CALLS INITIALIZATION/TEST CODE IN MODULE      :
                        ;-------------------------------------------------------------------------

017C                    ROM_CHECK       PROC    NEAR
017C B8 ---- R                  MOV     AX,DATA                 ; POINT ES TO DATA AREA
017F 8E C0                      MOV     ES,AX
0181 2A E4                      SUB     AH,AH                   ; ZERO OUT AH
0183 8A 47 02                   MOV     AL,[BX+2]               ; GET LENGTH INDICATOR
0186 C1 E0 09                   SHL     AX,9                    ; MULTIPLY BY 512
0189 8B C8                      MOV     CX,AX                   ; SET COUNT
018B C1 E8 04                   SHR     AX,4
018E 03 D0                      ADD     DX,AX                   ; SET POINTER TO NEXT MODULE
0190 E8 0172 R                  CALL    ROM_CHECKSUM_CNT        ; DO CHECKSUM
0193 74 05                      JZ      ROM_CHECK_1

0195 E8 0000 E                  CALL    ROM_ERR                 ; POST CHECKSUM ERROR
0198 EB 13                      JMP     SHORT ROM_CHECK_END     ; AND EXIT

019A                    ROM_CHECK_1:
019A 52                         PUSH    DX                      ; SAVE POINTER
019B 26: C7 06 0067 R 0003      MOV     ES:@IO_ROM_INIT,0003H   ; LOAD OFFSET
01A2 26: 8C 1E 0069 R           MOV     ES:@IO_ROM_SEG,DS       ; LOAD SEGMENT
01A7 26: FF 1E 0067 R           CALL    DWORD PTR ES:@IO_ROM_INIT; CALL INITIALIZE/TEST ROUTINE
01AC 5A                         POP     DX

01AD                    ROM_CHECK_END:
01AD C3                         RET                             ; RETURN TO CALLER

01AE                    ROM_CHECK       ENDP

                        ;--- KBD_RESET ---------------------------------------------------------
                        ;       THIS PROCEDURE WILL SEND A SOFTWARE RESET TO THE KEYBOARD.       :
                        ;       SCAN CODE  0AAH  SHOULD BE RETURNED TO THE PROCESSOR.           :
                        ;       SCAN CODE  065H  IS DEFINED FOR MANUFACTURING TEST              :
                        ;-------------------------------------------------------------------------

01AE                    KBD_RESET       PROC    NEAR
01AE B0 FF                      MOV     AL,0FFH                 ; SET KEYBOARD RESET COMMAND
01B0 E8 0000 E                  CALL    XMIT_8042               ; GO ISSUE THE COMMAND
01B3 E3 23                      JCXZ    G13                     ; EXIT IF ERROR

01B5 3C FA                      CMP     AL,KB_ACK
01B7 75 1F                      JNZ     G13

01B9 B0 FD                      MOV     AL,0FDH                 ; ENABLE KEYBOARD INTERRUPTS
01BB E6 21                      OUT     INTA01,AL               ; WRITE 8259 INTERRUPT MASK REGISTER
01BD C6 06 006B R 00            MOV     @INTR_FLAG,0            ; RESET INTERRUPT INDICATOR
01C2 FB                         STI                             ; ENABLE INTERRUPTS
01C3 B3 0A                      MOV     BL,10                   ; TRY FOR 400 MILLISECONDS
01C5 2B C9                      SUB     CX,CX                   ; SETUP INTERRUPT TIMEOUT COUNT
01C7                    G11:
01C7 F6 06 006B R 02            TEST    @INTR_FLAG,02H          ; DID A KEYBOARD INTERRUPT OCCUR ?
01CC 75 06                      JNZ     G12                     ; YES - READ SCAN CODE RETURNED
01CE E2 F7                      LOOP    G11                     ; NO - LOOP TILL TIMEOUT

01D0 FE CB                      DEC     BL
01D2 75 F3                      JNZ     G11                     ; TRY AGAIN
01D4                    G12:
01D4 E4 60                      IN      AL,PORT_A               ; READ KEYBOARD SCAN CODE
01D6 8A D8                      MOV     BL,AL                   ; SAVE SCAN CODE JUST READ
01D8                    G13:
01D8 C3                         RET                             ; RETURN TO CALLER

01D9                    KBD_RESET       ENDP

                        ;-------------------------------------------------------
                        ;       BLINK LED PROCEDURE FOR MFG RUN-IN TESTS        :
                        ;          IF LED IS ON, TURN IT OFF. IF OFF, TURN ON.  :
                        ;-------------------------------------------------------

01D9                    BLINK_INT       PROC    NEAR
01D9 FB                         STI
01DA 50                         PUSH    AX                      ; SAVE AX REGISTER CONTENTS
01DB E4 80                      IN      AL,MFG_PORT             ; READ CURRENT VALUE OF MFG_PORT
01DD 34 40                      XOR     AL,01000000B            ; FLIP CONTROL BIT
01DF E6 80                      OUT     MFG_PORT,AL
01E1 B0 20                      MOV     AL,EOI
01E3 E6 20                      OUT     INTA00,AL
01E5 58                         POP     AX                      ; RESTORE AX REGISTER
01E6 CF                         IRET

01E7                    BLINK_INT       ENDP
```

SECTION 5

```
                        PAGE
                        ;--------------------------------------------------------------------------------
                        ;       THIS ROUTINE INITIALIZES THE TIMER DATA AREA IN THE ROM BIOS             :
                        ;       DATA AREA.  IT IS CALLED BY THE POWER ON ROUTINES.  IT CONVERTS          :
                        ;       HR:MIN:SEC  FROM CMOS TO TIMER TICS.  IF CMOS IS INVALID, TIMER         :
                        ;       IS SET TO ZERO.                                                         :
                        ;                                                                               :
                        ; INPUT    NONE PASSED TO ROUTINE BY CALLER                                      :
                        ;          CMOS LOCATIONS USED FOR TIME                                          :
                        ;                                                                               :
                        ; OUTPUT   @TIMER_LOW                                                           :
                        ;          @TIMER_HIGH                                                          :
                        ;          @TIMER_OFL                                                           :
                        ;          ALL REGISTERS UNCHANGED                                              :
                        ;--------------------------------------------------------------------------------
= 0012                  COUNTS_SEC      EQU     18              ; TIMER DATA CONVERSION EQUATES
= 0444                  COUNTS_MIN      EQU     1092
= 0007                  COUNTS_HOUR     EQU     7               ; 65543 - 65536
= 0080                  UPDATE_TIMER    EQU     10000000B       ; RTC UPDATE IN PROCESS BIT MASK

01E7                    SET_TOD PROC    NEAR
01E7 60                         PUSHA
01E8 1E                         PUSH    DS
01E9 E8 0000 R                  CALL    DDS                     ; ESTABLISH SEGMENT
01EC 2B C0                      SUB     AX,AX
01EE A2 0070 R                  MOV     @TIMER_OFL,AL           ; RESET TIMER ROLL OVER INDICATOR
01F1 A3 006C R                  MOV     @TIMER_LOW,AX           ; AND TIMER COUNT
01F4 A3 006E R                  MOV     @TIMER_HIGH,AX
01F7 B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; CHECK CMOS VALIDITY
01F9 E8 0000 R                  CALL    CMOS_READ               ; READ DIAGNOSTIC LOCATION IN CMOS
01FC 24 C4                      AND     AL,BAD_BAT+BAD_CKSUM+CMOS_CLK_FAIL
01FE 2B C9                      SUB     CX,CX                   ; BAD BATTERY, CHKSUM ERROR, CLOCK ERROR
0200 75 64                      JNZ     POD_DONE                ; CMOS NOT VALID -- TIMER SET TO ZERO
0202                    UIP:
0202 B0 8A                      MOV     AL,CMOS_REG_A+NMI       ; ACCESS REGISTER A
0204 E8 0000 R                  CALL    CMOS_READ               ; READ CMOS CLOCK REGISTER A
0207 A8 80                      TEST    AL,UPDATE_TIMER
0209 E1 F7                      LOOPZ   UIP                     ; WAIT TILL UPDATE BIT IS ON

020B E3 59                      JCXZ    POD_DONE                ; CMOS CLOCK STUCK IF TIMEOUT
020D                    UIPOFF:
020D B0 8A                      MOV     AL,CMOS_REG_A+NMI       ; ACCESS REGISTER A
020F E8 0000 R                  CALL    CMOS_READ               ; READ CMOS CLOCK REGISTER A
0212 A8 80                      TEST    AL,UPDATE_TIMER
0214 E0 F7                      LOOPNZ  UIPOFF                  ; NEXT WAIT TILL END OF UPDATE

0216 E3 4E                      JCXZ    POD_DONE                ; CMOS CLOCK STUCK IF TIMEOUT

0218 B0 80                      MOV     AL,CMOS_SECONDS+NMI     ;       TIME JUST UPDATED
021A E8 0000 R                  CALL    CMOS_READ               ; ACCESS SECONDS VALUE IN CMOS
021D 3C 59                      CMP     AL,59H                  ; ARE THE SECONDS WITHIN LIMITS?
021F 77 48                      JA      TOD_ERROR               ; GO IF NOT

0221 E8 027F R                  CALL    CVT_BINARY              ; CONVERT IT TO BINARY
0224 8B C8                      MOV     CX,AX                   ; MOVE COUNT TO ACCUMULATION REGISTER
0226 C1 E9 02                   SHR     CX,2                    ; ADJUST FOR SYSTEMATIC SECONDS ERROR
0229 B3 12                      MOV     BL,COUNTS_SEC
022B F6 E3                      MUL     BL                      ; COUNT FOR SECONDS
022D 03 C8                      ADD     CX,AX
022F B0 82                      MOV     AL,CMOS_MINUTES+NMI
0231 E8 0000 R                  CALL    CMOS_READ               ; ACCESS MINUTES VALUE IN CMOS
0234 3C 59                      CMP     AL,59H                  ; ARE THE MINUTES WITHIN LIMITS?
0236 77 31                      JA      TOD_ERROR               ; GO IF NOT
0238 E8 027F R                  CALL    CVT_BINARY              ; CONVERT IT TO BINARY
023B 50                         PUSH    AX                      ; SAVE MINUTES COUNT
023C D1 E8                      SHR     AX,1                    ; ADJUST FOR SYSTEMATIC MINUTES ERROR
023E 03 C8                      ADD     CX,AX                   ; ADD ADJUSTMENT TO COUNT
0240 58                         POP     AX                      ; RECOVER BCD MINUTES VALUE
0241 BB 0444                    MOV     BX,COUNTS_MIN
0244 F7 E3                      MUL     BX                      ; COUNT FOR MINUTES
0246 03 C8                      ADD     CX,AX                   ; ADD TO ACCUMULATED VALUE
0248 B0 84                      MOV     AL,CMOS_HOURS+NMI
024A E8 0000 R                  CALL    CMOS_READ               ; ACCESS HOURS VALUE IN CMOS
024D 3C 23                      CMP     AL,23H                  ; ARE THE HOURS WITHIN LIMITS?
024F 77 18                      JA      TOD_ERROR               ; GO IF NOT

0251 E8 027F R                  CALL    CVT_BINARY              ; CONVERT IT TO BINARY
0254 8B D0                      MOV     DX,AX
0256 B3 07                      MOV     BL,COUNTS_HOUR
0258 F6 E3                      MUL     BL                      ; COUNT FOR HOURS
025A 03 C1                      ADD     AX,CX
025C 83 D2 00                   ADC     DX,0000H
025F 89 16 006E R               MOV     @TIMER_HIGH,DX
0263 A3 006C R                  MOV     @TIMER_LOW,AX
0266                    POD_DONE:
0266 1F                         POP     DS
0267 61                         POPA
0268 C3                         RET

0269                    TOD_ERROR:
0269 1F                         POP     DS                      ; RESTORE SEGMENT
026A 61                         POPA                            ; RESTORE REGISTERS
026B BE 0000 E                  MOV     SI,OFFSET E163          ; DISPLAY CLOCK ERROR
026E E8 003C R                  CALL    E_MSG
0271 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; SET CLOCK ERROR IN STATUS
0274 E8 0000 R                  CALL    CMOS_READ               ; READ DIAGNOSTIC CMOS LOCATION
0277 0C 04                      OR      AL,CMOS_CLK_FAIL        ; SET NEW STATUS WITH CMOS CLOCK ERROR
0279 86 C4                      XCHG    AL,AH                   ; MOVE NEW STATUS TO WORK REGISTER
027B E8 001A R                  CALL    CMOS_WRITE              ; UPDATE STATUS LOCATION
027E C3                         RET

027F                    SET_TOD ENDP

027F                    CVT_BINARY      PROC    NEAR
027F 8A E0                      MOV     AH,AL                   ; UNPACK 2 BCD DIGITS IN AL
0281 C0 EC 04                   SHR     AH,4
0284 24 0F                      AND     AL,0FH                  ; RESULT IS IN AX
0286 D5 0A                      AAD                             ; CONVERT UNPACKED BCD TO BINARY
0288 C3                         RET

0289                    CVT_BINARY      ENDP
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                        PAGE
                        ;--- D11 -- INT  ?? H -- ( IRQ LEVEL ?? ) ----------------------------------
                        ; TEMPORARY INTERRUPT SERVICE ROUTINE FOR POST                              :
                        ;                                                                           :
                        ;       THIS ROUTINE IS ALSO LEFT IN PLACE AFTER THE POWER ON DIAGNOSTICS   :
                        ;       TO SERVICE UNUSED INTERRUPT VECTORS.  LOCATION "@INTR_FLAG" WILL    :
                        ;       CONTAIN EITHER:                                                     :
                        ;        1) LEVEL OF HARDWARE INTERRUPT THAT CAUSED CODE TO BE EXECUTED, OR :
                        ;        2) "FF" FOR A NON-HARDWARE INTERRUPT THAT WAS EXECUTED ACCIDENTALLY. :
                        ;-------------------------------------------------------------------------

0289                    D11     PROC    NEAR
0289 50                         PUSH    AX                      ; SAVE REGISTER AX CONTENTS
028A 53                         PUSH    BX
028B B0 0B                      MOV     AL,0BH                  ; READ IN-SERVICE REGISTER
028D E6 20                      OUT     INTA00,AL               ; (FIND OUT WHAT LEVEL BEING
028F EB 00                      JMP     $+2                     ;  SERVICED)
0291 E4 20                      IN      AL,INTA00               ; GET LEVEL
0293 8A E0                      MOV     AH,AL                   ; SAVE IT
0295 0A C4                      OR      AL,AH                   ; 00? (NO HARDWARE ISR ACTIVE)
0297 75 04                      JNZ     HW_INT

0299 B4 FF                      MOV     AH,0FFH
029B EB 2F                      JMP     SHORT SET_INTR_FLAG     ; SET FLAG TO "FF" IF NON-HARDWARE
029D                    HW_INT:
029D B0 0B                      MOV     AL,0BH                  ; READ IN-SERVICE REGISTER FROM
029F E6 A0                      OUT     INTB00,AL               ; INTERRUPT CHIP #2
02A1 EB 00                      JMP     $+2                     ; I/O DELAY
02A3 E4 A0                      IN      AL,INTB00               ; CHECK THE SECOND INTERRUPT CHIP
02A5 8A F8                      MOV     BH,AL                   ; SAVE IT
02A7 0A FF                      OR      BH,BH
02A9 74 10                      JZ      NOT_SEC                 ; CONTINUE IF NOT

02AB E4 A1                      IN      AL,INTB01               ; GET SECOND INTERRUPT MASK
02AD 0A C7                      OR      AL,BH                   ; MASK OFF LEVEL BEING SERVICED
02AF EB 00                      JMP     $+2                     ; I/O DELAY
02B1 E6 A1                      OUT     INTB01,AL
02B3 B0 20                      MOV     AL,EOI                  ; SEND EOI TO SECOND CHIP
02B5 EB 00                      JMP     $+2                     ; I/O DELAY
02B7 E6 A0                      OUT     INTB00,AL
02B9 EB 0D                      JMP     SHORT IS_SEC
02BB                    NOT_SEC:
02BB E4 21                      IN      AL,INTA01               ; GET CURRENT MASK VALUE
02BD EB 00                      JMP     $+2                     ; I/O DELAY
02BF 80 E4 FB                   AND     AH,0FBH                 ; DO NOT DISABLE SECOND CONTROLLER
02C2 0A C4                      OR      AL,AH                   ; MASK OFF LEVEL BEING SERVICED
02C4 E6 21                      OUT     INTA01,AL               ; SET NEW INTERRUPT MASK
02C6 EB 00                      JMP     $+2                     ; I/O DELAY
02C8                    IS_SEC:
02C8 B0 20                      MOV     AL,EOI
02CA E6 20                      OUT     INTA00,AL
02CC                    SET_INTR_FLAG:
02CC 5B                         POP     BX                      ; RESTORE (BX) FROM STACK
02CD 1E                         PUSH    DS                      ; SAVE ACTIVE (DS)
02CE E8 0034 R                  CALL    DDS                     ; SET DATA SEGMENT
02D1 88 26 006B R               MOV     @INTR_FLAG,AH           ; SET FLAG
02D5 1F                         POP     DS
02D6 58                         POP     AX                      ; RESTORE REGISTER AX CONTENTS
02D7                    DUMMY_RETURN_1:                         ; NEED IRET FOR VECTOR TABLE
02D7 CF                         IRET

02D8                    D11     ENDP

                        ;--- HARDWARE INT  71 H -- ( IRQ LEVEL  9 ) -- TO INT  0A H ---------------
                        ; REDIRECT SLAVE INTERRUPT 9 TO INTERRUPT LEVEL 2                           :
                        ;       THIS ROUTINE FIELDS LEVEL 9 INTERRUPTS AND                          :
                        ;       CONTROL IS PASSED TO MASTER INTERRUPT LEVEL 2                       :
                        ;-------------------------------------------------------------------------

02D8                    RE_DIRECT PROC  NEAR
02D8 50                         PUSH    AX                      ; SAVE (AX)
02D9 B0 20                      MOV     AL,EOI
02DB E6 A0                      OUT     INTB00,AL               ; EOI TO SLAVE INTERRUPT CONTROLLER
02DD 58                         POP     AX                      ; RESTORE (AX)
02DE CD 0A                      INT     0AH                     ; GIVE CONTROL TO HARDWARE LEVEL 2

02E0 CF                         IRET                            ; RETURN

02E1                    RE_DIRECT ENDP

                        ;--- HARDWARE INT  75 H -- ( IRQ LEVEL 13 ) ---------------------------------
                        ; SERVICE X287 INTERRUPTS                                                   :
                        ;       THIS ROUTINE FIELDS X287 INTERRUPTS AND CONTROL                     :
                        ;       IS PASSED TO THE NMI INTERRUPT HANDLER FOR                          :
                        ;       COMPATIBILITY.                                                      :
                        ;-------------------------------------------------------------------------

02E1                    INT_287 PROC    NEAR
02E1 50                         PUSH    AX                      ; SAVE (AX)
02E2 32 C0                      XOR     AL,AL
02E4 E6 F0                      OUT     X287,AL                 ; REMOVE THE INTERRUPT REQUEST

02E6 B0 20                      MOV     AL,EOI                  ; ENABLE THE INTERRUPT
02E8 E6 A0                      OUT     INTB00,AL               ;  THE SLAVE
02EA E6 20                      OUT     INTA00,AL               ;  THE MASTER
02EC 58                         POP     AX                      ; RESTORE (AX)
02ED CD 02                      INT     02H                     ; GIVE CONTROL TO NMI

02EF CF                         IRET                            ; RETURN

02F0                    INT_287 ENDP

02F0                    PROC_SHUTDOWN   PROC                    ;       COMMON 80286 SHUTDOWN WAIT

02F0 B0 FE                      MOV     AL,SHUT_CMD             ; SHUTDOWN COMMAND
02F2 E6 64                      OUT     STATUS_PORT,AL          ; SEND TO KEYBOARD CONTROL PORT
02F4                    PROC_S:
02F4 F4                         HLT                             ; WAIT FOR 80286 RESET
02F5 EB FD                      JMP     PROC_S                  ; INSURE HALT

02F7                    PROC_SHUTDOWN   ENDP
02F7                    CODE    ENDS
                                END
```

SECTION 5

```
                        PAGE 118,121
                        TITLE TEST5 ---- 06/10/85  EXCEPTION INTERRUPT TEST HANDLERS
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  POST5
                                PUBLIC  SYSINIT1

                        ;--------------------------------------
                        ;       EXCEPTION INTERRUPT ROUTINE     :
                        ;--------------------------------------

                                ASSUME  CS:CODE,DS:ABS0
0000                    POST5:
0000                    EXC_00:
0000 B0 90                      MOV     AL,90H                  ;       <><> SET CHECKPOINT <><>
0002 E9 00B2 R                  JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
0005                    EXC_01:
0005 B0 91                      MOV     AL,91H                  ;       <><> SET CHECKPOINT <><>
0007 E9 00B2 R                  JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
000A                    EXC_02:
000A B0 92                      MOV     AL,92H                  ;       <><> SET CHECKPOINT <><>
000C E9 00B2 R                  JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
000F                    EXC_03:
000F B0 93                      MOV     AL,93H                  ;       <><> SET CHECKPOINT <><>
0011 E9 00B2 R                  JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
0014                    EXC_04:
0014 B0 94                      MOV     AL,94H                  ;       <><> SET CHECKPOINT <><>
0016 E9 00B2 R                  JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
0019                    EXC_05:
0019 06                         PUSH    ES
001A 6A 48                      PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER WITH SELECTOR
001C 07                         POP     ES

                        ;-----  FIX BOUND PARAMETERS

001D 2B FF                      SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
001F 26: C7 05 0000             MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO ZERO
0024 26: C7 45 02 7FFF          MOV     WORD PTR ES:[DI+2],07FFFH ; SET SECOND TO 07FFFH
002A 07                         POP     ES
002B B0 95                      MOV     AL,95H                  ;       <><> SET CHECKPOINT <><>
002D E9 00B2 R                  JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED

0030                    EXC_06:
0030 B0 96                      MOV     AL,96H                  ;       <><> SET CHECKPOINT <><>
0032 EB 7E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0034                    EXC_07:
0034 B0 97                      MOV     AL,97H                  ;       <><> SET CHECKPOINT <><>
0036 EB 7A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0038                    EXC_08:
0038 B0 98                      MOV     AL,98H                  ;       <><> SET CHECKPOINT <><>
003A EB 76                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
003C                    EXC_09:                                                          ↓
003C B0 99                      MOV     AL,99H                  ;       <><> SET CHECKPOINT <><>
003E EB 72                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0040                    EXC_10:
0040 B0 9A                      MOV     AL,9AH                  ;       <><> SET CHECKPOINT <><>
0042 EB 6E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0044                    EXC_11:
0044 B0 9B                      MOV     AL,9BH                  ;       <><> SET CHECKPOINT <><>
0046 EB 6A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0048                    EXC_12:
0048 B0 9C                      MOV     AL,9CH                  ;       <><> SET CHECKPOINT <><>
004A EB 66                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
004C                    EXC_13:
004C B0 9D                      MOV     AL,9DH                  ;       <><> SET CHECKPOINT <><>
004E EB 62                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0050                    EXC_14:
0050 B0 9E                      MOV     AL,9EH                  ;       <><> SET CHECKPOINT <><>
0052 EB 5E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0054                    EXC_15:
0054 B0 9F                      MOV     AL,9FH                  ;       <><> SET CHECKPOINT <><>
0056 EB 5A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0058                    EXC_16:
0058 B0 A0                      MOV     AL,0A0H                 ;       <><> SET CHECKPOINT <><>
005A EB 56                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
005C                    EXC_17:
005C B0 A1                      MOV     AL,0A1H                 ;       <><> SET CHECKPOINT <><>
005E EB 52                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0060                    EXC_18:
0060 B0 A2                      MOV     AL,0A2H                 ;       <><> SET CHECKPOINT <><>
0062 EB 4E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0064                    EXC_19:
0064 B0 A3                      MOV     AL,0A3H                 ;       <><> SET CHECKPOINT <><>
0066 EB 4A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0068                    EXC_20:
0068 B0 A4                      MOV     AL,0A4H                 ;       <><> SET CHECKPOINT <><>
006A EB 46                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
006C                    EXC_21:
006C B0 A5                      MOV     AL,0A5H                 ;       <><> SET CHECKPOINT <><>
006E EB 42                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0070                    EXC_22:
0070 B0 A6                      MOV     AL,0A6H                 ;       <><> SET CHECKPOINT <><>
0072 EB 3E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0074                    EXC_23:
0074 B0 A7                      MOV     AL,0A7H                 ;       <><> SET CHECKPOINT <><>
0076 EB 3A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0078                    EXC_24:
0078 B0 A8                      MOV     AL,0A8H                 ;       <><> SET CHECKPOINT <><>
007A EB 36                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
007C                    EXC_25:
007C B0 A9                      MOV     AL,0A9H                 ;       <><> SET CHECKPOINT <><>
007E EB 32                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0080                    EXC_26:
0080 B0 AA                      MOV     AL,0AAH                 ;       <><> SET CHECKPOINT <><>
0082 EB 2E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0084                    EXC_27:
0084 B0 AB                      MOV     AL,0ABH                 ;       <><> SET CHECKPOINT <><>
0086 EB 2A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0088                    EXC_28:
0088 B0 AC                      MOV     AL,0ACH                 ;       <><> SET CHECKPOINT <><>
008A EB 26                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
008C                    EXC_29:
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008C B0 AD                      MOV     AL,0ADH                 ;       <><> SET CHECKPOINT <><>
008E EB 22                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0090                    EXC_30:
0090 B0 AE                      MOV     AL,0AEH                 ;       <><> SET CHECKPOINT <><>
0092 EB 1E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0094                    EXC_31:
0094 B0 AF                      MOV     AL,0AFH                 ;       <><> SET CHECKPOINT <><>
0096 EB 1A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0098                    SYS_32:
0098 B0 B0                      MOV     AL,0B0H                 ;       <><> SET CHECKPOINT <><>
009A EB 16                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
009C                    SYS_33:
009C B0 B1                      MOV     AL,0B1H                 ;       <><> SET CHECKPOINT <><>
009E EB 12                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00A0                    SYS_34:
00A0 B0 B2                      MOV     AL,0B2H                 ;       <><> SET CHECKPOINT <><>
00A2 EB 0E                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00A4                    SYS_35:
00A4 B0 B3                      MOV     AL,0B3H                 ;       <><> SET CHECKPOINT <><>
00A6 EB 0A                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00A8                    SYS_36:
00A8 B0 B4                      MOV     AL,0B4H                 ;       <><> SET CHECKPOINT <><>
00AA EB 06                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00AC                    SYS_37:
00AC B0 B5                      MOV     AL,0B5H                 ;       <><> SET CHECKPOINT <><>
00AE EB 02                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00B0                    SYS_38:
00B0 B0 B6                      MOV     AL,0B6H                 ;       <><> SET CHECKPOINT <><>
                                                                ; GO TEST IF INTERRUPT WAS EXPECTED


00B2                    TEST_EXC:
00B2 E6 80                      OUT     MFG_PORT,AL             ; OUTPUT THE CHECKPOINT
00B4 3C AF                      CMP     AL,0AFH                 ; CHECK FOR EXCEPTION
00B6 77 1C                      JA      TEST_EXC0               ; GO IF A SYSTEM INTERRUPT

00B8 1E                         PUSH    DS                      ; SAVE THE CURRENT DATA SEGMENT
00B9 6A 08                      PUSH    BYTE PTR GDT_PTR
00BB 1F                         POP     DS
00BC C7 06 0048 FFFF            MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
00C2 C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
00C7 6A 48                      PUSH    BYTE PTR ES_TEMP
00C9 07                         POP     ES
00CA 1F                         POP     DS                      ; RESTORE REGISTERS
00CB 5A                         POP     DX                      ; CHECK IF CODE SEGMENT SECOND ON STACK
00CC 59                         POP     CX
00CD 51                         PUSH    CX
00CE 83 F9 40                   CMP     CX,SYS_ROM_CS
00D1 75 01                      JNZ     TEST_EXC0               ; CONTINUE IF ERROR CODE

00D3 52                         PUSH    DX                      ; PUT SEGMENT BACK ON STACK
00D4                    TEST_EXC0:
00D4 86 E0                      XCHG    AH,AL                   ; SAVE THE CHECKPOINT
00D6 E4 8B                      IN      AL,DMA_PAGE+0AH
00D8 3A C4                      CMP     AL,AH                   ; WAS THE EXCEPTION EXPECTED?
00DA 74 0E                      JZ      TEST_EXC3               ; GO IF YES
00DC                    TEST_EXC1:
00DC E4 80                      IN      AL,MFG_PORT             ; CHECK THE CURRENT CHECKPOINT
00DE 3C 3B                      CMP     AL,03BH                 ;  HALT IF CHECKPOINT BELOW 3BH
00E0 72 01                      JB      TEST_EXC2
00E2 CF                         IRET

00E3                    TEST_EXC2:
00E3 86 E0                      XCHG    AH,AL                   ; OUTPUT THE CURRENT CHECKPOINT
00E5 E6 80                      OUT     MFG_PORT,AL             ;   <><> CHECKPOINT  90 THRU  B5 <><>
00E7 F4                         HLT
00E8 EB F9                      JMP     TEST_EXC2               ; INSURE SYSTEM HALT

00EA                    TEST_EXC3:
00EA 2A C0                      SUB     AL,AL                   ; CLEAR DMA PAGE
00EC E6 8B                      OUT     DMA_PAGE+0AH,AL
00EE B8 0100                    MOV     AX,0100H                ; FOR BOUND INSTRUCTION EXPECTED (INT 5)
00F1 CF                         IRET                            ; RETURN

                        ;-------------------------------------------------------------------------
                        ;       THIS BUILDS THE DESCRIPTOR TABLES REQUIRED FOR PROTECTED MODE    :
                        ;               PROCESSOR MUST BE IN REAL MODE                           :
                        ;-------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

00F2                    SYSINIT1        PROC    NEAR
00F2 FA                         CLI                             ; NO INTERRUPTS ALLOWED
00F3 55                         PUSH    BP                      ; SAVE BP
00F4 B0 81                      MOV     AL,81H                  ;       <><><><><><><><><><><><>
00F6 E6 80                      OUT     MFG_PORT,AL             ;               <><> CHECKPOINT  81 <><>
00F8 E8 0149 R                  CALL    SIDT_BLD
00FB 8B EF                      MOV     BP,DI                   ; SAVE THE POINTER TO JUST PAST THE IDT
                                                                ; AS WE HAVE NO SDA, USE THE SIX BYTES
                                                                ;   HERE TO LOAD THE IDTR.  WE WILL SIDT
                                                                ;   WHEN WE GET TO SDA INITIALIZATION.
00FD B8 0800                    MOV     AX,SYS_IDT_LEN          ; SEGMENT LIMIT = LENGTH OF IDT
0100 AB                         STOSW                           ; STORE THAT AS IDT LIMIT
0101 B8 D0A0                    MOV     AX,SYS_IDT_LOC          ; IDT ADDRESS
0104 AB                         STOSW                           ;   AND ACCESS RIGHTS BYTE (UNDEFINED)
0105 B8 0000                    MOV     AX,0
0108 AB                         STOSW
                                SEGOV   ES                      ; LOAD THE IDT
0109 26                 +       DB      026H
                                LIDT    [BP]                    ;   REGISTER FROM THIS AREA
010A 0F                 +       DB      00FH
010B                    + ??0001 LABEL  BYTE
010B 8B 5E 00           +       MOV     BX,WORD PTR [BP]
010E                    + ??0002 LABEL  BYTE
010B                    +       ORG     OFFSET CS:??0001
010B 01                 +       DB      001H
010E                    +       ORG     OFFSET CS:??0002
010E 8B FD                      MOV     DI,BP                   ; ES:DI NOW --> END OF IDT AGAIN

                        ;-----  BUILD THE GDT.

0110 BF D8A0                    MOV     DI,GDT_LOC
0113 E8 0140 R                  CALL    GDT_BLD
0116 8B EF                      MOV     BP,DI                   ; SAVE THE ES:DI POINTER
0118 B8 0088                    MOV     AX,GDT_LEN              ; AX = LENGTH OF THE GDT
011B AB                         STOSW                           ; PUT THAT IN THE LIMIT FIELD
```

SECTION 5

```
011C B8 D8A0                    MOV     AX,GDT_LOC              ; AX = LOW WORD OF GDT ADDRESS
011F AB                         STOSW                           ; PUT THAT IN BASE FIELD - LOW
0120 B8 0000                    MOV     AX,0                    ; AX = HIGH BYTE OF ADDRESS, AND
0123 AB                         STOSW                           ;   ACCESS RIGHTS BYTE IS UNDEFINED
                                SEGOV   ES                      ; LOAD THE GDTR
0124 26                 +       DB      026H
                                LGDT    [BP]                    ;   FROM THIS AREA
0125 0F                 +       DB      00FH
0126                    + ??0004 LABEL  BYTE
0126 8B 56 00           +       MOV     DX,WORD PTR [BP]
0129                    + ??0005 LABEL  BYTE
0126                    +       ORG     OFFSET CS:??0004
0126 01                 +       DB      001H
0129                    +       ORG     OFFSET CS:??0005
0129 8B FD                      MOV     DI,BP                   ; RESTORE THE ES:DI POINTER
012B AB                         STOSW
012C AB                         STOSW
012D 8B FD                      MOV     DI,BP

                        ;-----  SWITCH TO VIRTUAL MODE

012F 5D                         POP     BP                      ; RESTORE BP
0130 B8 0001                    MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
0133 0F 01 F0           +       DB      00FH,001H,0F0H

0136 EA                          DB      0EAH                   ; JUMP FAR TO PURGE PRE-FETCH QUEUE
0137 013B R                      DW      OFFSET DONE            ;   TO OFFSET
0139 0040                        DW      SYS_ROM_CS             ;   IN SEGMENT
013B                    DONE:
013B B0 85                      MOV     AL,85H                  ;       <><><><><><><><><><><><><>
013D E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  82 <><>
013F C3                         RET                             ; SYSTEM INITIALIZATION

0140                    SYSINIT1        ENDP


0140                    GDT_BLD PROC    NEAR
0140 BE 01AF R                  MOV     SI,OFFSET GDT_DATA_START        ; DS:SI --> GDT
0143 B9 0044                    MOV     CX,(OFFSET GDT_DATA_END-OFFSET GDT_DATA_START)/2  ; WORD COUNT
0146 F3/ A5                     REP     MOVSW                           ; COPY GDT INTO MEMORY
0148 C3                         RET
0149                    GDT_BLD ENDP


0149                    SIDT_BLD        PROC    NEAR

                        ;-----  BUILD THE IDT.  THE IDT WILL CONTAIN VECTORS FOR EXCEPTION HANDLERS

0149 BE 0237 R                  MOV     SI,OFFSET SYS_IDT_OFFSETS  ; MAKE DS:SI POINT TO
014C 8C C8                      MOV     AX,CS                   ;   INTERRUPT ENTRY POINTS
014E 8E D8                      MOV     DS,AX
0150 BF D0A0                    MOV     DI,SYS_IDT_LOC          ; POINT TO SYS_IDT_LOC
0153 2B C0                      SUB     AX,AX
0155 8E C0                      MOV     ES,AX                   ;     WHERE THE IDT WILL BE.
0157 BB 0040                    MOV     BX,SYS_ROM_CS           ; CS IS THE SAME FOR ALL INTERRUPTS
015A B6 87                      MOV     DH,TRAP_GATE            ; ACCESS RIGHTS BYTE FOR THE GATE
015C B2 00                      MOV     DL,0                    ; THE WORD COUNT FIELD IS UNUSED
015E B9 0020                    MOV     CX,32                   ; THERE ARE 32 RESERVED INTERRUPTS
0161                    LOW_IDT:                                ; THIS LOOP BUILDS 32 DESCRIPTORS IN THE
                                                                ;   IDT FOR THE RESERVED INTERRUPTS
0161 A5                         MOVSW                           ; GET A ROUTINE ENTRY POINT
                                                                ;   AND PUT IT IN THE OFFSET FIELD
0162 8B C3                      MOV     AX,BX                   ; GET THE SYSTEM CODE SEGMENT SELECTOR
0164 AB                         STOSW                           ;   AND PUT IT IN THE SELECTOR FIELD
0165 8B C2                      MOV     AX,DX                   ; GET THE INTERRUPT GATE BYTE
0167 AB                         STOSW                           ;   AND PUT IN THE ACCESS RIGHTS FIELD
0168 B8 0000                    MOV     AX,0                    ; ZERO OUT
016B AB                         STOSW                           ;   THE RESERVED POSITIONS
016C E2 F3                      LOOP    LOW_IDT                 ;     AND REPEAT AS DIRECTED
016E B9 00E0                    MOV     CX,256-32               ; 256 TOTAL - 32 DONE = WHATEVER IS LEFT
0171 8D 0277 R                  MOV     BP,OFFSET FREE_INTS     ; THERE IS A COPY OF AN UN-INITIALIZED
                                                                ;   INTERRUPT DESCRIPTOR AT FREE_INTS
0174                    HIGH_IDT:
0174 8B F5                      MOV     SI,BP                   ; DS:SI --> FREE DESCRIPTOR
                                                                ; (ES:DI LEFT OFF AT INT 32)
0176 A5                         MOVSW                           ; MOVE OFFSET OF THE IRET INSTRUCTION
0177 A5                         MOVSW                           ; MOVE THE CS SELECTOR
0178 A5                         MOVSW                           ; MOVE THE ACCESS RIGHTS BYTE
0179 AB                         STOSW                           ; ZERO OUT THE RESERVED WORD
017A E2 F8                      LOOP    HIGH_IDT                ; FILL THE REMAINDER OF THE TABLE

                        ;-----  INITIALIZE THE ENTRY POINTS FOR POST TEST

017C 26: C7 06 D1A0 0098 R      MOV     ES:(SYS_IDT_LOC+(032*DESC_LEN).ENTRY_POINT),OFFSET SYS_32
0183 26: C7 06 D1A8 009C R      MOV     ES:(SYS_IDT_LOC+(033*DESC_LEN).ENTRY_POINT),OFFSET SYS_33
018A 26: C7 06 D1B0 00A0 R      MOV     ES:(SYS_IDT_LOC+(034*DESC_LEN).ENTRY_POINT),OFFSET SYS_34
0191 26: C7 06 D1B8 00A4 R      MOV     ES:(SYS_IDT_LOC+(035*DESC_LEN).ENTRY_POINT),OFFSET SYS_35
0198 26: C7 06 D1C0 00A8 R      MOV     ES:(SYS_IDT_LOC+(036*DESC_LEN).ENTRY_POINT),OFFSET SYS_36
019F 26: C7 06 D1C8 00AC R      MOV     ES:(SYS_IDT_LOC+(037*DESC_LEN).ENTRY_POINT),OFFSET SYS_37
01A6 26: C7 06 D1D0 00B0 R      MOV     ES:(SYS_IDT_LOC+(038*DESC_LEN).ENTRY_POINT),OFFSET SYS_38
01AD C3                         RET

01AE                    IRET_ADDR       LABEL   WORD            ; FOR UN-INITIALIZED INTERRUPTS
01AE CF                         IRET                            ; NULL RETURN
```

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                        PAGE
                        ;       THE FOLLOWING DATA DEFINES THE PRE-INITIALIZED GDT FOR POST TESTS.
                        ;       THESE MUST BE INITIALIZED IN THE ORDER IN WHICH THEY APPEAR IN THE
                        ;       GDT_DEF STRUCTURE DEFINITION AS IT IS IN "SYSDATA.INC".

= 01AF                  GDT_DATA_START  EQU     $

                        ;-----  FIRST ENTRY UNUSABLE  - (UNUSED_ENTRY)

01AF 0000               DW      0                       ; SEGMENT LIMIT
01B1 0000               DW      0                       ; SEGMENT BASE ADDRESS - LOW WORD
01B3 00                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
01B4 00                 DB      0                       ; ACCESS RIGHTS BYTE
01B5 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  THE GDT ITSELF  - (GDT_PTR)

01B7 0088               DW      GDT_LEN                 ; SEGMENT LIMIT
01B9 D8A0               DW      GDT_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
01BB 00                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
01BC 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01BD 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  THE SYSTEM IDT DESCRIPTOR  - (SYS_IDT_PTR)

01BF 0800               DW      SYS_IDT_LEN             ; SEGMENT LIMIT
01C1 D0A0               DW      SYS_IDT_LOC             ; SEGMENT BASE ADDRESS - LOW WORD
01C3 00                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
01C4 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01C5 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  THE SYSTEM DATA AREA DESCRIPTOR  - (RSDA_PTR)

01C7 0300               DW      SDA_LEN                 ; SEGMENT LIMIT
01C9 0400               DW      SDA_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
01CB 00                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
01CC 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01CD 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  COMPATIBLE MONOCHROME DISPLAY REGEN BUFFER  - (C_BWCRT_PTR)

01CF 1000               DW      MCRT_SIZE               ; SEGMENT LIMIT
01D1 0000               DW      MCRT@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
01D3 0B                 DB      MCRT@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
01D4 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01D5 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  COMPATIBLE COLOR DISPLAY REGEN BUFFER  - (C_CCRT_PTR)

01D7 4000               DW      CCRT_SIZE               ; SEGMENT LIMIT
01D9 8000               DW      CCRT@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
01DB 0B                 DB      CCRT@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
01DC 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01DD 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  ENHANCED GRAPHIC ADAPTER REGEN BUFFER  - (E_CCRT_PRT)

01DF FFFF               DW      ECCRT_SIZE              ; SEGMENT LIMIT
01E1 0000               DW      ECCRT@_LO_LO            ; SEGMENT BASE ADDRESS - LOW WORD
01E3 0A                 DB      ECCRT@_LO_HI            ; SEGMENT BASE ADDRESS - HIGH BYTE
01E4 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01E5 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  SECOND PART OF EGA  - (E_CCRT_PTR2)

01E7 FFFF               DW      ECCRT_SIZE              ; SEGMENT LIMIT
01E9 0000               DW      ECCRT@_HI_LO            ; SEGMENT BASE ADDRESS - LOW WORD
01EB 0B                 DB      ECCRT@_HI_HI            ; SEGMENT BASE ADDRESS - HIGH BYTE
01EC 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01ED 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  CODE SEGMENT FOR POST CODE, SYSTEM IDT  - (SYS_ROM_CS)

01EF FFFF               DW      MAX_SEG_LEN             ; SEGMENT LIMIT
01F1 0000               DW      CSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
01F3 0F                 DB      CSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
01F4 9B                 DB      CPL0_CODE_ACCESS        ; ACCESS RIGHTS BYTE
01F5 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  TEMPORARY DESCRIPTOR FOR ES  - (ES_TEMP)

01F7 FFFF               DW      MAX_SEG_LEN             ; SEGMENT LIMIT
01F9 0000               DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
01FB 00                 DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
01FC 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
01FD 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  TEMPORARY DESCRIPTOR FOR CS AS A DATA SEGMENT  - (CS_TEMP)

01FF FFFF               DW      MAX_SEG_LEN             ; SEGMENT LIMIT
0201 0000               DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
0203 00                 DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
0204 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0205 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  TEMPORARY DESCRIPTOR FOR SS  - (SS_TEMP)

0207 FFFF               DW      MAX_SEG_LEN             ; SEGMENT LIMIT
0209 0000               DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
020B 00                 DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
020C 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
020D 0000               DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  TEMPORARY DESCRIPTOR FOR DS  - (DS_TEMP)

020F FFFF               DW      MAX_SEG_LEN             ; SEGMENT LIMIT
0211 0000               DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
0213 00                 DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
0214 93                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0215 0000               DW      0                       ; RESERVED - MUST BE ZERO
```

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                        PAGE
                        ;-----  (POST_TR)
0217                    TR_LOC:
0217 0800                       DW      00800H                  ; SEGMENT LIMIT
0219 C000                       DW      0C000H                  ; SEGMENT BASE ADDRESS - LOW WORD
021B 00                         DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
021C 81                         DB      FREE_TSS                ; ACCESS RIGHTS BYTE
021D 0000                       DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  (POST_TSS_PTR)

021F 0800                       DW      00800H                  ; SEGMENT LIMIT
0221 0217 R                     DW      TR_LOC                  ; SEGMENT BASE ADDRESS - LOW WORD
0223 00                         DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
0224 93                         DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0225 0000                       DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  (POST_LDTR)
0227                    LDT_LOC:
0227 0088                       DW      GDT_LEN                 ; SEGMENT LIMIT
0229 D000                       DW      0D000H                  ; SEGMENT BASE ADDRESS - LOW WORD
022B 00                         DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
022C E2                         DB      LDT_DESC                ; ACCESS RIGHTS BYTE
022D 0000                       DW      0                       ; RESERVED - MUST BE ZERO

                        ;-----  (POST_LDT_PTR)

022F 0088                       DW      GDT_LEN                 ; SEGMENT LIMIT
0231 0227 R                     DW      LDT_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
0233 00                         DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
0234 93                         DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0235 0000                       DW      0                       ; RESERVED - MUST BE ZERO

= 0237                  GDT_DATA_END    EQU     $

                        ;-----  END OF PRE-ALLOCATED GDT


                        ;-----  ENTRY POINTS FOR THE FIRST 32 SYSTEM INTERRUPTS

0237                    SYS_IDT_OFFSETS         LABEL   WORD
                                                        ; INTERRUPTS AS DEFINED
0237 0000 R                     DW      OFFSET EXC_00           ; EXCPT 00 - DIVIDE ERROR
0239 0005 R                     DW      OFFSET EXC_01           ; EXCPT 01 - SINGLE STEP
023B 000A R                     DW      OFFSET EXC_02           ; EXCPT 02 - NMI, SYSTEM REQUEST FOR DI
023D 000F R                     DW      OFFSET EXC_03           ; EXCPT 03 - BREAKPOINT
023F 0014 R                     DW      OFFSET EXC_04           ; EXCPT 04 - INTO DETECT
0241 0019 R                     DW      OFFSET EXC_05           ; EXCPT 05 - BOUND
0243 0030 R                     DW      OFFSET EXC_06           ; EXCPT 06 - INVALID OPCODE
0245 0034 R                     DW      OFFSET EXC_07           ; EXCPT 07 - PROCESSOR EXT NOT AVAIL
0247 0038 R                     DW      OFFSET EXC_08           ; EXCPT 08 - DOUBLE EXCEPTION
0249 003C R                     DW      OFFSET EXC_09           ; EXCPT 09 - PROCESSOR EXT SEGMENT ERR
024B 0040 R                     DW      OFFSET EXC_10           ; EXCPT 10 - TSS BAD IN GATE TRANSFER
024D 0044 R                     DW      OFFSET EXC_11           ; EXCPT 11 - SEGMENT NOT PRESENT
024F 0048 R                     DW      OFFSET EXC_12           ; EXCPT 12 - STACK SEGMENT NOT PRESENT
0251 004C R                     DW      OFFSET EXC_13           ; EXCPT 13 - GENERAL PROTECTION
0253 0050 R                     DW      OFFSET EXC_14
0255 0054 R                     DW      OFFSET EXC_15
0257 0058 R                     DW      OFFSET EXC_16           ; EXCPT 16 - PROCESSOR EXTENSION ERROR
0259 005C R                     DW      OFFSET EXC_17
025B 0060 R                     DW      OFFSET EXC_18
025D 0064 R                     DW      OFFSET EXC_19
025F 0068 R                     DW      OFFSET EXC_20
0261 006C R                     DW      OFFSET EXC_21
0263 0070 R                     DW      OFFSET EXC_22
0265 0074 R                     DW      OFFSET EXC_23
0267 0078 R                     DW      OFFSET EXC_24
0269 007C R                     DW      OFFSET EXC_25
026B 0080 R                     DW      OFFSET EXC_26
026D 0084 R                     DW      OFFSET EXC_27
026F 0088 R                     DW      OFFSET EXC_28
0271 008C R                     DW      OFFSET EXC_29
0273 0090 R                     DW      OFFSET EXC_30
0275 0094 R                     DW      OFFSET EXC_31

                        ;-----  FORMAT INTERRUPT DESCRIPTORS (GATES) 32 - 255

0277 01AE R             FREE_INTS       DW      OFFSET IRET_ADDR        ; DESTINATION OFFSET
0279 0040                               DW      SYS_ROM_CS              ; DESTINATION SEGMENT
027B 00 86                              DB      0,INT_GATE              ; UNUSED AND ACCESS RIGHTS BYTE
027D                    SIDT_BLD        ENDP

027D                    CODE    ENDS
                                END
```

```
                        PAGE 118,121
                        TITLE TEST6 ---- 06/10/85  POST TESTS AND SYSTEM BOOT STRAP
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  BOOT_STRAP_1
                                PUBLIC  POST6
                                PUBLIC  STGTST_CNT
                                PUBLIC  ROM_ERR
                                PUBLIC  XMIT_8042

                                EXTRN   CMOS_READ:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   DISK_BASE:NEAR
                                EXTRN   E602:NEAR
                                EXTRN   ERR_BEEP:NEAR
                                EXTRN   E_MSG:NEAR
                                EXTRN   F3A:NEAR
                                EXTRN   PRT_SEG:NEAR

                                ASSUME  CS:CODE,DS:DATA

0000                    POST6   PROC    NEAR
                        ;--------------------------------------------------------------------
                        ; THIS SUBROUTINE PERFORMS A READ/WRITE STORAGE TEST ON A BLOCK      :
                        ;       OF STORAGE.                                                 :
                        ; ENTRY REQUIREMENTS:                                               :
                        ;       ES = ADDRESS OF STORAGE SEGMENT BEING TESTED                :
                        ;       DS = ADDRESS OF STORAGE SEGMENT BEING TESTED                :
                        ;       CX = WORD COUNT OF STORAGE BLOCK TO BE TESTED               :
                        ; EXIT PARAMETERS:                                                  :
                        ;       ZERO FLAG = 0 IF STORAGE ERROR (DATA COMPARE OR PARITY      :
                        ;       CHECK). AL=0 DENOTES A PARITY CHECK. ELSE AL=XOR'ED         :
                        ;       BIT PATTERN OF THE EXPECTED DATA PATTERN VS THE ACTUAL      :
                        ;       DATA READ.                                                  :
                        ; AX,BX,CX,DX,DI, AND SI ARE ALL DESTROYED.                         :
                        ;--------------------------------------------------------------------
0000                    STGTST_CNT      PROC    NEAR
0000 8B D9                      MOV     BX,CX                   ; SAVE WORD COUNT OF BLOCK TO TEST
0002 E4 61                      IN      AL,PORT_B
0004 0C 0C                      OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK LATCHES
0006 E6 61                      OUT     PORT_B,AL               ; TO RESET ANY PENDING ERROR
0008 24 F3                      AND     AL,RAM_PAR_ON
000A E6 61                      OUT     PORT_B,AL

                        ;-----  ROLL A BIT THROUGH THE FIRST WORD

000C 33 D2                      XOR     DX,DX                   ; CLEAR THE INITIAL DATA PATTERN
000E B9 0010                    MOV     CX,16                   ; ROLL 16 BIT POSITIONS
0011 2B FF                      SUB     DI,DI                   ; START AT BEGINNING OF BLOCK
0013 2B F6                      SUB     SI,SI                   ; INITIALIZE DESTINATION POINTER
0015 F9                         STC                             ; SET CARRY FLAG ON FOR FIRST BIT
0016                    C1:
0016 D1 D2                      RCL     DX,1                    ; MOVE BIT OVER LEFT TO NEXT POSITION
0018 89 15                      MOV     [DI],DX                 ; STORE DATA PATTERN
001A 8B 05                      MOV     AX,[DI]                 ; GET THE DATA WRITTEN
001C 33 C2                      XOR     AX,DX                   ; INSURE DATA AS EXPECTED (CLEAR CARRY)
001E E1 F6                      LOOPZ   C1                      ; LOOP TILL DONE OR ERROR

0020 75 66                      JNZ     C13                     ; EXIT IF ERROR

                        ;-----  CHECK CAS LINES FOR HIGH BYTE LOW BYTE

0022 BA FF00                    MOV     DX,0FF00H               ; TEST DATA - AX= 0000H
0025 89 05                      MOV     [DI],AX                 ; STORE DATA PATTERN  = 0000H
0027 88 75 01                   MOV     [DI+1],DH               ; WRITE A BYTE OF FFH AT ODD LOCATION
002A 8B 05                      MOV     AX,[DI]                 ; GET THE DATA - SHOULD BE 0FF00H
002C 33 C2                      XOR     AX,DX                   ; CHECK THE FIRST WRITTEN
002E 75 58                      JNZ     C13                     ; ERROR EXIT IF NOT ZERO

0030 89 05                      MOV     [DI],AX                 ; STORE DATA PATTERN OF 0000H
0032 88 35                      MOV     [DI],DH                 ; WRITE A BYTE OF FFH AT EVEN LOCATION
0034 86 F2                      XCHG    DH,DL                   ; SET DX= 00FFH AND BUS SETTLE
0036 8B 05                      MOV     AX,[DI]                 ; GET THE DATA
0038 33 C2                      XOR     AX,DX                   ; CHECK THE FIRST WRITTEN
003A 75 4C                      JNZ     C13                     ; EXIT IF NOT

                        ;-----  CHECK FOR I/O OR BASE MEMORY ERROR

003C E4 61                      IN      AL,PORT_B               ; CHECK FOR I/O - PARITY CHECK
003E 86 C4                      XCHG    AL,AH                   ; SAVE ERROR
0040 E4 87                      IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
0042 22 E0                      AND     AH,AL                   ; MASK FOR ERROR EXPECTED

                        ;-----  PARITY ERROR EXIT

0044 B8 0000                    MOV     AX,0                    ; RESTORE AX TO 0000
0047 75 3F                      JNZ     C13                     ; EXIT IF PARITY ERROR

0049 BA AA55                    MOV     DX,0AA55H               ; WRITE THE INITIAL DATA PATTERN
004C                    C3:
004C 2B FF                      SUB     DI,DI                   ; START AT BEGINNING OF BLOCK
004E 2B F6                      SUB     SI,SI                   ; INITIALIZE DESTINATION POINTER
0050 8B CB                      MOV     CX,BX                   ; SETUP BYTE COUNT FOR LOOP
0052 8B C2                      MOV     AX,DX                   ; GET THE PATTERN
0054 F3/ AB                     REP     STOSW                   ; STORE 64K BYTES (32K WORDS)
0056 8B CB                      MOV     CX,BX                   ; SET COUNT
0058 2B F6                      SUB     SI,SI                   ; START AT BEGINNING
005A                    C6:
005A AD                         LODSW                           ; GET THE FIRST WRITTEN
005B 33 C2                      XOR     AX,DX                   ; INSURE DATA AS EXPECTED
005D E1 FB                      LOOPZ   C6                      ; LOOP TILL DONE OR ERROR

005F 75 27                      JNZ     C13                     ; EXIT IF NOT EXPECTED (ERROR BITS ON)

                        ;-----  CHECK FOR I/O OR BASE MEMORY ERROR

0061 E4 61                      IN      AL,PORT_B               ; CHECK FOR I/O -PARITY CHECK
0063 86 C4                      XCHG    AL,AH                   ; SAVE ERROR
0065 E4 87                      IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
0067 22 E0                      AND     AH,AL
```

```
                        ;-----  PARITY ERROR EXIT
                        
0069 B8 0000                    MOV     AX,0                    ; RESTORE AX TO 0000
006C 75 1A                      JNZ     C13                     ; GO IF YES
                        
                        ;-----  CHECK FOR END OF 64K BLOCK
                        
006E 23 D2                      AND     DX,DX                   ; ENDING ZERO PATTERN WRITTEN TO MEMORY?
0070 74 16                      JZ      C13                     ; YES - RETURN TO CALLER WITH AL=0
                        
                        ;-----  SETUP NEXT PATTERN
                        
0072 81 FA 55AA                 CMP     DX,055AAH               ; CHECK IF LAST PATTERN =55AA
0076 74 0B                      JZ      C9                      ; GO IF NOT
0078 81 FA 0101                 CMP     DX,0101H                ; LAST PATTERN 0101?
007C 74 0B                      JZ      C10                     ; GO IF YES
007E BA 55AA                    MOV     DX,055AAH               ; WRITE 55AA TO STORAGE
0081 EB C9                      JMP     C3
                        
                        ;-----  INSURE PARITY BITS ARE NOT STUCK ON
                        
0083 BA 0101            C9:     MOV     DX,0101H                ; WRITE 0101 TO STORAGE
0086 EB C4                      JMP     C3
                        
                        ;-----  EXIT STORAGE TEST
0088                    C13:
0088 C3                         RET                             ; ERROR IF ZF NOT SET
                        
                        ;-----  CHECKER BOARD TEST
                        
0089 2B FF              C10:    SUB     DI,DI                   ; POINT TO START OF BLOCK
008B 8B CB                      MOV     CX,BX                   ; GET THE BLOCK COUNT
008D D1 E9                      SHR     CX,1                    ; DIVIDE BY 2
008F B8 AAAA                    MOV     AX,1010101010101010B    ; SECOND CHECKER PATTERN
0092 BE 5555                    MOV     SI,0101010101010101B    ; FIRST CHECKER PATTERN
0095                    C11:
0095 96                         XCHG    AX,SI                   ; FIRST CHECKER PATTERN TO AX
0096 AB                         STOSW                           ; WRITE IT TO MEMORY
0097 96                         XCHG    AX,SI                   ; SECOND CHECKER PATTERN TO AX
0098 AB                         STOSW                           ; WRITE IT TO MEMORY
0099 E2 FA                      LOOP    C11                     ; DO IT FOR CX COUNT
                        
009B 2B F6                      SUB     SI,SI                   ; POINT TO START OF BLOCK
009D 8B CB                      MOV     CX,BX                   ; GET THE BLOCK COUNT
009F D1 E9                      SHR     CX,1                    ; DIVIDE BY 2
00A1 BF 5555                    MOV     DI,0101010101010101B    ; CHECK CORRECT
00A4 BA AAAA                    MOV     DX,1010101010101010B
00A7                    C12:
00A7 AD                         LODSW                           ; GET THE DATA
00A8 33 C7                      XOR     AX,DI                   ; CHECK CORRECT
00AA 75 DC                      JNZ     C13                     ; EXIT IF NOT
                        
00AC AD                         LODSW                           ; GET NEXT DATA
00AD 33 C2                      XOR     AX,DX                   ; CHECK SECOND PATTERN
00AF E1 F6                      LOOPZ   C12                     ; CONTINUE TILL DONE
                        
00B1 75 D5                      JNZ     C13                     ; ERROR EXIT IF NOT CORRECT
                        
                        ;-----  CHECK FOR I/O OR BASE MEMORY PARITY CHECK
                        
00B3 E4 61                      IN      AL,PORT_B               ; CHECK FOR I/O-PARITY CHECK
00B5 86 C4                      XCHG    AL,AH                   ; SAVE ERROR
00B7 E4 87                      IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
00B9 22 E0                      AND     AH,AL
                        
                        ;-----  CHECKPOINT 32 FOR ADDRESS LINE 0->15 FAILURE
                        
00BB B0 32                      MOV     AL,32H                  ;       <><><><><><><><><><><><><>
00BD E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  32 <><>
00BF B8 0000                    MOV     AX,0                    ; RESTORE AX (SET AX TO ZERO)
00C2 75 C4                      JNZ     C13                     ; EXIT IF PARITY ERROR
                        
                        ;-----  64K ADDRESS TEST AND FILL WITH ZERO
                        
00C4 48                         DEC     AX                      ; WRITE FIRST AND LAST LOCATION=FFFF
00C5 2B FF                      SUB     DI,DI                   ; POINT TO START OF BLOCK
00C7 8B CB                      MOV     CX,BX                   ; GET THE BLOCK COUNT
00C9 83 E9 02                   SUB     CX,2                    ; DO ALL LOCATIONS BUT LAST
00CC AB                         STOSW                           ; WRITE FIRST LOCATION AS FFFFH
00CD 40                         INC     AX                      ; WRITE ZERO
00CE F3/ AB                     REP     STOSW                   ; WRITE IT
00D0 48                         DEC     AX                      ; LAST WORD IS FFFF
00D1 AB                         STOSW
00D2 2B F6                      SUB     SI,SI                   ; POINT TO START OF BLOCK
00D4 8B CB                      MOV     CX,BX                   ; GET THE BLOCK COUNT
00D6 83 E9 02                   SUB     CX,2
00D9 AD                         LODSW                           ; GET THE DATA
00DA 35 FFFF                    XOR     AX,0FFFFH               ; CHECK CORRECT
00DD 75 A9                      JNZ     C13                     ; EXIT IF NOT
00DF                    C12A:
00DF AD                         LODSW                           ; GET NEXT DATA
00E0 0B C0                      OR      AX,AX                   ; ANY BIT ON ?
00E2 E1 FB                      LOOPZ   C12A                    ; CONTINUE TILL LAST WORD
00E4 75 A2                      JNZ     C13                     ; GO IF NOT CORRECT
00E6 AD                         LODSW                           ; GET LAST WORD
00E7 35 FFFF                    XOR     AX,0FFFFH               ; S/B FFFF
00EA 75 9C                      JNZ     C13                     ; EXIT IF NOT
                        
                        ;-----  CLEAR WORD 0 AND FFFE
                        
00EC 2B FF                      SUB     DI,DI                   ; CLEAR FIRST WORD
00EE AB                         STOSW
00EF BF FFFE                    MOV     DI,0FFFEH               ; CLEAR TOP WORD
00F2 AB                         STOSW
                        
                        ;-----  CHECK FOR I/O OR BASE MEMORY
                        
00F3 E4 61                      IN      AL,PORT_B               ; CHECK FOR I/O - PARITY CHECK
00F5 86 C4                      XCHG    AL,AH                   ; SAVE ERROR
00F7 E4 87                      IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
00F9 22 E0                      AND     AH,AL
00FB B8 0000                    MOV     AX,0                    ; SET AX EQUAL ZERO
00FE EB 88                      JMP     C13                     ; ERROR EXIT IF ZF NOT SET
0100                    STGTST_CNT      ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ;  PRINT ADDRESS AND ERROR MESSAGE FOR ROM CHECKSUM ERRORS                       :
                        ;--------------------------------------------------------------------------------
0100                    ROM_ERR PROC    NEAR
0100 52                         PUSH    DX                      ; SAVE POINTER
0101 06                         PUSH    ES
0102 50                         PUSH    AX
0103 B8 ---- R                  MOV     AX,DATA                 ; SET ES TO DATA SEGMENT
0106 8E C0                      MOV     ES,AX
0108 58                         POP     AX                      ; RESTORE AX
0109 50                         PUSH    AX
010A 8C DA                      MOV     DX,DS                   ; GET ADDRESS POINTER
010C 26: 88 36 0015 R           MOV     ES:@MFG_ERR_FLAG,DH     ;       <><><><><><><><><><><><><><><>
                                                                ;               <><> CHECKPOINTS C0->F4 <><>
0111 81 FA C800                 CMP     DX,0C800H               ; DISPLAY CARD IN ERROR?
0115 7C 0D                      JL      ROM_ERR_BEEP            ; GIVE DISPLAY CARD FAIL BEEP
0117 E8 0000 E                  CALL    PRT_SEG                 ; PRINT SEGMENT IN ERROR
011A BE 0000 E                  MOV     SI,OFFSET F3A           ; DISPLAY ERROR MESSAGE
011D E8 0000 E                  CALL    E_MSG
0120                    ROM_ERR_END:
0120 58                         POP     AX
0121 07                         POP     ES
0122 5A                         POP     DX
0123 C3                         RET
0124                    ROM_ERR_BEEP:
0124 BA 0102                    MOV     DX,0102H                ; BEEP 1 LONG, 2 SHORT
0127 E8 0000 E                  CALL    ERR_BEEP
012A EB F4                      JMP     SHORT ROM_ERR_END
012C                    ROM_ERR ENDP
                        ;--------------------------------------------------------------------------
                        ; THIS SUBROUTINE SENDS AN OUTPUT COMMAND TO THE KEYBOARD AND            :
                        ;       RECEIVES THE KEYBOARD RESPONSE.                                  :
                        ; ENTRY REQUIREMENTS:                                                    :
                        ;       AL = COMMAND/DATA TO BE SENT                                     :
                        ; EXIT PARAMETERS:                                                       :
                        ;       ZERO FLAG = 1 IF ACK RECEIVED FROM THE KEY BOARD                 :
                        ;       AL = RESPONSE                                                    :
                        ;--------------------------------------------------------------------------
012C                    XMIT_8042 PROC  NEAR

                        ;-----  CHECK INPUT BUFFER FULL

012C 86 E0                      XCHG    AH,AL                   ; SAVE COMMAND
012E 2B C9                      SUB     CX,CX                   ; SET LOOP TIME-OUT
0130                    XMITLOOP:
0130 E4 64                      IN      AL,STATUS_PORT
0132 A8 02                      TEST    AL,INPT_BUF_FULL        ; CHECK INPUT BUFFER FULL
0134 E0 FA                      LOOPNZ  XMITLOOP
0136 E3 34                      JCXZ    SHORT XMIT_EXIT
0138 86 E0                      XCHG    AH,AL                   ; RESTORE COMMAND

                        ;-----  ISSUE THE COMMAND

013A E6 60                      OUT     PORT_A,AL               ; SEND THE COMMAND
013C 2B C9                      SUB     CX,CX                   ; SET LOOP COUNT

                        ;-----  CHECK OUTPUT BUFFER FULL

013E E4 64              XMIT_1: IN      AL,STATUS_PORT
0140 8A E0                      MOV     AH,AL                   ; SAVE STATUS
0142 A8 01                      TEST    AL,OUT_BUF_FULL         ; CHECK IF 8042 HAS DATA
0144 74 02                      JZ      XMIT_2                  ; GO IF NOT
0146 E4 60                      IN      AL,PORT_A               ; FLUSH DATA
0148 F6 C4 02           XMIT_2: TEST    AH,INPT_BUF_FULL        ; CHECK COMMAND ACCEPTED
014B E0 F1                      LOOPNZ  XMIT_1
014D 75 1D                      JNZ     SHORT XMIT_EXIT         ; NO FLUSH OR COMMAND NOT ACCEPTED

                        ;-----  CHECK OUTPUT BUFFER FULL

014F B3 06                      MOV     BL,6                    ; SET COUNT
0151 2B C9                      SUB     CX,CX                   ; SET LOOP COUNT
0153 E4 64              XMIT_3: IN      AL,STATUS_PORT
0155 A8 01                      TEST    AL,OUT_BUF_FULL         ; CHECK IF HAS DATA
0157 E1 FA                      LOOPZ   XMIT_3                  ; WAIT TILL DONE
0159 75 08                      JNZ     XMIT_4
015B FE CB                      DEC     BL                      ; DECREMENT OUTER LOOP
015D 75 F4                      JNZ     SHORT XMIT_3            ; TRY AGAIN
015F FE C3                      INC     BL                      ; SET ERROR FLAG
0161 EB 09                      JMP     SHORT XMIT_EXIT         ; 8042 STUCK BUSY

                        ;-----  GET THE DATA

0163 2B C9              XMIT_4: SUB     CX,CX                   ; ALLOW TIME FOR POSSIBLE
                                                                ; ERROR -> SYSTEM UNIT OR KEYBOARD
0165 E2 FE              XMIT_5: LOOP    XMIT_5
0167 E4 60                      IN      AL,PORT_A
0169 83 E9 01                   SUB     CX,01H                  ; SET CX OTHER THAN ZERO
016C                    XMIT_EXIT:
016C C3                         RET
016D                    XMIT_8042 ENDP

                        ;--- BOOT_STRAP -- INT  19 H ----------------------------
                        ; BOOT STRAP LOADER                                     :
                        ;       TRACK 0, SECTOR 1 IS READ INTO THE              :
                        ;       BOOT LOCATION (SEGMENT 0 OFFSET 7C00)           :
                        ;       AND CONTROL IS TRANSFERRED THERE.               :
                        ;                                                       :
                        ;       IF THERE IS A HARDWARE ERROR CONTROL IS         :
                        ;       TRANSFERRED TO THE ROM BASIC ENTRY POINT        :
                        ;-----------------------------------------------------
                                ASSUME CS:CODE,DS:ABS0,ES:ABS0

016D                    BOOT_STRAP_1    PROC    NEAR

016D B8 ---- R                  MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
0170 8E D8                      MOV     DS,AX
0172 8E C0                      MOV     ES,AX

                        ;-----  RESET THE DISK PARAMETER TABLE VECTOR

0174 C7 06 0078 R 0000 E        MOV     WORD PTR @DISK_POINTER, OFFSET DISK_BASE
017A 8C 0E 007A R               MOV     WORD PTR @DISK_POINTER+2,CS
```

SECTION 5

```
                        ;-----  CLEAR @BOOT_LOCN
                        
01E0 33 C0                      XOR     AX,AX
01E2 B9 0100                    MOV     CX,256                  ; CLEAR 256 WORDS
01E5 BF 7C00 R                  MOV     DI,OFFSET @BOOT_LOCN
01E8 F3/ AB                     REP     STOSW
                        
                        ;-----  LOAD SYSTEM FROM DISKETTE -- CX HAS RETRY COUNT
                        
01EA FB                         STI
01EB B9 0004                    MOV     CX,4                    ; SET RETRY COUNT
01EE 51                 H1:     PUSH    CX                      ; IPL SYSTEM
01EF B4 00                      MOV     AH,0                    ; RESET THE DISKETTE SYSTEM
01F1 CD 13                      INT     13H                     ; DISKETTE_IO
01F3 72 0F                      JC      H2                      ; IF ERROR, TRY AGAIN
                        
01F5 B8 0201                    MOV     AX,201H                 ; READ IN THE SINGLE SECTOR
01F8 2B D2                      SUB     DX,DX                   ; TO THE BOOT LOCATION
01FA 8E C2                      MOV     ES,DX
01FC BB 7C00 R                  MOV     BX,OFFSET @BOOT_LOCN    ; DRIVE 0, HEAD 0
01FF B9 0001                    MOV     CX,1                    ; SECTOR 1, TRACK 0
0202 CD 13                      INT     13H                     ; DISKETTE IO
0204 59                 H2:     POP     CX                      ; RECOVER RETRY COUNT
0205 73 09                      JNC     H4                      ; CARRY FLAG SET BY UNSUCCESSFUL READ
0207 80 FC 80                   CMP     AH,80H                  ; IF TIME OUT, NO RETRY
020A 74 22                      JZ      H5                      ; TRY FIXED DISK
020C E2 E0                      LOOP    H1                      ; DO IT FOR RETRY TIMES
020E EB 1E                      JMP     SHORT H5                ; TRY FIXED DISK
                        
                        ;-----  BOOT RECORD READ SUCCESSFUL
                        ;-----  INSURE FIRST BYTE OF LOADED BOOT RECORD IS VALID (NOT ZERO)
                        
0210 80 3E 7C00 R 06    H4:     CMP     BYTE PTR @BOOT_LOCN,06H ; CHECK FOR FIRST INSTRUCTION INVALID
0215 72 71                      JB      H10                     ; IF BOOT NOT VALID PRINT MESSAGE HALT
                        
                        ;-----  INSURE DATA PATTERN FIRST 8 WORDS NOT ALL EQUAL
                        
0217 BF 7C00 R                  MOV     DI,OFFSET @BOOT_LOCN    ; CHECK DATA PATTERN
021A B9 0008                    MOV     CX,8                    ; CHECK THE NEXT 8 WORDS
021D A1 7C00 R                  MOV     AX,WORD PTR @BOOT_LOCN
                        
0220 83 C7 02           H4A:    ADD     DI,2                    ; POINT TO NEXT LOCATION
0223 3B 05                      CMP     AX,[DI]                 ; CHECK DATA PATTERN FOR A FILL PATTERN
0225 E1 F9                      LOOPZ   H4A
0227 74 5F                      JZ      H10                     ; BOOT NOT VALID PRINT MESSAGE HALT
                        
0229 EA 7C00 ---- R     H4_A:   JMP     @BOOT_LOCN
                        
                        ;-----  ATTEMPT BOOTSTRAP FROM FIXED DISK
                        
022E B0 44              H5:     MOV     AL,044H                 ;       <><><><><><><><><><><><>
0230 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  44 <><>
                                ASSUME  DS:DATA
0232 E8 0000 E                  CALL    DDS
0235 F6 06 0088 R 01            TEST    @LASTRATE,DUAL          ; FLOPPY/FIXED DISK CARD INSTALLED
                                ASSUME  DS:ABS0
023A B8 ---- R                  MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
023D 8E D8                      MOV     DS,AX
023F 74 3D                      JZ      H9                      ; GO IF NOT
                        
                        ;-----  CHECK FOR FIXED DISK INITIALIZATION ERROR
                        
0241 B0 0E                      MOV     AL,CMOS_DIAG            ; GET POST POWER ON STATUS (NMI ENABLED)
0243 E8 0000 E                  CALL    CMOS_READ               ; FROM DIAGNOSTIC STATUS BYTE
0246 A8 08                      TEST    AL,HF_FAIL              ; DID WE HAVE A FIXED DISK FAILURE?
0248 75 34                      JNZ     H9                      ; GO IF YES
                        
024A 2B C0                      SUB     AX,AX                   ; RESET DISKETTE
024C 2B D2                      SUB     DX,DX
024E CD 13                      INT     13H
0250 B9 0003                    MOV     CX,3                    ; RETRY COUNT
0253                    H6:
0253 51                         PUSH    CX                      ; SAVE RETRY COUNT
0254 BA 0080                    MOV     DX,0080H                ; FIXED DISK ZERO
0257 B8 0201                    MOV     AX,0201H                ; READ IN A SINGLE SECTOR
025A 2B DB                      SUB     BX,BX
025C 8E C3                      MOV     ES,BX
025E BB 7C00 R                  MOV     BX,OFFSET @BOOT_LOCN    ; TO THE BOOT LOCATION
0261 B9 0001                    MOV     CX,1                    ; SECTOR 1, TRACK 0
0264 CD 13                      INT     13H                     ; FILE I/O CALL
0266 59                         POP     CX                      ; RECOVER RETRY COUNT
0267 72 08                      JC      H8
0269 81 3E 7DFE R AA55          CMP     WORD PTR @BOOT_LOCN+510D,0AA55H ; TEST FOR GENERIC BOOT BLOCK
026F 74 B8                      JZ      H4_A
                        
0271 51                 H8:     PUSH    CX
0272 BA 0080                    MOV     DX,0080H                ; FIXED DISK ZERO
0275 2B C0                      SUB     AX,AX                   ; RESET THE FIXED DISK
0277 CD 13                      INT     13H                     ; FILE I/O CALL
0279 59                         POP     CX                      ; RESTORE LOOP COUNT
027A 72 08                      JC      H10A                    ; IF ERROR, TRY AGAIN
027C E2 D5                      LOOP    H6                      ; DO IT FOR RETRY TIMES
                        
                        ;-----  UNABLE TO IPL FROM THE DISKETTE OR FIXED DISK
                        
027E B0 45              H9:     MOV     AL,045H                 ;       <><><><><><><><><><><><>
0280 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  45 <><>
                        
0282 CD 18                      INT     18H                     ; GO TO RESIDENT BASIC
                        
                        ;-----  HARD FILE RESET FAILURE
                        
0284 EB FE              H10A:   LOOP    H8                      ; TRY RESET AGAIN
0286 EB F6                      JMP     H9                      ; GO TO RESIDENT BASIC
                        
                        ;-----  IF DISKETTE READ OK BUT BOOT RECORD IS NOT STOP SYSTEM ALLOW SOFT RESET
                        
0288 BE 0000 E          H10:    MOV     SI,OFFSET E602          ; PRINT DISKETTE BOOT
028B E8 0000 E                  CALL    E_MSG                   ; PRINT MESSAGE
028E EB FE              H11:    JMP     H11
0290                    BOOT_STRAP_1    ENDP
0290                    POST6   ENDP
0290                    CODE    ENDS
                                END
```

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                        PAGE 118,121
                        TITLE DSKETTE -- 06/10/85  DISKETTE BIOS
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  DISK_INT_1
                                PUBLIC  SEEK
                                PUBLIC  DSKETTE_SETUP
                                PUBLIC  DISKETTE_IO_1

                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   DISK_BASE:NEAR          ; DISKETTE PARAMETER TABLE LOCATION
                                EXTRN   WAITF:NEAR              ; FIXED WAIT ROUTINE - (CX)*15.086 US

                        ;-- INT 13H ------------------------------------------------------------------
                        ; DISKETTE I/O
                        ;       THIS INTERFACE PROVIDES ACCESS TO THE 5 1/4" DISKETTE DRIVES
                        ;       320/360K DISKETTE DRIVES AND 1.2M DISKETTE DRIVES SUPPORTED
                        ; INPUT
                        ;       (AH)= 00H  RESET DISKETTE SYSTEM
                        ;                  HARD RESET TO NEC, PREPARE COMMAND, RECALIBRATE REQUIRED
                        ;                  ON ALL DRIVES
                        ;-------------------------------------------------------------------------------
                        ;       (AH)= 01H  READ THE STATUS OF THE SYSTEM INTO (AH)
                        ;                  @DSKETTE_STATUS FROM LAST OPERATION IS USED
                        ;-------------------------------------------------------------------------------
                        ;       REGISTERS FOR READ/WRITE/VERIFY/FORMAT
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;       (DH) - HEAD NUMBER (0-1 ALLOWED, NOT VALUE CHECKED)
                        ;       (CH) - TRACK NUMBER (NOT VALUE CHECKED)
                        ;                MEDIA      DRIVE          TRACK NUMBER
                        ;              320/360    320/360            0-39
                        ;              320/360     1.2M              0-39
                        ;               1.2M       1.2M              0-79
                        ;               720K       720K              0-79
                        ;       (CL) - SECTOR NUMBER (NOT VALUE CHECKED, NOT USED FOR FORMAT)
                        ;                MEDIA      DRIVE          SECTOR NUMBER
                        ;              320/360    320/360             1-8/9
                        ;              320/360     1.2M               1-8/9
                        ;               1.2M       1.2M               1-15
                        ;               720K       720K               1-9
                        ;       (AL) - NUMBER OF SECTORS (NOT VALUE CHECKED)
                        ;                MEDIA      DRIVE          MAX NUMBER OF SECTORS
                        ;              320/360    320/360              8/9
                        ;              320/360     1.2M                8/9
                        ;               1.2M       1.2M                15
                        ;               720K       720K                9
                        ;
                        ;       (ES:BX) - ADDRESS OF BUFFER ( REQUIRED FOR VERIFY)
                        ;
                        ;-------------------------------------------------------------------------------
                        ;       (AH)= 02H  READ THE DESIRED SECTORS INTO MEMORY
                        ;-------------------------------------------------------------------------------
                        ;       (AH)= 03H  WRITE THE DESIRED SECTORS FROM MEMORY
                        ;-------------------------------------------------------------------------------
                        ;       (AH)= 04H  VERIFY THE DESIRED SECTORS
                        ;-------------------------------------------------------------------------------
                        ;       (AH)= 05H  FORMAT THE DESIRED TRACK
                        ;                  FOR THE FORMAT OPERATION, THE BUFFER POINTER (ES,BX) MUST
                        ;                  POINT TO THE COLLECTION OF DESIRED ADDRESS FIELDS FOR THE
                        ;                  TRACK.  EACH FIELD IS COMPOSED OF 4 BYTES, (C,H,R,N), WHERE
                        ;                  C = TRACK NUMBER, H=HEAD NUMBER, R = SECTOR NUMBER, N= NUMBER
                        ;                  OF BYTES PER SECTOR (00=128, 01=256, 02=512, 03=1024,)
                        ;                  THERE MUST BE ONE ENTRY FOR EVERY SECTOR ON THE TRACK.
                        ;                  THIS INFORMATION IS USED TO FIND THE REQUESTED SECTOR DURING
                        ;                  READ/WRITE ACCESS.
                        ;                  PRIOR TO FORMATTING A DISKETTE, IF THERE EXISTS MORE THAN
                        ;                  ONE SUPPORTED MEDIA FORMAT TYPE WITHIN THE DRIVE IN QUESTION,
                        ;                  THEN "SET DASD TYPE" (INT 13H, AH = 17H) MUST BE CALLED TO
                        ;                  SET THE DISKETTE TYPE THAT IS TO BE FORMATTED.  IF "SET DASD
                        ;                  TYPE" IS NOT CALLED, THE FORMAT ROUTINE WILL ASSUME THE
                        ;                  MEDIA FORMAT TO BE THE MAXIMUM CAPACITY OF THE DRIVE.
                        ;                  IN ORDER TO FORMAT 320/360K MEDIA IN EITHER A 320/360K OR
                        ;                  1.2M DISKETTE DRIVE THE GAP LENGTH FOR FORMAT PARAMETER
                        ;                  OF DISK_BASE MUST BE CHANGE TO 050H.  ALSO THE EOT
                        ;                  PARAMETER (LAST SECTOR ON TRACK) MUST BE SET TO THE
                        ;                  DESIRED NUMBER OF SECTORS/TRACK - 8 FOR 320K, 9 FOR 360K.
                        ;                  DISK_BASE IS POINTED TO BY DISK POINTER LOCATED AT
                        ;                  ABSOLUTE ADDRESS 0:78.
                        ;                  WHEN 320/360K FORMAT OPERATIONS ARE COMPLETE, THE PARAMETERS
                        ;                  SHOULD BE RESTORED TO THEIR RESPECTIVE INITIAL VALUES.
                        ;-------------------------------------------------------------------------------
                        ;       (AH)= 08H  READ DRIVE PARAMETERS
                        ;       REGISTERS
                        ;         INPUT
                        ;           (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;         OUTPUT
                        ;           (ES:DI) POINTS TO DISK BASE
                        ;           (CH) - LOW ORDER 8 OF 10 BITS MAXIMUM NUMBER OF TRACKS
                        ;           (CL) - BITS 7 & 6 - HIGH ORDER TWO BITS OF MAXIMUM TRACKS
                        ;                - BITS 5 THRU 0 - MAXIMUM SECTORS PER TRACK
                        ;           (DH) - MAXIMUM HEAD NUMBER
                        ;           (DL) - NUMBER OF DISKETTE DRIVES INSTALLED
                        ;           (BH) - 0
                        ;           (BL) - BITS 7 THRU 4 - 0
                        ;                  BITS 3 THRU 0 - VALID DRIVE TYPE VALUE IN CMOS
                        ;           (AX) - 0
                        ;         UNDER THE FOLLOWING CIRCUMSTANCES:
                        ;           (1) THE DRIVE NUMBER IS INVALID,
                        ;           (2) THE DRIVE TYPE IS UNKNOWN AND CMOS IS NOT PRESENT,
                        ;           (3) THE DRIVE TYPE IS UNKNOWN AND CMOS IS BAD,
                        ;           (4) OR THE DRIVE TYPE IS UNKNOWN AND THE CMOS DRIVE TYPE IS INVALID
                        ;         THEN ES,AX,BX,CX,DH,DI=0 ; DL=NUMBER OF DRIVES.
                        ;         IF NO DRIVES ARE PRESENT THEN: ES,AX,BX,CX,DX,DI=0.
                        ;         @DSKETTE_STATUS = 0 AND CY IS RESET.
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ;       (AH)= 15H  READ DASD TYPE
                        ;       REGISTERS
                        ;       (AH) - ON RETURN IF CARRY FLAG NOT SET, OTHERWISE ERROR
                        ;                00 - DRIVE NOT PRESENT
                        ;                01 - DISKETTE, NO CHANGE LINE AVAILABLE
                        ;                02 - DISKETTE, CHANGE LINE AVAILABLE
                        ;                03 - FIXED DISK
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;
                        ;--------------------------------------------------------------------------------
                        ;       (AH)= 16H  DISK CHANGE LINE STATUS
                        ;       REGISTERS
                        ;       (AH)=00 - DISK CHANGE LINE NOT ACTIVE
                        ;            06 - DISK CHANGE LINE ACTIVE & CARRY BIT ON
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;
                        ;--------------------------------------------------------------------------------
                        ;       (AH)= 17H  SET DASD TYPE FOR FORMAT
                        ;       REGISTERS
                        ;       (AL) -   00 - NOT USED
                        ;                01 - DISKETTE 320/360K IN 360K DRIVE
                        ;                02 - DISKETTE 360K IN 1.2M DRIVE
                        ;                03 - DISKETTE 1.2M IN 1.2M DRIVE
                        ;                04 - DISKETTE 720K IN 720K DRIVE
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED;
                        ;              DO NOT USE WHEN DISKETTE ATTACH CARD USED)
                        ;--------------------------------------------------------------------------------
                        ;       DISK CHANGE STATUS IS ONLY CHECKED WHEN A 1.2M BYTE DISKETTE
                        ;       DRIVE IS SPECIFIED.  IF THE DISK CHANGE LINE IS FOUND TO BE
                        ;       ACTIVE THE FOLLOWING ACTIONS TAKE PLACE:
                        ;                ATTEMPT TO RESET DISK CHANGE LINE TO INACTIVE STATE.
                        ;                IF ATTEMPT SUCCEEDS SET DASD TYPE FOR FORMAT AND RETURN DISK
                        ;                CHANGE ERROR CODE
                        ;                IF ATTEMPT FAILS RETURN TIMEOUT ERROR CODE AND SET DASD TYPE
                        ;                TO A PREDETERMINED STATE INDICATING MEDIA TYPE UNKNOWN.
                        ;       IF THE DISK CHANGE LINE IN INACTIVE PERFORM SET DASD TYPE FOR FORMAT.
                        ;
                        ; DATA VARIABLE -- @DISK_POINTER
                        ;       DOUBLE WORD POINTER TO THE CURRENT SET OF DISKETTE PARAMETERS
                        ;--------------------------------------------------------------------------------
                        ; OUTPUT FOR ALL FUNCTIONS
                        ;       AH = STATUS OF OPERATION
                        ;                STATUS BITS ARE DEFINED IN THE EQUATES FOR @DSKETTE_STATUS
                        ;                VARIABLE IN THE DATA SEGMENT OF THIS MODULE
                        ;       CY = 0   SUCCESSFUL OPERATION (AH=0 ON RETURN, EXCEPT FOR READ DASD
                        ;                TYPE AH=(15)).
                        ;       CY = 1   FAILED OPERATION (AH HAS ERROR REASON)
                        ;       FOR READ/WRITE/VERIFY
                        ;                DS,BX,DX,CX PRESERVED
                        ;       NOTE: IF AN ERROR IS REPORTED BY THE DISKETTE CODE, THE APPROPRIATE
                        ;                ACTION IS TO RESET THE DISKETTE, THEN RETRY THE OPERATION.
                        ;                ON READ ACCESSES, NO MOTOR START DELAY IS TAKEN, SO THAT
                        ;                THREE RETRIES ARE REQUIRED ON READS TO ENSURE THAT THE
                        ;                PROBLEM IS NOT DUE TO MOTOR START-UP.
                        ;--------------------------------------------------------------------------------
                        .LIST
                        ; DISKETTE STATE MACHINE - ABSOLUTE ADDRESS 40:90 (DRIVE A) & 91 (DRIVE B)
                        .LIST
                        ;   ---------------------------------------------------------------
                        ;   |       |       |       |       |       |       |       |       |
                        ;   |   7   |   6   |   5   |   4   |   3   |   2   |   1   |   0   |
                        ;   |       |       |       |       |       |       |       |       |
                        ;   ---------------------------------------------------------------
                        ;       |       |       |       |       |       |       |       |
                        ;       |       |       |       |       |       ---------------
                        ;       |       |       |       |       |               |
                        ;       |       |       |       |   RESERVED            |
                        ;       |       |       |       |                   PRESENT STATE
                        ;       |       |       |       |       000: 360K IN 360K DRIVE UNESTABLISHED
                        ;       |       |       |       |       001: 360K IN 1.2M DRIVE UNESTABLISHED
                        ;       |       |       |       |       010: 1.2M IN 1.2M DRIVE UNESTABLISHED
                        ;       |       |       |       |       011: 360K IN 360K DRIVE ESTABLISHED
                        ;       |       |       |       |       100: 360K IN 1.2M DRIVE ESTABLISHED
                        ;       |       |       |       |       101: 1.2M IN 1.2M DRIVE ESTABLISHED
                        ;       |       |       |       |       110: RESERVED
                        ;       |       |       |       |       111: NONE OF THE ABOVE
                        ;       |       |       |       |
                        ;       |       |       |       ------> MEDIA/DRIVE ESTABLISHED
                        ;       |       |       |
                        ;       |       |       ---------------> DOUBLE STEPPING REQUIRED (360K IN 1.2M
                        ;       |       |                         DRIVE)
                        ;       |       |
                        ;       ---------------------------------> DATA TRANSFER RATE FOR THIS DRIVE:
                        ;
                        ;                                               00: 500 KBS
                        ;                                               01: 300 KBS
                        ;                                               10: 250 KBS
                        ;                                               11: RESERVED
                        ;
                        .LIST
                        ;--------------------------------------------------------------------------------
                        ; STATE OPERATION STARTED - ABSOLUTE ADDRESS 40:92 (DRIVE A) & 93 (DRIVE B)
                        ;--------------------------------------------------------------------------------
                        ; PRESENT CYLINDER NUMBER - ABSOLUTE ADDRESS 40:94 (DRIVE A) & 95 (DRIVE B)
                        ;--------------------------------------------------------------------------------
```

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                        PAGE
                                ASSUME  CS:CODE,DS:DATA,ES:DATA
                        .LIST
0000                    DISKETTE_IO_1   PROC    FAR             ;>>> ENTRY POINT FOR ORG 0EC59H
0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 55                         PUSH    BP                      ; USER REGISTER
0002 57                         PUSH    DI                      ; USER REGISTER
0003 52                         PUSH    DX                      ; HEAD #, DRIVE # OR USER REGISTER
0004 53                         PUSH    BX                      ; BUFFER OFFSET PARAMETER OR REGISTER
0005 51                         PUSH    CX                      ; TRACK #-SECTOR # OR USER REGISTER
0006 8B EC                      MOV     BP,SP                   ; BP    => PARAMETER LIST DEP. ON AH
                                                                ; [BP]    = SECTOR #
                                                                ; [BP+1] = TRACK #
                                                                ; [BP+2] = BUFFER OFFSET
                                                                ; FOR RETURN OF DRIVE PARAMETERS:
                                                                ; CL/[BP] = BITS 7&6 HI BITS OF MAX CYL
                                                                ;           BITS 0-5 MAX SECTORS/TRACK
                                                                ; CH/[BP+1] = LOW 8 BITS OF MAX CYL.
                                                                ; BL/[BP+2] = BITS 7-4 = 0
                                                                ;           BITS 3-0 = VALID CMOS TYPE
                                                                ; BH/[BP+3] = 0
                                                                ; DL/[BP+4] = # DRIVES INSTALLED
                                                                ; DH/[BP+5] = MAX HEAD #
                                                                ; DI/[BP+6] = OFFSET TO DISK BASE
0008 1E                         PUSH    DS                      ; BUFFER SEGMENT PARM OR USER REGISTER
0009 56                         PUSH    SI                      ; USER REGISTERS
000A E8 0000 E                  CALL    DDS                     ; SEGMENT OF BIOS DATA AREA TO DS
000D 80 FC 18                   CMP     AH,(FNC_TAE-FNC_TAB)/2  ; CHECK FOR > LARGEST FUNCTION
0010 72 02                      JB      OK_FUNC                 ; FUNCTION OK

0012 B4 14                      MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION
0014                    OK_FUNC:
0014 80 FC 01                   CMP     AH,1                    ; RESET OR STATUS ?
0017 76 0C                      JBE     OK_DRV                  ; IF RESET OR STATUS DRIVE ALWAYS OK
0019 80 FC 08                   CMP     AH,8                    ; READ DRIVE PARMS ?
001C 74 07                      JZ      OK_DRV                  ; IF SO DRIVE CHECKED LATER
001E 80 FA 01                   CMP     DL,1                    ; DRIVES 0 AND 1 OK
0021 76 02                      JBE     OK_DRV                  ; IF 0 OR 1 THEN JUMP
0023 B4 14                      MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION
0025                    OK_DRV:
0025 8A CC                      MOV     CL,AH                   ; CL = FUNCTION
0027 32 ED                      XOR     CH,CH                   ; CX = FUNCTION
0029 D0 E1                      SHL     CL,1                    ; FUNCTION TIMES 2
002B BB 004E R                  MOV     BX,OFFSET FNC_TAB       ; LOAD START OF FUNCTION TABLE
002E 03 D9                      ADD     BX,CX                   ; ADD OFFSET INTO TABLE => ROUTINE
0030 8A E6                      MOV     AH,DH                   ; AX = HEAD #,# OF SECTORS OR DASD TYPE
0032 32 F6                      XOR     DH,DH                   ; DX = DRIVE #
0034 8B F0                      MOV     SI,AX                   ; SI = HEAD #,# OF SECTORS OR DASD TYPE
0036 8B FA                      MOV     DI,DX                   ; DI = DRIVE #
0038 8A 26 0041 R               MOV     AH,@DSKETTE_STATUS      ; LOAD STATUS TO AH FOR STATUS FUNCTION
003C C6 06 0041 R 00            MOV     @DSKETTE_STATUS,0       ; INITIALIZE FOR ALL OTHERS

                        ;       THROUGHOUT THE DISKETTE BIOS, THE FOLLOWING INFORMATION IS CONTAINED IN
                        ;       THE FOLLOWING MEMORY LOCATIONS AND REGISTERS. NOT ALL DISKETTE BIOS
                        ;       FUNCTIONS REQUIRE ALL OF THESE PARAMETERS.
                        ;
                        ;               DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS OR DASD TYPE FOR FORMAT
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1] : TRACK #
                        ;               [BP+2] : BUFFER OFFSET
                        ;
                        ;       ACROSS CALLS TO SUBROUTINES THE CARRY FLAG (CY=1), WHERE INDICATED IN
                        ;       SUBROUTINE PROLOGUES, REPRESENTS AN EXCEPTION RETURN (NORMALLY AN ERROR
                        ;       CONDITION). IN MOST CASES, WHEN CY = 1, @DSKETTE_STATUS CONTAINS THE
                        ;       SPECIFIC ERROR CODE.
                                                                ; (AH) = @DSKETTE_STATUS
0041 2E: FF 17                  CALL    WORD PTR CS:[BX]        ; CALL THE REQUESTED FUNCTION
0044 5E                         POP     SI                      ; RESTORE ALL REGISTERS
0045 1F                         POP     DS
0046 59                         POP     CX
0047 5B                         POP     BX
0048 5A                         POP     DX
0049 5F                         POP     DI
004A 5D                         POP     BP
004B CA 0002                    RET     2                       ; THROW AWAY SAVED FLAGS

                        ;--------------------------------------------------------------------------------
004E 007E R             FNC_TAB DW      DISK_RESET              ; AH = 00; RESET
0050 00EB R                     DW      DISK_STATUS             ; AH = 01; STATUS
0052 00F4 R                     DW      DISK_READ               ; AH = 02; READ
0054 0100 R                     DW      DISK_WRITE              ; AH = 03; WRITE
0056 010C R                     DW      DISK_VERF               ; AH = 04; VERIFY
0058 0118 R                     DW      DISK_FORMAT             ; AH = 05; FORMAT
005A 016A R                     DW      FNC_ERR                 ; AH = 06; INVALID
005C 016A R                     DW      FNC_ERR                 ; AH = 07; INVALID
005E 0174 R                     DW      DISK_PARMS              ; AH = 08; READ DRIVE PARAMETERS
0060 016A R                     DW      FNC_ERR                 ; AH = 09; INVALID
0062 016A R                     DW      FNC_ERR                 ; AH = 0A; INVALID
0064 016A R                     DW      FNC_ERR                 ; AH = 0B; INVALID
0066 016A R                     DW      FNC_ERR                 ; AH = 0C; INVALID
0068 016A R                     DW      FNC_ERR                 ; AH = 0D; INVALID
006A 016A R                     DW      FNC_ERR                 ; AH = 0E; INVALID
006C 016A R                     DW      FNC_ERR                 ; AH = 0F; INVALID
006E 016A R                     DW      FNC_ERR                 ; AH = 10; INVALID
0070 016A R                     DW      FNC_ERR                 ; AH = 11; INVALID
0072 016A R                     DW      FNC_ERR                 ; AH = 12; INVALID
0074 016A R                     DW      FNC_ERR                 ; AH = 13; INVALID
0076 016A R                     DW      FNC_ERR                 ; AH = 14; INVALID
0078 021A R                     DW      DISK_TYPE               ; AH = 15; READ DASD TYPE
007A 023C R                     DW      DISK_CHANGE             ; AH = 16; CHANGE STATUS
007C 0267 R                     DW      FORMAT_SET              ; AH = 17; SET DASD TYPE
= 007E                  FNC_TAE EQU     $                       ; END

007E                    DISKETTE_IO_1   ENDP
```

```
                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; DISK_RESET:   RESET THE DISKETTE SYSTEM.
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------------
007E                    DISK_RESET      PROC    NEAR
007E BA 03F2                    MOV     DX,03F2H                ; ADAPTER CONTROL PORT
0081 FA                         CLI                             ; NO INTERRUPTS
0082 A0 003F R                  MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
0085 24 3F                      AND     AL,00111111B            ; KEEP SELECTED AND MOTOR ON BITS
0087 C0 C0 04                   ROL     AL,4                    ; MOTOR VALUE TO HIGH NIBBLE
                                                                ; DRIVE SELECT TO LOW NIBBLE
008A 0C 08                      OR      AL,00001000B            ; TURN ON INTERRUPT ENABLE
008C EE                         OUT     DX,AL                   ; RESET THE ADAPTER
008D C6 06 003E R 00            MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
0092 EB 00                      JMP     $+2                     ; WAIT FOR I/O
0094 0C 04                      OR      AL,00000100B            ; TURN OFF RESET BIT
0096 EE                         OUT     DX,AL                   ; RESET THE ADAPTER
0097 FB                         STI                             ; ENABLE THE INTERRUPTS
0098 E8 087C R                  CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
009B 72 44                      JC      DR_ERR                  ; IF ERROR, RETURN IT
009D B9 00C0                    MOV     CX,11000000B            ; CL = EXPECTED @NEC_STATUS

00A0                    NXT_DRV:
00A0 51                         PUSH    CX                      ; SAVE FOR CALL
00A1 B8 00E0 R                  MOV     AX,OFFSET DR_POP_ERR    ; LOAD NEC_OUTPUT ERROR ADDRESS
00A4 50                         PUSH    AX                      ; "
00A5 B4 08                      MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
00A7 E8 07BD R                  CALL    NEC_OUTPUT
00AA 58                         POP     AX                      ; THROW AWAY ERROR RETURN
00AB E8 08A4 R                  CALL    RESULTS                 ; READ IN THE RESULTS
00AE 59                         POP     CX                      ; RESTORE AFTER CALL
00AF 72 30                      JC      DR_ERR                  ; ERROR RETURN
00B1 3A 0E 0042 R               CMP     CL,@NEC_STATUS          ; TEST FOR DRIVE READY TRANSITION
00B5 75 2A                      JNZ     DR_ERR                  ; EVERYTHING OK
00B7 FE C1                      INC     CL                      ; NEXT EXPECTED @NEC_STATUS
00B9 80 F9 C3                   CMP     CL,11000011B            ; ALL POSSIBLE DRIVES CLEARED
00BC 76 E2                      JBE     NXT_DRV                 ; FALL THRU IF 11000100B OR >

                        ;-----  SEND SPECIFY COMMAND TO NEC

00BE B8 00D8 R                  MOV     AX,OFFSET RESBAC        ; LOAD ERROR ADDRESS
00C1 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
00C2 B4 03                      MOV     AH,03H                  ; SPECIFY COMMAND
00C4 E8 07BD R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
00C7 2A D2                      SUB     DL,DL                   ; FIRST SPECIFY BYTE
00C9 E8 06CC R                  CALL    GET_PARM                ; GET PARAMETER TO AH
00CC E8 07BD R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
00CF B2 01                      MOV     DL,1                    ; SECOND SPECIFY BYTE
00D1 E8 06CC R                  CALL    GET_PARM                ; GET PARAMETER TO AH
00D4 E8 07BD R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
00D7 58                         POP     AX                      ; POP ERROR RETURN
00D8                    RESBAC:
00D8 E8 0620 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
00DB 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
00DD 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
00DF C3                         RET

00E0                    DR_POP_ERR:
00E0 59                         POP     CX                      ; CLEAR STACK
00E1                    DR_ERR:
00E1 80 0E 0041 R 20            OR      @DSKETTE_STATUS,BAD_NEC ; SET ERROR CODE
00E6 EB F0                      JMP     SHORT RESBAC            ; RETURN FROM RESET
00E8                    DISK_RESET      ENDP

                        ;--------------------------------------------------------------------------------
                        ; DISK_STATUS:  DISKETTE STATUS.
                        ;
                        ; ON ENTRY:     AH : STATUS OF PREVIOUS OPERATION
                        ;
                        ; ON EXIT:      AH, @DSKETTE_STATUS, CY REFLECT STATUS OF PREVIOUS OPERATION.
                        ;--------------------------------------------------------------------------------
00E8                    DISK_STATUS     PROC    NEAR
00E8 88 26 0041 R               MOV     @DSKETTE_STATUS,AH      ; PUT BACK FOR SETUP_END
00EC E8 0620 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
00EF 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
00F1 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
00F3 C3                         RET
00F4                    DISK_STATUS     ENDP
                        ;--------------------------------------------------------------------------------
                        ; DISK_READ:    DISKETTE READ.
                        ;
                        ; ON ENTRY:     DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------------
00F4                    DISK_READ       PROC    NEAR
00F4 80 26 003F R 7F            AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
00F9 B8 E646                    MOV     AX,0E646H               ; AX = NEC COMMAND, DMA COMMAND
00FC E8 035C R                  CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
00FF C3                         RET
0100                    DISK_READ       ENDP
                        ;--------------------------------------------------------------------------------
                        ; DISK_WRITE:   DISKETTE WRITE.
                        ;
                        ; ON ENTRY:     DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------------
0100                    DISK_WRITE      PROC    NEAR
0100 B8 C54A                    MOV     AX,0C54AH               ; AX = NEC COMMAND, DMA COMMAND
```

```
0103 80 0E 003F R 80            OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
0108 E8 035C R                  CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
010B C3                         RET
010C                    DISK_WRITE      ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_VERF:    DISKETTE VERIFY.
                        ;
                        ; ON ENTRY:     DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------
010C                    DISK_VERF       PROC    NEAR
010C 80 26 003F R 7F            AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
0111 B8 E642                    MOV     AX,0E642H               ; AX = NEC COMMAND, DMA COMMAND
0114 E8 035C R                  CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
0117 C3                         RET
0118                    DISK_VERF       ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_FORMAT:  DISKETTE FORMAT.
                        ;
                        ; ON ENTRY:     DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------
0118                    DISK_FORMAT     PROC    NEAR
0118 E8 02C8 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
011B E8 03CE R                  CALL    FMT_INIT                ; ESTABLISH STATE IF UNESTABLISHED
011E 80 0E 003F R 80            OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
0123 E8 0416 R                  CALL    MED_CHANGE              ; CHECK MEDIA CHANGE AND RESET IF SO
0126 72 37                      JC      FM_DON                  ; MEDIA CHANGED, SKIP
0128 E8 0451 R                  CALL    SEND_RATE               ; SEND DATA RATE TO CONTROLLER
012B B0 4A                      MOV     AL,04AH                 ; WILL WRITE TO THE DISKETTE
012D E8 0471 R                  CALL    DMA_SETUP               ; SET UP THE DMA
0130 72 2D                      JC      FM_DON                  ; RETURN WITH ERROR
0132 B4 4D                      MOV     AH,04DH                 ; ESTABLISH THE FORMAT COMMAND
0134 E8 04C7 R                  CALL    NEC_INIT                ; INITIALIZE THE NEC
0137 B8 015F R                  MOV     AX,OFFSET FM_DON        ; LOAD ERROR ADDRESS
013A 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
013B B2 03                      MOV     DL,3                    ; BYTES/SECTOR VALUE TO NEC
013D E8 06CC R                  CALL    GET_PARM
0140 E8 07BD R                  CALL    NEC_OUTPUT
0143 B2 04                      MOV     DL,4                    ; SECTORS/TRACK VALUE TO NEC
0145 E8 06CC R                  CALL    GET_PARM
0148 E8 07BD R                  CALL    NEC_OUTPUT
014B B2 07                      MOV     DL,7                    ; GAP LENGTH VALUE TO NEC
014D E8 06CC R                  CALL    GET_PARM
0150 E8 07BD R                  CALL    NEC_OUTPUT
0153 B2 08                      MOV     DL,8                    ; FILLER BYTE TO NEC
0155 E8 06CC R                  CALL    GET_PARM
0158 E8 07BD R                  CALL    NEC_OUTPUT
015B 58                         POP     AX                      ; THROW AWAY ERROR
015C E8 0530 R                  CALL    NEC_TERM                ; TERMINATE, RECEIVE STATUS, ETC.
015F                    FM_DON:
015F E8 02EE R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0162 E8 0620 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
0165 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
0167 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
0169 C3                         RET
016A                    DISK_FORMAT     ENDP
                        ;--------------------------------------------------------------------------
                        ; FNC_ERR :     INVALID FUNCTION REQUESTED OR INVALID DRIVE; SET BAD COMMAND IN
                        ;               STATUS.
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------
016A                    FNC_ERR PROC    NEAR                    ; INVALID FUNCTION REQUEST
016A 8B C6                      MOV     AX,SI                   ; RESTORE AL
016C B4 01                      MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR
016E 88 26 0041 R               MOV     @DSKETTE_STATUS,AH      ; STORE IN DATA AREA
0172 F9                         STC                             ; SET CARRY INDICATING ERROR
0173 C3                         RET
0174                    FNC_ERR ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_PARMS:   READ DRIVE PARAMETERS.
                        ;
                        ; ON ENTRY:     DI : DRIVE #
                        ;
                        ; ON EXIT:      CL/[BP]    = BITS 7 & 6 HIGH 2 BITS OF MAX CYLINDER
                        ;                             BITS 0-5 MAX SECTORS/TRACK
                        ;               CH/[BP+1] = LOW 8 BITS OF MAX CYLINDER
                        ;               BL/[BP+2] = BITS 7-4 = 0
                        ;                           BITS 3-0 = VALID CMOS DRIVE TYPE
                        ;               BH/[BP+3] = 0
                        ;               DL/[BP+4] = # DRIVES INSTALLED  (VALUE CHECKED)
                        ;               DH/[BP+5] = MAX HEAD #
                        ;               DI/[BP+6] = OFFSET OF DISK_BASE
                        ;               ES        = SEGMENT OF DISK_BASE
                        ;               AX        = 0
                        ;
                        ;               NOTE : THE ABOVE INFORMATION IS STORED IN THE USERS STACK AT
                        ;                      THE LOCATIONS WHERE THE MAIN ROUTINE WILL POP THEM
                        ;                      INTO THE APPROPRIATE REGISTERS BEFORE RETURNING TO THE
                        ;                      CALLER.
                        ;--------------------------------------------------------------------------
0174                    DISK_PARMS      PROC    NEAR
0174 81 FF 0080                 CMP     DI,80H                  ; CHECK FOR FIXED MEDIA TYPE REQUEST
0178 72 06                      JB      DISK_P2                 ; CONTINUE IF NOT REQUEST FALL THROUGH

                        ;-----  FIXED DISK REQUEST FALL THROUGH ERROR

017A 8B C6                      MOV     AX,SI                   ; RESTORE AL WITH CALLERS VALUE
017C B4 01                      MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR IN (AH)
```

SECTION 5

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                        STC                             ; SET ERROR RETURN CODE
                        RET
                ;
                DISK_P2:
                        CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
                        MOV     WORD PTR [BP+2],0       ; DRIVE TYPE = 0
                        MOV     AX,@EQUIP_FLAG          ; LOAD EQUIPMENT FLAG FOR # DISKETTES
                        AND     AL,11000001B            ; KEEP DISKETTE DRIVE BITS
                        MOV     DL,2                    ; DISKETTE DRIVES = 2
                        CMP     AL,01000001B            ; 2 DRIVES INSTALLED ?
                        JZ      DISK_P3                 ; IF YES JUMP
                ;
                        DEC     DL                      ; DISKETTE DRIVES = 1
                        CMP     AL,00000001B            ; 1 DRIVE INSTALLED ?
                        JNZ     DISK_P8                 ; IF NO JUMP
                DISK_P3:
                        MOV     [BP+4],DL               ; STORE NUMBER OF DRIVES
                        CMP     DI,1                    ; CHECK FOR VALID DRIVE
                        JA      DISK_P9                 ; DRIVE INVALID
                        MOV     BYTE PTR[BP+5],1        ; MAXIMUM HEAD NUMBER = 1
                        CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
                        JC      DISK_P4                 ; IF CMOS BAD CHECKSUM ESTABLISHED
                        OR      AL,AL                   ; TEST FOR NO DRIVE TYPE
                        JZ      DISK_P4                 ; JUMP IF SO
                        CMP     AL,(DR_PTE-DR_PT)/2     ; > MAXIMUM
                        JA      DISK_P4                 ; IF SO JUMP
                ;
                        MOV     [BP+2],AL               ; STORE VALID CMOS DRIVE TYPE
                        DEC     AL                      ; MAKE 0 ORIGIN
                        SHL     AL,1                    ; ACCOUNT FOR FIELD WIDTH
                        MOV     BL,AL                   ; FINISH MAKING INDEX POINTER
                        XOR     BH,BH                   ; CLEAR HIGH ORDER INDEX
                        MOV     CX,CS:WORD PTR DR_PT[BX]; GET MAX TRACK AND SECTOR
                ;
                DISK_P4:
                        MOV     AL,@DSK_STATE[DI]       ; LOAD STATE FOR THIS DRIVE
                        TEST    AL,MED_DET              ; CHECK FOR ESTABLISHED STATE
                        JNZ     DISK_P5                 ; GO TO CMOS FOR DRIVE CHECK
                        CMP     BYTE PTR [BP+2],0       ; CHECK FOR CMOS BAD/INVALID
                        JZ      DISK_P9                 ; CMOS BAD/INVALID AND UNESTABLISHED
                        JMP     SHORT DISK_P6           ; CMOS GOOD AND UNESTABLISHED; USE CMOS
                ;
                DISK_P5:
                        AND     AL,RATE_MSK             ; ISOLATE STATE
                        MOV     CX,WORD PTR CS:DR_PT+2  ; GET DRIVE PARAMETERS FOR 1.2 M DRIVE
                        CMP     AL,RATE_250             ; 1.2M DRIVE ?
                        JNE     DISK_P6                 ; 300 OR 500 RATE IS 1.2M DRIVE
                ;
                        MOV     CX,WORD PTR CS:DR_PT    ; GET DRIVE PARAMETERS 360K DRIVE
                        TEST    @DSK_STATE[DI],TRK_CAPA ; 80 TRACK ?
                        JZ      DISK_P6                 ; MUST BE 360
                ;
                        MOV     CX,WORD PTR CS:DR_PT+4  ; GET DRIVE PARAMETERS
                DISK_P6:                                ;
                        MOV     [BP],CX                 ; SAVE POINTER IN STACK FOR RETURN
                        LEA     AX,DISK_BASE            ; ADDRESS OF DISK_BASE
                        MOV     [BP+6],AX               ; SAVE IN STACK
                        MOV     AX,CS                   ; SEGMENT DISK_BASE (SAME AS THIS ONE)
                DISK_P7:
                        MOV     ES,AX                   ; ES IS SEGMENT OF TABLE
                        CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
                        XOR     AX,AX                   ; CLEAR
                        CLC
                        RET
                ;
                ;-----  NO DRIVE PRESENT HANDLER
                ;
                DISK_P8:
                        MOV     BYTE PTR [BP+4],0       ; CLEAR NUMBER OF DRIVES
                DISK_P9:
                        XOR     AX,AX                   ; CLEAR PARMS IF NO DRIVES OR CMOS BAD
                        MOV     [BP],AX                 ; TRACKS, SECTORS/TRACK = 0
                        MOV     [BP+5],AH               ; HEAD = 0
                        MOV     [BP+6],AX               ; OFFSET TO DISK_BASE = 0
                        JMP     DISK_P7                 ; EXIT
                DISK_PARMS      ENDP
                ;--------------------------------------------------------------------------------
                ;       DRIVE PARAMETER TABLE
                ;--------------------------------------------------------------------------------
                DR_PT   DB      09H,027H                ; MAX. TRACKS, SECTORS/TRACK 360K
                        DB      0FH,04FH                ;       "           "           1.2M
                        DB      09H,04FH                ;       "           "           720K
                DR_PTE  EQU     $
                ;--------------------------------------------------------------------------------
                ; DISK_TYPE:    THIS ROUTINE RETURNS THE TYPE OF MEDIA INSTALLED.
                ;
                ;  ON ENTRY:    DI      : DRIVE #
                ;
                ;  ON EXIT:     AH : DRIVE TYPE, CY=0
                ;--------------------------------------------------------------------------------
                DISK_TYPE       PROC    NEAR
                        CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
                        MOV     AL,@DSK_STATE[DI]       ; GET PRESENT STATE INFORMATION
                        OR      AL,AL                   ; CHECK FOR NO DRIVE
                        JZ      NO_DRV                  ;
                        MOV     AH,NOCHGLN              ; NO CHANGE LINE FOR 40 TRACK DRIVE
                        TEST    AL,TRK_CAPA             ; IS THIS DRIVE AN 80 TRACK DRIVE?
                        JZ      DT_BACK                 ; IF NO JUMP
                        MOV     AH,CHGLN                ; CHANGE LINE FOR 80 TRACK DRIVE
                ;
                DT_BACK:
                        PUSH    AX                      ; SAVE RETURN VALUE
                        CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
                        POP     AX                      ; RESTORE RETURN VALUE
                        CLC                             ; NO ERROR
                        MOV     BX,SI                   ; GET SAVED AL TO BL
                        MOV     AL,BL                   ; PUT BACK FOR RETURN
                        RET
                NO_DRV:
                        XOR     AH,AH                   ; NO DRIVE PRESENT OR UNKNOWN
                        JMP     SHORT DT_BACK
                DISK_TYPE ENDP
                ;--------------------------------------------------------------------------------
                ; DISK_CHANGE : THIS ROUTINE RETURNS THE STATE OF THE DISK CHANGE LINE.
```

```
                        ;
                        ; ON ENTRY:     DI : DRIVE #
                        ;
                        ; ON EXIT:      AH : @DSKETTE_STATUS
                        ;               00 - DISK CHANGE LINE INACTIVE, CY = 0
                        ;               06 - DISK CHANGE LINE ACTIVE, CY = 1
                        ;--------------------------------------------------------------------------------
023C                    DISK_CHANGE     PROC    NEAR
023C E8 02C8 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
023F 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; GET MEDIA STATE INFORMATION
0243 0A C0                      OR      AL,AL                   ; DRIVE PRESENT ?
0245 74 19                      JZ      DC_NON                  ; JUMP IF NO DRIVE
0247 A8 01                      TEST    AL,TRK_CAPA             ; 80 TRACK DRIVE ?
0249 74 05                      JZ      SETIT                   ; IF SO , CHECK CHANGE LINE
                        ;
024B E8 08E3 R                  CALL    READ_DSKCHNG            ; GO CHECK STATE OF DISK CHANGE LINE
024E 74 05                      JZ      FINIS                   ; CHANGE LINE NOT ACTIVE
                        ;
0250 C6 06 0041 R 06    SETIT:  MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; INDICATE MEDIA REMOVED
                        ;
0255 E8 02EE R          FINIS:  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0258 E8 0620 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
025B 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
025D 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
025F C3                         RET
                        ;
0260                    DC_NON:
0260 80 0E 0041 R 80            OR      @DSKETTE_STATUS,TIME_OUT        ; SET TIMEOUT, NO DRIVE
0265 EB EE                      JMP     SHORT FINIS
0267                    DISK_CHANGE     ENDP
                        ;--------------------------------------------------------------------------------
                        ; FORMAT_SET :  THIS ROUTINE IS USED TO ESTABLISH THE TYPE OF MEDIA TO BE USED
                        ;               FOR THE FOLLOWING FORMAT OPERATION.
                        ;
                        ; ON ENTRY:     SI LOW : DASD TYPE FOR FORMAT
                        ;               DI     : DRIVE #
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS REFLECTS STATUS
                        ;               AH : @DSKETTE_STATUS
                        ;               CY = 1 IF ERROR
                        ;--------------------------------------------------------------------------------
0267                    FORMAT_SET      PROC    NEAR
0267 E8 02C8 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
026A 56                         PUSH    SI                      ; SAVE DASD TYPE
026B 8B C6                      MOV     AX,SI                   ; AH = ? , AL = DASD TYPE
026D 32 E4                      XOR     AH,AH                   ; AH = 0 , AL = DASD TYPE
026F 8B F0                      MOV     SI,AX                   ; SI = DASD TYPE
0271 80 A5 0090 R 0F            AND     @DSK_STATE[DI],NOT MED_DET+DBL_STEP+RATE_MSK    ; CLEAR STATE
0276 4E                         DEC     SI                      ; CHECK FOR 320/360K MEDIA & DRIVE
0277 75 07                      JNZ     NOT_320                 ; BYPASS IF NOT
0279 80 8D 0090 R 90            OR      @DSK_STATE[DI],MED_DET+RATE_250 ; SET TO 320/360
027E EB 37                      JMP     SHORT S0
                        ;
0280                    NOT_320:
0280 E8 0416 R                  CALL    MED_CHANGE              ; CHECK FOR TIME_OUT
0283 80 3E 0041 R 80            CMP     @DSKETTE_STATUS,TIME_OUT
0288 74 2D                      JZ      S0                      ; IF TIME OUT TELL CALLER
                        ;
028A 4E                         DEC     SI                      ; CHECK FOR 320/360K IN 1.2M DRIVE
028B 75 07                      JNZ     NOT_320_12              ; BYPASS IF NOT
028D 80 8D 0090 R 70            OR      @DSK_STATE[DI],MED_DET+DBL_STEP+RATE_300 ; SET STATE
0292 EB 23                      JMP     SHORT S0
                        ;
0294                    NOT_320_12:
0294 4E                         DEC     SI                      ; CHECK FOR 1.2M MEDIA IN 1.2M DRIVE
0295 75 07                      JNZ     NOT_12                  ; BYPASS IF NOT
0297 80 8D 0090 R 10            OR      @DSK_STATE[DI],MED_DET+RATE_500  ; SET STATE VARIABLE
029C EB 19                      JMP     SHORT S0                ; RETURN TO CALLER
                        ;
029E                    NOT_12:
029E 4E                         DEC     SI                      ; CHECK FOR SET DASD TYPE 04
029F 75 20                      JNZ     FS_ERR                  ; BAD COMMAND EXIT IF NOT VALID TYPE
                        ;
02A1 F6 85 0090 R 04            TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
02A6 74 09                      JZ      ASSUME                  ; IF STILL NOT DETERMINED ASSUME
02A8 B0 50                      MOV     AL,MED_DET+RATE_300
02AA F6 85 0090 R 02            TEST    @DSK_STATE[DI],FMT_CAPA ; MULTIPLE FORMAT CAPABILITY ?
02AF 75 02                      JNZ     OR_IT_IN                ; IF 1.2 M THEN DATA RATE 300
                        ;
02B1                    ASSUME:
02B1 B0 90                      MOV     AL,MED_DET+RATE_250     ; SET UP
                        ;
02B3                    OR_IT_IN:
02B3 08 85 0090 R               OR      @DSK_STATE[DI],AL       ; OR IN THE CORRECT STATE
                        ;
02B7                    S0:
02B7 E8 02EE R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
02BA E8 0620 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
02BD 5B                         POP     BX                      ; GET SAVED AL TO BL
02BE 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
02C0 C3                         RET
                        ;
02C1                    FS_ERR:
02C1 C6 06 0041 R 01            MOV     @DSKETTE_STATUS,BAD_CMD ; UNKNOWN STATE,BAD COMMAND
02C6 EB EF                      JMP     SHORT S0
                        ;
02C8                    FORMAT_SET      ENDP
                        ;--------------------------------------------------------------------------------
                        ; XLAT_NEW:  TRANSLATES DISKETTE STATE LOCATIONS FROM COMPATIBLE MODE TO
                        ;           NEW ARCHITECTURE.
                        ;
                        ; ON ENTRY:     DI : DRIVE
                        ;--------------------------------------------------------------------------------
02C8                    XLAT_NEW        PROC    NEAR            ;
02C8 83 FF 01                   CMP     DI,1                    ; VALID DRIVE ?
02CB 77 1C                      JA      XN_OUT                  ; IF INVALID BACK
02CD 80 BD 0090 R 00            CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
02D2 74 16                      JZ      DO_DET                  ; IF NO DRIVE ATTEMPT DETERMINE
02D4 8B CF                      MOV     CX,DI                   ; CX = DRIVE NUMBER
02D6 C0 E1 02                   SHL     CL,2                    ; CL = SHIFT COUNT, A=0, B=4
02D9 A0 008F R                  MOV     AL,@HF_CNTRL            ; DRIVE INFORMATION
02DC D2 C8                      ROR     AL,CL                   ; TO LOW NIBBLE
02DE 24 07                      AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
02E0 80 A5 0090 R F8            AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA
```

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02E5 08 85 0090 R                       OR      @DSK_STATE[DI],AL       ; UPDATE DRIVE STATE
02E9                            XN_OUT:
02E9 C3                                 RET

02EA                            DO_DET:
02EA E8 08ED R                          CALL    DRIVE_DET               ; TRY TO DETERMINE
02ED C3                                 RET

02EE                            XLAT_NEW        ENDP
                                ;--------------------------------------------------------------------------------
                                ; XLAT_OLD : TRANSLATES DISKETTE STATE LOCATIONS FROM NEW ARCHITECTURE TO
                                ;            COMPATIBLE MODE.
                                ;
                                ; ON ENTRY:     DI : DRIVE
                                ;--------------------------------------------------------------------------------
02EE                            XLAT_OLD        PROC    NEAR
02EE 83 FF 01                           CMP     DI,1                    ; VALID DRIVE ?
02F1 77 68                              JA      XO_OUT                  ; IF INVALID BACK
02F3 80 BD 0090 R 00                    CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
02F8 74 61                              JZ      XO_OUT                  ; IF NO DRIVE TRANSLATE DONE

                                ;-----  TEST FOR SAVED DRIVE INFORMATION ALREADY SET

02FA 8B CF                              MOV     CX,DI                   ; CX = DRIVE NUMBER
02FC C0 E1 02                           SHL     CL,2                    ; CL = SHIFT COUNT, A=0, B=4
02FF B4 02                              MOV     AH,FMT_CAPA             ; LOAD MULTIPLE DATA RATE BIT MASK
0301 D2 CC                              ROR     AH,CL                   ; ROTATE BY MASK
0303 84 26 008F R                       TEST    @HF_CNTRL,AH            ; MULTIPLE-DATA RATE DETERMINED ?
0307 75 16                              JNZ     SAVE_SET                ; IF SO, NO NEED TO RE-SAVE

                                ;-----  ERASE DRIVE BITS IN @HF_CNTRL FOR THIS DRIVE

0309 B4 07                              MOV     AH,DRV_DET+FMT_CAPA+TRK_CAPA    ; MASK TO KEEP
030B D2 CC                              ROR     AH,CL                   ; FIX MASK TO KEEP
030D F6 D4                              NOT     AH                      ; TRANSLATE MASK
030F 20 26 008F R                       AND     @HF_CNTRL,AH            ; KEEP BITS FROM OTHER DRIVE INTACT

                                ;-----  ACCESS CURRENT DRIVE BITS AND STORE IN @HF_CNTRL

0313 8A 85 0090 R                       MOV     AL,@DSK_STATE[DI]       ; ACCESS STATE
0317 24 07                              AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
0319 D2 C8                              ROR     AL,CL                   ; FIX FOR THIS DRIVE
031B 08 06 008F R                       OR      @HF_CNTRL,AL            ; UPDATE SAVED DRIVE STATE

                                ;-----  TRANSLATE TO COMPATIBILITY MODE

031F                            SAVE_SET:
031F 8A A5 0090 R                       MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
0323 8A FC                              MOV     BH,AH                   ; TO BH FOR LATER
0325 80 E4 C0                           AND     AH,RATE_MSK             ; KEEP ONLY RATE
0328 B0 02                              MOV     AL,M1D1U                ; AL = 1.2 IN 1.2 UNESTABLISHED
032A 80 FC 00                           CMP     AH,RATE_500             ; RATE 500 ?
032D 74 1C                              JZ      TST_DET                 ; JUMP IF 1.2 IN 1.2
032F B0 01                              MOV     AL,M3D1U                ; AL = 360 IN 1.2 UNESTABLISHED
0331 80 FC 40                           CMP     AH,RATE_300             ; RATE 300 ?
0334 75 09                              JNZ     CHK_250                 ; IF SO FALL THRU
0336 F6 C7 20                           TEST    BH,DBL_STEP             ; CHECK FOR DOUBLE STEP
0339 75 10                              JNZ     TST_DET                 ; MUST BE 360 IN 1.2

033B                            UNKNO:
033B B0 07                              MOV     AL,MED_UNK              ; NONE OF THE ABOVE
033D EB 13                              JMP     SHORT AL_SET            ; PROCESS COMPLETE

033F                            CHK_250:
033F B0 00                              MOV     AL,M3D3U                ; AL = 360 IN 360 UNESTABLISHED
0341 80 FC 80                           CMP     AH,RATE_250             ; RATE 250 ?
0344 75 F6                              JNZ     UNKNO                   ; IF SO FALL THRU
0346 F6 C7 01                           TEST    BH,TRK_CAPA             ; 80 TRACK CAPABILITY ?
0349 75 F0                              JNZ     UNKNO                   ; IF SO JUMP, FALL THRU TEST DET

034B                            TST_DET:
034B F6 C7 10                           TEST    BH,MED_DET              ; DETERMINED ?
034E 74 02                              JZ      AL_SET                  ; IF NOT THEN SET
0350 04 03                              ADD     AL,3                    ; MAKE DETERMINED/ESTABLISHED

0352                            AL_SET:
0352 80 A5 0090 R F8                    AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA  ; CLEAR DRIVE
0357 08 85 0090 R                       OR      @DSK_STATE[DI],AL       ; REPLACE WITH COMPATIBLE MODE
035B                            XO_OUT:
035B C3                                 RET
035C                            XLAT_OLD        ENDP
                                ;--------------------------------------------------------------------------------
                                ; RD_WR_VF : COMMON READ, WRITE AND VERIFY; MAIN LOOP FOR STATE RETRIES.
                                ;
                                ; ON ENTRY:     AH : READ/WRITE/VERIFY DMA PARAMETER
                                ;               AL : READ/WRITE/VERIFY NEC PARAMETER
                                ;
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                                ;--------------------------------------------------------------------------------
035C                            RD_WR_VF        PROC    NEAR
035C 50                                 PUSH    AX                      ; SAVE DMA, NEC PARAMETERS
035D E8 02C8 R                          CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
0360 E8 039B R                          CALL    SETUP_STATE             ; STATE INITIALIZATIONS
0363 58                                 POP     AX                      ; RESTORE DMA,NEC PARAMETERS

0364                            DO_AGAIN:
0364 50                                 PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
0365 E8 0416 R                          CALL    MED_CHANGE              ; MEDIA CHANGE AND RESET IF CHANGED
0368 58                                 POP     AX                      ; RESTORE READ/WRITE/VERIFY
0369 72 21                              JC      RWV_END                 ; MEDIA CHANGE ERROR OR TIME-OUT
036B 50                                 PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
036C E8 0451 R                          CALL    SEND_RATE               ; SEND DATA RATE TO NEC
036F E8 063A R                          CALL    SETUP_DBL               ; CHECK FOR DOUBLE STEP
0372 72 12                              JC      CHK_RET                 ; ERROR FROM READ ID, POSSIBLE RETRY
0374 58                                 POP     AX                      ; RESTORE NEC,DMA COMMAND
0375 50                                 PUSH    AX                      ; SAVE NEC COMMAND
0376 E8 0471 R                          CALL    DMA_SETUP               ; SET UP THE DMA
0379 58                                 POP     AX                      ; RESTORE NEC COMMAND
037A 72 16                              JC      RWV_BAC                 ; CHECK FOR DMA BOUNDARY ERROR
037C 50                                 PUSH    AX                      ; SAVE NEC COMMAND
037D E8 04C7 R                          CALL    NEC_INIT                ; INITIALIZE NEC
0380 E8 04EC R                          CALL    RWV_COM                 ; OP CODE COMMON TO READ/WRITE/VERIFY
0383 E8 0530 R                          CALL    NEC_TERM                ; TERMINATE, GET STATUS, ETC.
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0386                    CHK_RET:
0386 E8 05B1 R                  CALL    RETRY                   ; CHECK FOR, SETUP RETRY
0389 58                         POP     AX                      ; RESTORE READ/WRITE/VERIFY PARAMETER
038A 72 D8                      JC      DO_AGAIN                ; CY = 1 MEANS RETRY

038C                    RWV_END:
038C E8 0582 R                  CALL    DSTATE                  ; ESTABLISH STATE IF SUCCESSFUL
038F E8 05F3 R                  CALL    NUM_TRANS               ; AL = NUMBER TRANSFERRED

0392                    RWV_BAC:                                ; BAD DMA ERROR ENTRY
0392 50                         PUSH    AX                      ; SAVE NUMBER TRANSFERRED
0393 E8 02EE R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0396 58                         POP     AX                      ; RESTORE NUMBER TRANSFERRED
0397 E8 0620 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
039A C3                         RET
039B                    RD_WR_VF        ENDP
                        ;--------------------------------------------------------------------------------
                        ; SETUP_STATE:  INITIALIZES START AND END RATES.
                        ;--------------------------------------------------------------------------------
039B                    SETUP_STATE     PROC    NEAR            ;
039B F6 85 0090 R 10            TEST    @DSK_STATE[DI],MED_DET  ; MEDIA DETERMINED ?
03A0 75 2B                      JNZ     J1C                     ; NO STATES IF DETERMINED
03A2 B8 4080                    MOV     AX,RATE_300*H+RATE_250  ; AH = START RATE,  AL = END RATE
03A5 F6 85 0090 R 04            TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE ?
03AA 74 0C                      JZ      AX_SET                  ; DO NOT KNOW DRIVE
03AC B0 00                      MOV     AL,RATE_500             ; SET UP FOR 1.2 M END RATE
03AE F6 85 0090 R 02            TEST    @DSK_STATE[DI],FMT_CAPA ; 1.2 M ?
03B3 75 03                      JNZ     AX_SET                  ; JUMP WITH FIXED END RATE
03B5 B8 8080                    MOV     AX,RATE_250*X           ; START & EMD RATE = 250 FOR 360 DRIVE

03B8                    AX_SET:
03B8 80 A5 0090 R 1F            AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP ; TURN OFF THE RATE
03BD 08 A5 0090 R               OR      @DSK_STATE[DI],AH       ; RATE FIRST TO TRY
03C1 80 26 008B R F3            AND     @LASTRATE,NOT STRT_MSK  ; ERASE LAST TO TRY RATE BITS
03C6 C0 C8 04                   ROR     AL,4                    ; TO OPERATION LAST RATE LOCATION
03C9 08 06 008B R               OR      @LASTRATE,AL            ; LAST RATE
03CD                    J1C:
03CD C3                         RET
03CE                    SETUP_STATE     ENDP
                        ;--------------------------------------------------------------------------------
                        ;  FMT_INIT: ESTABLISH STATE IF UNESTABLISHED AT FORMAT TIME.
                        ;--------------------------------------------------------------------------------
03CE                    FMT_INIT        PROC    NEAR
03CE F6 85 0090 R 10            TEST    @DSK_STATE[DI],MED_DET  ; IS MEDIA ESTABLISHED
03D3 75 3C                      JNZ     FI_OUT                  ; IF SO RETURN
03D5 E8 06B3 R                  CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
03D8 72 38                      JC      CL_DRV                  ; ERROR IN CMOS ASSUME NO DRIVE
03DA FE C8                      DEC     AL                      ; MAKE ZERO ORIGIN
03DC 78 34                      JS      CL_DRV                  ; NO DRIVE IF AL 0
03DE 8A A5 0090 R               MOV     AH,@DSK_STATE[DI]       ; AH = CURRENT STATE
03E2 80 E4 0F                   AND     AH,NOT MED_DET+DBL_STEP+RATE_MSK        ; CLEAR
03E5 0A C0                      OR      AL,AL                   ; CHECK FOR 360
03E7 75 05                      JNZ     N_360                   ; IF 360 WILL BE 0
03E9 80 CC 90                   OR      AH,MED_DET+RATE_250     ; ESTABLISH MEDIA
03EC EB 1F                      JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

03EE                    N_360:
03EE FE C8                      DEC     AL                      ; 1.2 M DRIVE
03F0 75 05                      JNZ     N_12                    ; JUMP IF NOT
03F2 80 CC 10                   OR      AH,MED_DET+RATE_500     ; DEFAULT TO 1.2M FORMAT
03F5 EB 16                      JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

03F7                    N_12:
03F7 FE C8                      DEC     AL                      ; CHECK FOR TYPE 3
03F9 75 17                      JNZ     CL_DRV                  ; NO DRIVE, CMOS BAD
03FB F6 C4 04                   TEST    AH,DRV_DET              ; IS DRIVE DETERMINED
03FE 74 0A                      JZ      ISNT_12                 ; TREAT AS NON 1.2 DRIVE
0400 F6 C4 02                   TEST    AH,FMT_CAPA             ; IS 1.2M
0403 74 05                      JZ      ISNT_12                 ; JUMP IF NOT
0405 80 CC 50                   OR      AH,MED_DET+RATE_300     ; RATE 300
0408 EB 03                      JMP     SHORT SKP_STATE         ; CONTINUE

040A                    ISNT_12:
040A 80 CC 90                   OR      AH,MED_DET+RATE_250     ; MUST BE RATE 250

040D                    SKP_STATE:
040D 88 A5 0090 R               MOV     @DSK_STATE[DI],AH       ; STORE AWAY

0411                    FI_OUT:
0411 C3                         RET

0412                    CL_DRV:
0412 32 E4                      XOR     AH,AH                   ; CLEAR STATE
0414 EB F7                      JMP     SHORT SKP_STATE         ; SAVE IT
0416                    FMT_INIT        ENDP
                        ;--------------------------------------------------------------------------------
                        ; MED_CHANGE:   CHECKS FOR MEDIA CHANGE, RESETS MEDIA CHANGE, CHECKS MEDIA
                        ;               CHANGE AGAIN.
                        ;
                        ; ON EXIT:      CY = 1 MEANS MEDIA CHANGE OR TIMEOUT
                        ;               @DSKETTE_STATUS = ERROR CODE
                        ;--------------------------------------------------------------------------------
0416                    MED_CHANGE      PROC    NEAR
0416 E8 08E3 R                  CALL    READ_DSKCHNG            ; READ DISK CHANGE LINE STATE
0419 74 34                      JZ      MED_C9                  ; BYPASS HANDLING DISK CHANGE LINE
041B 80 A5 0090 R EF            AND     @DSK_STATE[DI],NOT MED_DET      ; CLEAR STATE FOR THIS DRIVE

                        ;       THIS SEQUENCE ENSURES WHENEVER A DISKETTE IS CHANGED THAT
                        ;       ON THE NEXT OPERATION THE REQUIRED MOTOR START UP TIME WILL
                        ;       BE WAITED. (DRIVE MOTOR MAY GO OFF UPON DOOR OPENING).

0420 8B CF                      MOV     CX,DI                   ; CL = DRIVE #
0422 B0 01                      MOV     AL,1                    ; MOTOR ON BIT MASK
0424 D2 E0                      SHL     AL,CL                   ; TO APPROPRIATE POSITION
0426 F6 D0                      NOT     AL                      ; KEEP ALL BUT MOTOR ON
0428 FA                         CLI                             ; NO INTERRUPTS
0429 20 06 003F R               AND     @MOTOR_STATUS,AL        ; TURN MOTOR OFF INDICATOR
042D FB                         STI                             ; INTERRUPTS ENABLED
042E E8 06E1 R                  CALL    MOTOR_ON                ; TURN MOTOR ON

                        ;-----  THIS SEQUENCE OF SEEKS IS USED TO RESET DISKETTE CHANGE SIGNAL

0431 E8 007E R                  CALL    DISK_RESET              ; RESET NEC
0434 B5 01                      MOV     CH,01H                  ; MOVE TO CYLINDER 1
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SECTION 5

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0436 E8 07DE R                  CALL    SEEK                    ; ISSUE SEEK
0439 32 ED                      XOR     CH,CH                   ; MOVE TO CYLINDER 0
043B E8 07DE R                  CALL    SEEK                    ; ISSUE SEEK
043E C6 06 0041 R 06            MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; STORE IN STATUS

0443 E8 08E3 R                  CALL    READ_DSKCHNG            ; CHECK MEDIA CHANGED AGAIN
0446 74 05                      JZ      MED_C8                  ; IF ACTIVE, NO DISKETTE, TIMEOUT

0448 C6 06 0041 R 80            MOV     @DSKETTE_STATUS,TIME_OUT; TIMEOUT IF DRIVE EMPTY
044D                    MED_C8:
044D F9                         STC                             ; MEDIA CHANGED, SET CY
044E C3                         RET
044F                    MED_C9:
044F F8                         CLC                             ; NO MEDIA CHANGED, CLEAR CY
0450 C3                         RET
0451                    MED_CHANGE      ENDP
                        ;--------------------------------------------------------------------------
                        ; SEND_RATE:     SENDS DATA RATE COMMAND TO NEC IF PREVIOUS RATE WAS DIFFERENT.
                        ;--------------------------------------------------------------------------
0451                    SEND_RATE       PROC    NEAR
0451 8A 26 008B R               MOV     AH,@LASTRATE            ; GET LAST DATA RATE SELECTED
0455 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
0459 25 C0C0                    AND     AX,SEND_MSK*X           ; KEEP ONLY RATE BITS OF BOTH
045C 3A C4                      CMP     AL,AH                   ; COMPARE TO PREVIOUSLY TRIED
045E 74 10                      JE      C_S_OUT                 ; IF SAME, NO NEW TRANSFER RATE

0460 80 26 008B R 3F            AND     @LASTRATE,NOT SEND_MSK  ; ELSE CLEAR LAST RATE ATTEMPTED
0465 08 06 008B R               OR      @LASTRATE,AL            ; SAVE NEW RATE FOR NEXT CHECK
0469 C0 C0 02                   ROL     AL,2                    ; MOVE TO BIT OUTPUT POSITIONS
046C BA 03F7                    MOV     DX,03F7H                ; OUTPUT NEW DATA RATE
046F EE                         OUT     DX,AL

0470                    C_S_OUT:
0470 C3                         RET
0471                    SEND_RATE       ENDP
                        ;--------------------------------------------------------------------------
                        ; DMA_SETUP:     THIS ROUTINE SETS UP THE DMA FOR READ/WRITE/VERIFY OPERATIONS.
                        ;
                        ; ON ENTRY:      AL = DMA COMMAND
                        ;
                        ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------
0471                    DMA_SETUP       PROC    NEAR
0471 FA                         CLI                             ; DISABLE INTERRUPTS DURING DMA SET-UP
0472 E6 0C                      OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
0474 EB 00                      JMP     $+2                     ; WAIT FOR I/O
0476 E6 0B                      OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
0478 8C C0                      MOV     AX,ES                   ; GET THE ES VALUE
047A C1 C0 04                   ROL     AX,4                    ; ROTATE LEFT
047D 8A E8                      MOV     CH,AL                   ; GET HIGHEST NIBBLE OF ES TO CH
047F 24 F0                      AND     AL,11110000B            ; ZERO THE LOW NIBBLE FROM SEGMENT
0481 03 46 02                   ADD     AX,[BP+2]               ; TEST FOR CARRY FROM ADDITION
0484 73 02                      JNC     J33
0486 FE C5                      INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
0488                    J33:
0488 50                         PUSH    AX                      ; SAVE START ADDRESS
0489 E6 04                      OUT     DMA+4,AL                ; OUTPUT LOW ADDRESS
048B EB 00                      JMP     $+2                     ; WAIT FOR I/O
048D 8A C4                      MOV     AL,AH
048F E6 04                      OUT     DMA+4,AL                ; OUTPUT HIGH ADDRESS
0491 8A C5                      MOV     AL,CH                   ; GET HIGH 4 BITS
0493 EB 00                      JMP     $+2                     ; I/O WAIT STATE
0495 24 0F                      AND     AL,00001111B
0497 E6 81                      OUT     081H,AL                 ; OUTPUT HIGH 4 BITS TO PAGE REGISTER

                        ;-----  DETERMINE COUNT

0499 8B C6                      MOV     AX,SI                   ; AL = # OF SECTORS
049B 86 C4                      XCHG    AL,AH                   ; AH = # OF SECTORS
049D 2A C0                      SUB     AL,AL                   ; AL = 0, AX = # OF SECTORS * 256
049F D1 E8                      SHR     AX,1                    ; AX = # SECTORS * 128
04A1 50                         PUSH    AX                      ; SAVE # OF SECTORS * 128
04A2 B2 03                      MOV     DL,3                    ; GET BYTES/SECTOR PARAMETER
04A4 E8 06CC R                  CALL    GET_PARM                ; "
04A7 8A CC                      MOV     CL,AH                   ; SHIFT COUNT (0=128, 1=256 ETC)
04A9 58                         POP     AX                      ; AX = # OF SECTORS * 128
04AA D3 E0                      SHL     AX,CL                   ; SHIFT BY PARAMETER VALUE
04AC 48                         DEC     AX                      ;-1 FOR DMA VALUE
04AD 50                         PUSH    AX                      ; SAVE COUNT VALUE
04AE E6 05                      OUT     DMA+5,AL                ; LOW BYTE OF COUNT
04B0 EB 00                      JMP     $+2                     ; WAIT FOR I/O
04B2 8A C4                      MOV     AL,AH
04B4 E6 05                      OUT     DMA+5,AL                ; HIGH BYTE OF COUNT
04B6 FB                         STI                             ; RE-ENABLE INTERRUPTS
04B7 59                         POP     CX                      ; RECOVER COUNT VALUE
04B8 58                         POP     AX                      ; RECOVER ADDRESS VALUE
04B9 03 C1                      ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
04BB B0 02                      MOV     AL,2                    ; MODE FOR 8237
04BD E6 0A                      OUT     DMA+10,AL               ; INITIALIZE THE DISKETTE CHANNEL
04BF 73 05                      JNC     NO_BAD                  ; CHECK FOR ERROR
04C1 C6 06 0041 R 09            MOV     @DSKETTE_STATUS,DMA_BOUNDARY    ; SET ERROR
04C6                    NO_BAD:
04C6 C3                         RET                             ; CY SET BY ABOVE IF ERROR
04C7                    DMA_SETUP       ENDP
                        ;--------------------------------------------------------------------------
                        ; NEC_INIT:      THIS ROUTINE SEEKS TO THE REQUESTED TRACK AND INITIALIZES THE
                        ;                NEC FOR THE READ/WRITE/VERIFY/FORMAT OPERATION.
                        ;
                        ; ON ENTRY:      AH : NEC COMMAND TO BE PERFORMED
                        ;
                        ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------
04C7                    NEC_INIT        PROC    NEAR
04C7 50                         PUSH    AX                      ; SAVE NEC COMMAND
04C8 E8 06E1 R                  CALL    MOTOR_ON                ; TURN MOTOR ON FOR SPECIFIC DRIVE

                        ;-----  DO THE SEEK OPERATION

04CB 8A 6E 01                   MOV     CH,[BP+1]               ; CH = TRACK #
04CE E8 07DE R                  CALL    SEEK                    ; MOVE TO CORRECT TRACK
04D1 58                         POP     AX                      ; RECOVER COMMAND
04D2 72 17                      JC      ER_1                    ; ERROR ON SEEK
04D4 BB 04EB R                  MOV     BX,OFFSET ER_1          ; LOAD ERROR ADDRESS
04D7 53                         PUSH    BX                      ; PUSH NEC_OUT ERROR RETURN
```

```
                        ;-----  SEND OUT THE PARAMETERS TO THE CONTROLLER

                                CALL    NEC_OUTPUT              ; OUTPUT THE OPERATION COMMAND
                                MOV     AX,SI                   ; AH = HEAD #
                                MOV     BX,DI                   ; BL = DRIVE #
                                SAL     AH,2                    ; MOVE IT TO BIT 2
                                AND     AH,00000100B            ; ISOLATE THAT BIT
                                OR      AH,BL                   ; OR IN THE DRIVE NUMBER
                                CALL    NEC_OUTPUT              ; FALL THRU CY SET IF ERROR
                                POP     BX                      ; THROW AWAY ERROR RETURN
                        ER_1:
                                RET
                        NEC_INIT        ENDP
                        ;--------------------------------------------------------------------------------
                        ; RWV_COM:       THIS ROUTINE SENDS PARAMETERS TO THE NEC SPECIFIC TO THE
                        ;                READ/WRITE/VERIFY OPERATIONS.
                        ;
                        ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------------
                        RWV_COM PROC    NEAR
                                MOV     AX,OFFSET ER_2          ; LOAD ERROR ADDRESS
                                PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
                                MOV     AH,[BP+1]               ; OUTPUT TRACK #
                                CALL    NEC_OUTPUT
                                MOV     AX,SI                   ; OUTPUT HEAD #
                                CALL    NEC_OUTPUT
                                MOV     AH,[BP]                 ; OUTPUT SECTOR #
                                CALL    NEC_OUTPUT
                                MOV     DL,3                    ; BYTES/SECTOR PARAMETER FROM BLOCK
                                CALL    GET_PARM                ; . TO THE NEC
                                CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
                                MOV     DL,4                    ; EOT PARAMETER FROM BLOCK
                                CALL    GET_PARM                ; . TO THE NEC
                                CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
                                MOV     AL,@DSK_STATE[DI]       ; GET DRIVE STATE VALUE
                                MOV     AH,01BH                 ; 1.2/1.2 DRIVE GAP LENGTH
                                AND     AL,RATE_MSK             ; STRIP OFF HIGH BITS
                                JZ      R15                     ; IF SO JUMP
                                MOV     AH,023H                 ; 320,360/1.2 DRIVE GAP LENGTH
                                DEC     AL                      ; CHECK FOR 320 MEDIA IN 1.2 DRIVE
                                JZ      R15                     ; IF SO JUMP

                                MOV     AH,02AH                 ; 360/360 DRIVE GAP LENGTH
                        R15:
                                CALL    NEC_OUTPUT
                                MOV     DL,6                    ; DTL PARAMETER FROM BLOCK
                                CALL    GET_PARM                ;  TO THE NEC
                                CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
                                POP     AX                      ; THROW AWAY ERROR EXIT
                        ER_2:
                                RET
                        RWV_COM ENDP
                        ;--------------------------------------------------------------------------------
                        ; NEC_TERM:      THIS ROUTINE WAITS FOR THE OPERATION THEN ACCEPTS THE STATUS
                        ;                FROM THE NEC FOR THE READ/WRITE/VERIFY/FORMAT OPERATION.
                        ;
                        ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------------
                        NEC_TERM        PROC    NEAR

                        ;-----  LET THE OPERATION HAPPEN

                                PUSH    SI                      ; SAVE HEAD #, # OF SECTORS
                                CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
                                PUSHF
                                CALL    RESULTS                 ; GET THE NEC STATUS
                                JC      SET_END_POP
                                POPF
                                JC      SET_END                 ; LOOK FOR ERROR

                        ;-----  CHECK THE RESULTS RETURNED BY THE CONTROLLER

                                CLD                             ; SET THE CORRECT DIRECTION
                                MOV     SI,OFFSET @NEC_STATUS   ; POINT TO STATUS FIELD
                                LODS    @NEC_STATUS             ; GET ST0
                                AND     AL,11000000B            ; TEST FOR NORMAL TERMINATION
                                JZ      SET_END                 ;
                                CMP     AL,01000000B            ; TEST FOR ABNORMAL TERMINATION
                                JNZ     J18                     ; NOT ABNORMAL, BAD NEC

                        ;-----  ABNORMAL TERMINATION, FIND OUT WHY

                                LODS    @NEC_STATUS             ; GET ST1
                                SAL     AL,1                    ; TEST FOR EOT FOUND
                                MOV     AH,RECORD_NOT_FND
                                JC      J19
                                SAL     AL,2
                                MOV     AH,BAD_CRC
                                JC      J19
                                SAL     AL,1                    ; TEST FOR DMA OVERRUN
                                MOV     AH,BAD_DMA
                                JC      J19
                                SAL     AL,2                    ; TEST FOR RECORD NOT FOUND
                                MOV     AH,RECORD_NOT_FND
                                JC      J19
                                SAL     AL,1
                                MOV     AH,WRITE_PROTECT        ; TEST FOR WRITE_PROTECT
                                JC      J19
                                SAL     AL,1                    ; TEST MISSING ADDRESS MARK
                                MOV     AH,BAD_ADDR_MARK
                                JC      J19

                        ;-----  NEC MUST HAVE FAILED
                        J18:
                                MOV     AH,BAD_NEC
                        J19:
                                OR      @DSKETTE_STATUS,AH
                        SET_END:
                                CMP     @DSKETTE_STATUS,1       ; SET ERROR CONDITION
                                CMC                             ;
                                POP     SI                      ; RESTORE HEAD #, # OF SECTORS
                                RET
```

```
                        SET_END_POP:
                                POPF
                                JMP     SHORT SET_END
                        NEC_TERM        ENDP
                        ;--------------------------------------------------------------------------
                        ; DSTATE:       ESTABLISH STATE UPON SUCCESSFUL OPERATION.
                        ;--------------------------------------------------------------------------
0582                    DSTATE  PROC    NEAR
0582 80 3E 0041 R 00            CMP     @DSKETTE_STATUS,0       ; CHECK FOR ERROR
0587 75 27                      JNZ     SETBAC                  ; IF ERROR JUMP
0589 80 8D 0090 R 10            OR      @DSK_STATE[DI],MED_DET  ; NO ERROR, MARK MEDIA AS DETERMINED
058E F6 85 0090 R 04            TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
0593 75 1B                      JNZ     SETBAC                  ; IF DETERMINED NO TRY TO DETERMINE
0595 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; LOAD STATE
0599 24 C0                      AND     AL,RATE_MSK             ; KEEP ONLY RATE
059B 3C 80                      CMP     AL,RATE_250             ; CHECK FOR 1.2M
059D 75 0C                      JNE     M_12                    ; MUST BE 1.2
059F 80 A5 0090 R FD            AND     @DSK_STATE[DI],NOT FMT_CAPA     ; TURN OFF FORMAT CAPABILITY
05A4 80 8D 0090 R 04            OR      @DSK_STATE[DI],DRV_DET  ; MARK DRIVE DETERMINED
05A9 EB 05                      JMP     SHORT SETBAC            ; BACK
                        M_12:
05AB 80 8D 0090 R 06            OR      @DSK_STATE[DI],DRV_DET+FMT_CAPA ; TURN ON DETERMINED & FMT CAPA
                        SETBAC:
05B0 C3                         RET
05B1                    DSTATE  ENDP
                        ;--------------------------------------------------------------------------
                        ; RETRY:        DETERMINES WHETHER A RETRY IS NECESSARY. IF RETRY IS REQUIRED
                        ;               THEN STATE INFORMATION IS UPDATED FOR RETRY.
                        ;
                        ; ON EXIT:      CY = 1 FOR RETRY, CY = 0 FOR NO RETRY
                        ;--------------------------------------------------------------------------
05B1                    RETRY   PROC    NEAR
05B1 80 3E 0041 R 00            CMP     @DSKETTE_STATUS,0       ; GET STATUS OF OPERATION
05B6 74 39                      JZ      NO_RETRY                ; SUCCESSFUL OPERATION
05B8 80 3E 0041 R 80            CMP     @DSKETTE_STATUS,TIME_OUT        ; IF TIME OUT NO RETRY
05BD 74 32                      JZ      NO_RETRY                ;
05BF 8A A5 0090 R               MOV     AH,@DSK_STATE[DI]       ; GET MEDIA STATE OF DRIVE
05C3 F6 C4 10                   TEST    AH,MED_DET              ; ESTABLISHED/DETERMINED ?
05C6 75 29                      JNZ     NO_RETRY                ; IF ESTABLISHED STATE THEN TRUE ERROR
05C8 80 E4 C0                   AND     AH,RATE_MSK             ; ISOLATE RATE
05CB 8A 2E 008B R               MOV     CH,@LASTRATE            ; GET START OPERATION STATE
05CF C0 C5 04                   ROL     CH,4                    ; TO CORRESPONDING BITS
05D2 80 E5 C0                   AND     CH,RATE_MSK             ; ISOLATE RATE BITS
05D5 3A EC                      CMP     CH,AH                   ; ALL RATES TRIED
05D7 74 18                      JE      NO_RETRY                ; IF YES, THEN TRUE ERROR
                        ;       SETUP STATE INDICATOR FOR RETRY ATTEMPT TO NEXT RATE
                        ;         00000000B (500) -> 10000000B (250)
                        ;         10000000B (250) -> 01000000B (300)
                        ;         01000000B (300) -> 00000000B (500)
05D9 80 FC 01                   CMP     AH,RATE_500+1           ; SET CY FOR RATE 500
05DC D0 DC                      RCR     AH,1                    ; TO NEXT STATE
05DE 80 E4 C0                   AND     AH,RATE_MSK             ; KEEP ONLY RATE BITS
05E1 80 A5 0090 R 1F            AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP    ; RATE, DBL STEP OFF
05E6 08 A5 0090 R               OR      @DSK_STATE[DI],AH       ; TURN ON NEW RATE
05EA C6 06 0041 R 00            MOV     @DSKETTE_STATUS,0       ; RESET STATUS FOR RETRY
05EF F9                         STC                             ; SET CARRY FOR RETRY
05F0 C3                         RET                             ; RETRY RETURN
                        NO_RETRY:
05F1 F8                         CLC                             ; CLEAR CARRY NO RETRY
05F2 C3                         RET                             ; NO RETRY RETURN
05F3                    RETRY   ENDP
                        ;--------------------------------------------------------------------------
                        ; NUM_TRANS:    THIS ROUTINE CALCULATES THE NUMBER OF SECTORS THAT WERE
                        ;               ACTUALLY TRANSFERRED TO/FROM THE DISKETTE.
                        ;
                        ; ON ENTRY:     [BP+1] = TRACK
                        ;               SI-HI  = HEAD
                        ;               [BP]   = START SECTOR
                        ;
                        ; ON EXIT:      AL = NUMBER ACTUALLY TRANSFERRED
                        ;--------------------------------------------------------------------------
05F3                    NUM_TRANS       PROC    NEAR
05F3 32 C0                      XOR     AL,AL                   ; CLEAR FOR ERROR
05F5 80 3E 0041 R 00            CMP     @DSKETTE_STATUS,0       ; CHECK FOR ERROR
05FA 75 23                      JNZ     NT_OUT                  ; IF ERROR 0 TRANSFERRED
05FC B2 04                      MOV     DL,4                    ; SECTORS/TRACK OFFSET TO DL
05FE E8 06CC R                  CALL    GET_PARM                ; AH = SECTORS/TRACK
0601 8A 1E 0047 R               MOV     BL,@NEC_STATUS+5        ; GET ENDING SECTOR
0605 8B CE                      MOV     CX,SI                   ; CH = HEAD # STARTED
0607 3A 2E 0046 R               CMP     CH,@NEC_STATUS+4        ; GET HEAD ENDED UP ON
060B 75 0B                      JNZ     DIF_HD                  ; IF ON SAME HEAD, THEN NO ADJUST
060D 8A 2E 0045 R               MOV     CH,@NEC_STATUS+3        ; GET TRACK ENDED UP ON
0611 3A 6E 01                   CMP     CH,[BP+1]               ; IS IT ASKED FOR TRACK
0614 74 04                      JZ      SAME_TRK                ; IF SAME TRACK NO INCREASE
0616 02 DC                      ADD     BL,AH                   ; ADD SECTORS/TRACK
0618                    DIF_HD:
0618 02 DC                      ADD     BL,AH                   ; ADD SECTORS/TRACK
061A                    SAME_TRK:
061A 2A 5E 00                   SUB     BL,[BP]                 ; SUBTRACT START FROM END
061D 8A C3                      MOV     AL,BL                   ; TO AL
                        NT_OUT:
061F C3                         RET
0620                    NUM_TRANS       ENDP
                        ;--------------------------------------------------------------------------
                        ; SETUP_END:    RESTORES @MOTOR_COUNT TO PARAMETER PROVIDED IN TABLE AND LOADS
                        ;               @DSKETTE_STATUS TO AH, AND SETS CY.
                        ;
                        ; ON EXIT:      AH, @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------
0620                    SETUP_END       PROC    NEAR
0620 B2 02                      MOV     DL,2                    ; GET THE MOTOR WAIT PARAMETER
0622 50                         PUSH    AX                      ; SAVE NUMBER TRANSFERRED
0623 E8 06CC R                  CALL    GET_PARM
0626 88 26 0040 R               MOV     @MOTOR_COUNT,AH         ; STORE UPON RETURN
062A 58                         POP     AX                      ; RESTORE NUMBER TRANSFERRED
062B 8A 26 0041 R               MOV     AH,@DSKETTE_STATUS      ; GET STATUS OF OPERATION
```

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                                OR      AH,AH                   ; CHECK FOR ERROR
                                JZ      NUN_ERR                 ; NO ERROR
                                XOR     AL,AL                   ; CLEAR NUMBER RETURNED

                        NUN_ERR:
                                CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
                                CMC                             ; SUCCESS OR FAILURE
                                RET
                        SETUP_END       ENDP
                        ;--------------------------------------------------------------------------------
                        ; SETUP_DBL:    CHECK DOUBLE STEP.
                        ;
                        ; ON ENTRY :    AH = RATE; DI = DRIVE
                        ;
                        ; ON EXIT :     CY = 1 MEANS ERROR
                        ;--------------------------------------------------------------------------------
                        SETUP_DBL       PROC    NEAR
                                MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
                                TEST    AH,MED_DET              ; ESTABLISHED STATE ?
                                JNZ     NO_DBL                  ; IF ESTABLISHED THEN DOUBLE DONE

                        ;-----  CHECK FOR TRACK 0 TO SPEED UP ACKNOWLEDGE OF UNFORMATTED DISKETTE

                                MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
                                CALL    MOTOR_ON                ; ENSURE MOTOR STAY ON
                                MOV     CH,0                    ; LOAD TRACK 0
                                CALL    SEEK                    ; SEEK TO TRACK 0
                                CALL    READ_ID                 ; READ ID FUNCTION
                                JC      SD_ERR                  ; IF ERROR NO TRACK 0

                        ;-----  INITIALIZE START AND MAX TRACKS (TIMES 2 FOR BOTH HEADS)

                                MOV     CX,0450H                ; START, MAX TRACKS
                                TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACK CAPABILITY
                                JZ      CNT_OK                  ; IF NOT COUNT IS SETUP
                                MOV     CL,0A0H                 ; MAXIMUM TRACK 1.2 MB

                        ;       ATTEMPT READ ID OF ALL TRACKS, ALL HEADS UNTIL SUCCESS; UPON SUCCESS,
                        ;       MUST SEE IF ASKED FOR TRACK IN SINGLE STEP MODE = TRACK ID READ; IF NOT
                        ;       THEN SET DOUBLE STEP ON.

                        CNT_OK:
                                PUSH    CX                      ; SAVE TRACK, COUNT
                                MOV     @DSKETTE_STATUS,0       ; CLEAR STATUS, EXPECT ERRORS
                                XOR     AX,AX                   ; CLEAR AX
                                SHR     CH,1                    ; HALVE TRACK, CY = HEAD
                                RCL     AL,3                    ; AX = HEAD IN CORRECT BIT
                                PUSH    AX                      ; SAVE HEAD
                                CALL    SEEK                    ; SEEK TO TRACK
                                POP     AX                      ; RESTORE HEAD
                                OR      DI,AX                   ; DI = HEAD OR'ED DRIVE
                                CALL    READ_ID                 ; READ ID HEAD 0
                                PUSHF                           ; SAVE RETURN FROM READ_ID
                                AND     DI,11111011B            ; TURN OFF HEAD 1 BIT
                                POPF                            ; RESTORE ERROR RETURN
                                POP     CX                      ; RESTORE COUNT
                                JNC     DO_CHK                  ; IF OK, ASKED = RETURNED TRACK ?
                                INC     CH                      ; INC FOR NEXT TRACK
                                CMP     CH,CL                   ; REACHED MAXIMUM YET
                                JNZ     CNT_OK                  ; CONTINUE TILL ALL TRIED

                        ;-----  FALL THRU, READ ID FAILED FOR ALL TRACKS

                        SD_ERR:
                                STC                             ; SET CARRY FOR ERROR
                                RET                             ; SETUP_DBL ERROR EXIT

                        DO_CHK:
                                MOV     CL,@NEC_STATUS+3        ; LOAD RETURNED TRACK
                                MOV     @DSK_TRK[DI],CL         ; STORE TRACK NUMBER
                                SHR     CH,1                    ; HALVE TRACK
                                CMP     CH,CL                   ; IS IT THE SAME AS ASKED FOR TRACK
                                JZ      NO_DBL                  ; IF SAME THEN NO DOUBLE STEP
                                OR      @DSK_STATE[DI],DBL_STEP ; TURN ON DOUBLE STEP REQUIRED

                        NO_DBL:
                                CLC                             ; CLEAR ERROR FLAG
                                RET
                        SETUP_DBL       ENDP
                        ;--------------------------------------------------------------------------------
                        ; READ_ID :     READ ID FUNCTION.
                        ;
                        ; ON ENTRY:     DI : BIT 2 = HEAD; BITS 1,0 = DRIVE
                        ;
                        ; ON EXIT:      DI : BIT 2 IS RESET, BITS 1,0 = DRIVE
                        ;               @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;--------------------------------------------------------------------------------
                        READ_ID PROC    NEAR
                                MOV     AX,OFFSET ER_3          ; MOVE NEC OUTPUT ERROR ADDRESS
                                PUSH    AX
                                MOV     AH,4AH                  ; READ ID COMMAND
                                CALL    NEC_OUTPUT              ; TO CONTROLLER
                                MOV     AX,DI                   ; DRIVE # TO AH, HEAD 0
                                MOV     AH,AL
                                CALL    NEC_OUTPUT              ; TO CONTROLLER
                                CALL    NEC_TERM                ; WAIT FOR OPERATION, GET STATUS
                                POP     AX                      ; THROW AWAY ERROR ADDRESS
                        ER_3:
                                RET
                        READ_ID ENDP
                        ;--------------------------------------------------------------------------------
                        ; CMOS_TYPE:    RETURNS DISKETTE TYPE FROM CMOS
                        ;
                        ; ON ENTRY:     DI : DRIVE #
                        ;
                        ; ON EXIT:      AL = TYPE (IF VALID)    ; CY REFLECTS STATUS
                        ;--------------------------------------------------------------------------------
                        CMOS_TYPE       PROC    NEAR
                                MOV     AL,CMOS_DIAG            ; CMOS DIAGNOSTIC STATUS BYTE ADDRESS
                                CALL    CMOS_READ               ; GET CMOS STATUS
                                TEST    AL,BAD_BAT+BAD_CKSUM    ; BATTERY GOOD AND CHECKSUM VALID ?
                                STC                             ; SET CY = 1 INDICATING ERROR FOR RETURN
                                JNZ     CMOS_T9                 ; ERROR EXIT IF EITHER ERROR BIT WAS ON
```

```
06BD B0 10                      MOV     AL,CMOS_DISKETTE        ; ADDRESS OF DISKETTE BYTE IN CMOS
06BF E8 0000 E                  CALL    CMOS_READ               ; GET DISKETTE BYTE
06C2 0B FF                      OR      DI,DI                   ; SEE WHICH DRIVE IN QUESTION
06C4 75 03                      JNZ     CMOS_T5                 ; IF DRIVE 1, DATA IN LOW NIBBLE

06C6 C0 C8 04                   ROR     AL,4                    ; EXCHANGE NIBBLES IF SECOND DRIVE
06C9                    CMOS_T5:
06C9 24 0F                      AND     AL,00FH                 ; KEEP ONLY DRIVE DATA, RESET CY = 0
06CB                    CMOS_T9:
06CB C3                         RET                             ; CY = STATUS OF READ
06CC                    CMOS_TYPE       ENDP
                        ;--------------------------------------------------------------------------
                        ; GET_PARM:      THIS ROUTINE FETCHES THE INDEXED POINTER FROM THE DISK_BASE
                        ;                BLOCK POINTED TO BY THE DATA VARIABLE @DISK_POINTER. A BYTE FROM
                        ;                THAT TABLE IS THEN MOVED INTO AH, THE INDEX OF THAT BYTE BEING
                        ;                THE PARAMETER IN DL.
                        ;
                        ; ON ENTRY:      DL = INDEX OF BYTE TO BE FETCHED
                        ;
                        ; ON EXIT:       AH = THAT BYTE FROM BLOCK
                        ;                AL,DH DESTROYED
                        ;--------------------------------------------------------------------------
06CC                    GET_PARM        PROC    NEAR
06CC 1E                         PUSH    DS
06CD 56                         PUSH    SI
06CE 2B C0                      SUB     AX,AX                   ; DS = 0 , BIOS DATA AREA
06D0 8E D8                      MOV     DS,AX
06D2 87 D3                      XCHG    DX,BX                   ; BL = INDEX
06D4 2A FF                      SUB     BH,BH                   ; BX = INDEX
                                ASSUME  DS:ABS0
06D6 C5 36 0078 R               LDS     SI,@DISK_POINTER        ; POINT TO BLOCK
06DA 8A 20                      MOV     AH,[SI+BX]              ; GET THE WORD
06DC 87 D3                      XCHG    DX,BX                   ; RESTORE BX
06DE 5E                         POP     SI
06DF 1F                         POP     DS
06E0 C3                         RET
                                ASSUME  DS:DATA
06E1                    GET_PARM        ENDP
                        ;--------------------------------------------------------------------------
                        ; MOTOR_ON :     TURN MOTOR ON AND WAIT FOR MOTOR START UP TIME. THE @MOTOR_COUNT
                        ;                IS REPLACED WITH A SUFFICIENTLY HIGH NUMBER (0FFH) TO ENSURE
                        ;                THAT THE MOTOR DOES NOT GO OFF DURING THE OPERATION. IF THE
                        ;                MOTOR NEEDED TO BE TURNED ON, THE MULTI-TASKING HOOK FUNCTION
                        ;                (AX=90FDH, INT 15H) IS CALLED TELLING THE OPERATING SYSTEM
                        ;                THAT THE BIOS IS ABOUT TO WAIT FOR MOTOR START UP. IF THIS
                        ;                FUNCTION RETURNS WITH CY = 1, IT MEANS THAT THE MINIMUM WAIT
                        ;                HAS BEEN COMPLETED. AT THIS POINT A CHECK IS MADE TO ENSURE
                        ;                THAT THE MOTOR WASN'T TURNED OFF BY THE TIMER. IF THE HOOK DID
                        ;                NOT WAIT, THE WAIT FUNCTION (AH=086H) IS CALLED TO WAIT THE
                        ;                PRESCRIBED AMOUNT OF TIME. IF THE CARRY FLAG IS SET ON RETURN,
                        ;                IT MEANS THAT THE FUNCTION IS IN USE AND DID NOT PERFORM THE
                        ;                WAIT. A TIMER 1 WAIT LOOP WILL THEN DO THE WAIT.
                        ;
                        ; ON ENTRY:      DI = DRIVE #
                        ;
                        ; ON EXIT:       AX,BX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------
06E1                    MOTOR_ON        PROC    NEAR
06E1 E8 072A R                  CALL    TURN_ON                 ; TURN ON MOTOR
06E4 72 43                      JC      MOT_IS_ON               ; IF CY=1 NO WAIT
06E6 E8 02EE R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
06E9 B8 90FD                    MOV     AX,090FDH               ; LOAD WAIT CODE & TYPE
06EC CD 15                      INT     15H                     ; TELL OPERATING SYSTEM ABOUT TO DO WAIT
06EE 9C                         PUSHF                           ; SAVE CY FOR TEST
06EF E8 02C8 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
06F2 9D                         POPF                            ; RESTORE CY FOR TEST
06F3 73 05                      JNC     M_WAIT                  ; BYPASS LOOP IF OP SYSTEM HANDLED WAIT
06F5 E8 072A R                  CALL    TURN_ON                 ; CHECK AGAIN IF MOTOR ON
06F8 72 2F                      JC      MOT_IS_ON               ; IF NO WAIT MEANS IT IS ON

06FA                    M_WAIT:
06FA B2 0A                      MOV     DL,10                   ; GET THE MOTOR WAIT PARAMETER
06FC E8 06CC R                  CALL    GET_PARM
06FF 8A C4                      MOV     AL,AH                   ; AL = MOTOR WAIT PARAMETER
0701 32 E4                      XOR     AH,AH                   ; AX = MOTOR WAIT PARAMETER
0703 3C 08                      CMP     AL,8                    ; SEE IF AT LEAST A SECOND IS SPECIFIED
0705 73 02                      JAE     GP2                     ; IF YES, CONTINUE
0707 B0 08                      MOV     AL,8                    ; ONE SECOND WAIT FOR MOTOR START UP

                        ;-----  AX CONTAINS NUMBER OF 1/8 SECONDS (125000 MICROSECONDS) TO WAIT

0709 50                 GP2:    PUSH    AX                      ; SAVE WAIT PARAMETER
070A BA F424                    MOV     DX,62500                ; LOAD LARGEST POSSIBLE MULTIPLIER
070D F7 E2                      MUL     DX                      ; MULTIPLY BY HALF OF WHAT'S NECESSARY
070F 8B CA                      MOV     CX,DX                   ; CX = HIGH WORD
0711 8B D0                      MOV     DX,AX                   ; CX,DX = 1/2 * (# OF MICROSECONDS)
0713 F8                         CLC                             ; CLEAR CARRY FOR ROTATE
0714 D1 D2                      RCL     DX,1                    ; DOUBLE LOW WORD, CY CONTAINS OVERFLOW
0716 D1 D1                      RCL     CX,1                    ; DOUBLE HI, INCLUDING LOW WORD OVERFLOW
0718 B4 86                      MOV     AH,86H                  ; LOAD WAIT CODE
071A CD 15                      INT     15H                     ; PERFORM WAIT
071C 58                         POP     AX                      ; RESTORE WAIT PARAMETER
071D 73 0A                      JNC     MOT_IS_ON               ; CY MEANS WAIT COULD NOT BE DONE

                        ;-----  FOLLOWING LOOPS REQUIRED WHEN RTC WAIT FUNCTION IS ALREADY IN USE

071F                    J13:                                    ;       WAIT FOR 1/8 SECOND PER (AL)
071F B9 205E                    MOV     CX,8286                 ; COUNT FOR 1/8 SECOND AT 15.085737 US
0722 E8 0000 E                  CALL    WAITF                   ; GO TO FIXED WAIT ROUTINE
0725 FE C8                      DEC     AL                      ; DECREMENT TIME VALUE
0727 75 F6                      JNZ     J13                     ; ARE WE DONE YET

0729                    MOT_IS_ON:
0729 C3                         RET
072A                    MOTOR_ON        ENDP
                        ;--------------------------------------------------------------------------
                        ; TURN_ON :      TURN MOTOR ON AND RETURN WAIT STATE.
                        ;
                        ; ON ENTRY:      DI = DRIVE #
                        ;
                        ; ON EXIT:       CY = 0 MEANS WAIT REQUIRED
                        ;                CY = 1 MEANS NO WAIT REQUIRED
                        ;                AX,BX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------
```

```
                        TURN_ON PROC    NEAR
                                MOV     BX,DI                   ; BX = DRIVE #
                                MOV     CL,BL                   ; CL = DRIVE #
                                ROL     BL,4                    ; BL = DRIVE SELECT
                                CLI                             ; NO INTERRUPTS WHILE DETERMINING STATUS
                                MOV     @MOTOR_COUNT,0FFH       ; ENSURE MOTOR STAYS ON FOR OPERATION
                                MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
                                AND     AL,00110000B            ; KEEP ONLY DRIVE SELECT BITS
                                MOV     AH,1                    ; MASK FOR DETERMINING MOTOR BIT
                                SHL     AH,CL                   ; AH = MOTOR ON, A=00000001, B=00000010

                        ;  AL = DRIVE SELECT FROM @MOTOR_STATUS
                        ;  BL = DRIVE SELECT DESIRED
                        ;  AH = MOTOR ON MASK DESIRED

                                CMP     AL,BL                   ; REQUESTED DRIVE ALREADY SELECTED ?
                                JNZ     TURN_IT_ON              ; IF NOT SELECTED JUMP
                                TEST    AH,@MOTOR_STATUS        ; TEST MOTOR ON BIT
                                JNZ     NO_MOT_WAIT             ; JUMP IF MOTOR ON AND SELECTED

                        TURN_IT_ON:
                                OR      AH,BL                   ; AH = DRIVE SELECT AND MOTOR ON
                                MOV     BH,@MOTOR_STATUS        ; SAVE COPY OF @MOTOR_STATUS BEFORE
                                AND     BH,00001111B            ; KEEP ONLY MOTOR BITS
                                AND     @MOTOR_STATUS,11001111B ; CLEAR OUT DRIVE SELECT
                                OR      @MOTOR_STATUS,AH        ; OR IN DRIVE SELECTED AND MOTOR ON
                                MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
                                MOV     BL,AL                   ; BL=@MOTOR_STATUS AFTER, BH=BEFORE
                                AND     BL,00001111B            ; KEEP ONLY MOTOR BITS
                                STI                             ; ENABLE INTERRUPTS AGAIN
                                AND     AL,00111111B            ; STRIP AWAY UNWANTED BITS
                                ROL     AL,4                    ; PUT BITS IN DESIRED POSITIONS
                                OR      AL,00001100B            ; NO RESET, ENABLE DMA/INTERRUPT
                                MOV     DX,03F2H                ; SELECT DRIVE AND TURN ON MOTOR
                                OUT     DX,AL                   ; "
                                CMP     BL,BH                   ; NEW MOTOR TURNED ON ?
                                JZ      NO_MOT_WAIT             ; NO WAIT REQUIRED IF JUST SELECT
                                CLC                             ; SET CARRY MEANING WAIT
                                RET

                        NO_MOT_WAIT:
                                STC                             ; SET NO WAIT REQUIRED
                                STI                             ; INTERRUPTS BACK ON
                                RET
                        TURN_ON ENDP
                        ;--------------------------------------------------------------------------
                        ; HD_WAIT :      WAIT FOR HEAD SETTLE TIME.
                        ;
                        ; ON ENTRY:      DI : DRIVE #
                        ;
                        ; ON EXIT:       AX,BX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------
                        HD_WAIT         PROC    NEAR
                                MOV     DL,9                    ; GET HEAD SETTLE PARAMETER
                                CALL    GET_PARM                ; "
                                TEST    @MOTOR_STATUS,10000000B ; SEE IF A WRITE OPERATION
                                JZ      ISNT_WRITE              ; IF NOT, DO NOT ENFORCE ANY VALUES
                                OR      AH,AH                   ; CHECK FOR ANY WAIT?
                                JNZ     DO_WAT                  ; IF THERE DO NOT ENFORCE
                                MOV     AH,HD12_SETTLE          ; LOAD 1.2M HEAD SETTLE MINIMUM
                                MOV     AL,@DSK_STATE[DI]       ; LOAD STATE
                                AND     AL,RATE_MSK             ; KEEP ONLY RATE
                                CMP     AL,RATE_250             ; 1.2 M DRIVE ?
                                JNZ     DO_WAT                  ; DEFAULT HEAD SETTLE LOADED

                                MOV     AH,HD320_SETTLE         ; USE 320/360 HEAD SETTLE
                                JMP     SHORT DO_WAT            ; "

                        ISNT_WRITE:
                                OR      AH,AH                   ; CHECK FOR NO WAIT
                                JZ      HW_DONE                 ; IF NOT WRITE AND 0 ITS OK

                        ;-----  AH CONTAINS NUMBER OF MILLISECONDS TO WAIT

                        DO_WAT:
                                MOV     AL,AH                   ; AL = # MILLISECONDS
                                XOR     AH,AH                   ; AX = # MILLISECONDS
                                PUSH    AX                      ; SAVE HEAD SETTLE PARAMETER
                                MOV     DX,1000                 ; SET UP FOR MULTIPLY TO MICROSECONDS
                                MUL     DX                      ; DX,AX = # MICROSECONDS
                                MOV     CX,DX                   ; CX,AX = # MICROSECONDS
                                MOV     DX,AX                   ; CX,DX = # MICROSECONDS
                                MOV     AH,86H                  ; LOAD WAIT CODE
                                INT     15H                     ; PERFORM WAIT
                                POP     AX                      ; RESTORE HEAD SETTLE PARAMETER
                                JNC     HW_DONE                 ; CHECK FOR EVENT WAIT ACTIVE

                        J29:                                    ;       1 MILLISECOND LOOP
                                MOV     CX,66                   ; COUNT AT 15.085737 US PER COUNT
                                CALL    WAITF                   ; DELAY FOR 1 MILLISECOND
                                DEC     AL                      ; DECREMENT THE COUNT
                                JNZ     J29                     ; DO AL MILLISECOND # OF TIMES
                        HW_DONE:
                                RET
                        HD_WAIT         ENDP
                        ;--------------------------------------------------------------------------
                        ; NEC_OUTPUT:    THIS ROUTINE SENDS A BYTE TO THE NEC CONTROLLER AFTER TESTING
                        ;                FOR CORRECT DIRECTION AND CONTROLLER READY THIS ROUTINE WILL
                        ;                TIME OUT IF THE BYTE IS NOT ACCEPTED WITHIN A REASONABLE AMOUNT
                        ;                OF TIME, SETTING THE DISKETTE STATUS ON COMPLETION.
                        ;
                        ; ON ENTRY:      AH = BYTE TO BE OUTPUT
                        ;
                        ; ON EXIT:       CY = 0  SUCCESS
                        ;                CY = 1  FAILURE -- DISKETTE STATUS UPDATED
                        ;                        IF A FAILURE HAS OCCURRED, THE RETURN IS MADE ONE LEVEL
                        ;                        HIGHER THAN THE CALLER OF NEC_OUTPUT. THIS REMOVES THE
                        ;                        REQUIREMENT OF TESTING AFTER EVERY CALL OF NEC_OUTPUT.
                        ;                AX,BX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------
                        NEC_OUTPUT      PROC    NEAR
                                MOV     DX,03F4H                ; STATUS PORT
                                MOV     BL,2                    ; HIGH ORDER COUNTER
                                XOR     CX,CX                   ; COUNT FOR TIME OUT
```

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                        J23:    IN      AL,DX                   ; GET STATUS
                                AND     AL,11000000B            ; KEEP STATUS AND DIRECTION
                                CMP     AL,10000000B            ; STATUS 1 AND DIRECTION 0 ?
                                JZ      J27                     ; STATUS AND DIRECTION OK
                                LOOP    J23                     ; CONTINUE TILL CX EXHAUSTED

                                DEC     BL                      ; DECREMENT COUNTER
                                JNZ     J23                     ; REPEAT TILL DELAY FINISHED, CX = 0

                        ;-----  FALL THRU TO ERROR RETURN

                                OR      @DSKETTE_STATUS,TIME_OUT
                                POP     AX                      ; DISCARD THE RETURN ADDRESS
                                STC                             ; INDICATE ERROR TO CALLER
                                RET

                        ;-----  DIRECTION AND STATUS OK; OUTPUT BYTE

                        J27:    MOV     AL,AH                   ; GET BYTE TO OUTPUT
                                INC     DX                      ; DATA PORT = STATUS PORT + 1
                                OUT     DX,AL                   ; OUTPUT THE BYTE
                                RET                             ; CY = 0 FROM TEST INSTRUCTION
                        NEC_OUTPUT      ENDP
                        ;--------------------------------------------------------------------------------
                        ; SEEK:         THIS ROUTINE WILL MOVE THE HEAD ON THE NAMED DRIVE TO THE NAMED
                        ;               TRACK.  IF THE DRIVE HAS NOT BEEN ACCESSED SINCE THE DRIVE
                        ;               RESET COMMAND WAS ISSUED, THE DRIVE WILL BE RECALIBRATED.
                        ;
                        ; ON ENTRY:     DI : DRIVE #
                        ;               CH : TRACK #
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                        ;               AX,BX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------------
                        SEEK    PROC    NEAR
                                MOV     BX,DI                   ; BX = DRIVE #
                                MOV     DX,OFFSET NEC_ERR       ; LOAD RETURN ADDRESS
                                PUSH    DX                      ; ON STACK FOR NEC_OUTPUT ERROR
                                MOV     AL,1                    ; ESTABLISH MASK FOR RECALIBRATE TEST
                                XCHG    CL,BL                   ; GET DRIVE VALUE INTO CL
                                ROL     AL,CL                   ; SHIFT MASK BY THE DRIVE VALUE
                                XCHG    CL,BL                   ; RECOVER TRACK VALUE
                                TEST    AL,@SEEK_STATUS         ; TEST FOR RECALIBRATE REQUIRED
                                JNZ     J28A                    ; JUMP IF RECALIBRATE NOT REQUIRED

                                OR      @SEEK_STATUS,AL         ; TURN ON THE NO RECALIBRATE BIT IN FLAG
                                CALL    RECAL                   ; RECALIBRATE DRIVE
                                JNC     AFT_RECAL               ; RECALIBRATE DONE

                        ;-----  ISSUE RECALIBRATE FOR 80 TRACK DISKETTES

                                MOV     @DSKETTE_STATUS,0       ; CLEAR OUT INVALID STATUS
                                CALL    RECAL                   ; RECALIBRATE DRIVE
                                JC      RB                      ; IF RECALIBRATE FAILS TWICE THEN ERROR
                        ;
                        AFT_RECAL:
                                MOV     @DSK_TRK[DI],0          ; SAVE NEW CYLINDER AS PRESENT POSITION
                                OR      CH,CH                   ; CHECK FOR SEEK TO TRACK 0
                                JZ      DO_WAIT                 ; HEAD SETTLE, CY = 0 IF JUMP

                        ;-----  DRIVE IS IN SYNCHRONIZATION WITH CONTROLLER, SEEK TO TRACK

                        J28A:   TEST    @DSK_STATE[DI],DBL_STEP ; CHECK FOR DOUBLE STEP REQUIRED
                                JZ      R7                      ; SINGLE STEP REQUIRED BYPASS DOUBLE
                                SHL     CH,1                    ; DOUBLE NUMBER OF STEP TO TAKE

                        R7:     CMP     CH,@DSK_TRK[DI]         ; SEE IF ALREADY AT THE DESIRED TRACK
                                JE      RB                      ; IF YES, DO NOT NEED TO SEEK

                                MOV     @DSK_TRK[DI],CH         ; SAVE NEW CYLINDER AS PRESENT POSITION
                                MOV     AH,0FH                  ; SEEK COMMAND TO NEC
                                CALL    NEC_OUTPUT
                                MOV     BX,DI                   ; BX = DRIVE #
                                MOV     AH,BL                   ; OUTPUT DRIVE NUMBER
                                CALL    NEC_OUTPUT
                                MOV     AH,@DSK_TRK[DI]         ; GET CYLINDER NUMBER
                                CALL    NEC_OUTPUT
                                CALL    CHK_STAT_2              ; ENDING INTERRUPT AND SENSE STATUS

                        ;-----  WAIT FOR HEAD SETTLE

                        DO_WAIT:
                                PUSHF                           ; SAVE STATUS
                                CALL    HD_WAIT                 ; WAIT FOR HEAD SETTLE TIME
                                POPF                            ; RESTORE STATUS
                        RB:
                                POP     AX                      ; CLEAR ERROR RETURN FROM NEC_OUTPUT
                        NEC_ERR:
                                RET                             ; RETURN TO CALLER
                        SEEK    ENDP
                        ;--------------------------------------------------------------------------------
                        ; RECAL :       RECALIBRATE DRIVE
                        ;
                        ; ON ENTRY      DI = DRIVE #
                        ;
                        ; ON EXIT:      CY  REFLECTS STATUS OF OPERATION.
                        ;--------------------------------------------------------------------------------
                        RECAL   PROC    NEAR
                                PUSH    CX
                                MOV     AX,OFFSET RC_BACK       ; LOAD NEC_OUTPUT ERROR
                                PUSH    AX
                                MOV     AH,07H                  ; RECALIBRATE COMMAND
                                CALL    NEC_OUTPUT
                                MOV     BX,DI                   ; BX = DRIVE #
                                MOV     AH,BL
                                CALL    NEC_OUTPUT              ; OUTPUT THE DRIVE NUMBER
                                CALL    CHK_STAT_2              ; GET THE INTERRUPT AND SENSE INT STATUS
                                POP     AX                      ; THROW AWAY ERROR
                        RC_BACK:
                                POP     CX
                                RET
                        RECAL   ENDP
                        ;--------------------------------------------------------------------------------
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                        ; CHK_STAT_2:   THIS ROUTINE HANDLES THE INTERRUPT RECEIVED AFTER RECALIBRATE,
                        ;               SEEK, OR RESET TO THE ADAPTER.  THE INTERRUPT IS WAITED FOR, THE
                        ;               INTERRUPT STATUS SENSED, AND THE RESULT RETURNED TO THE CALLER.
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                        ;--------------------------------------------------------------------------------
0855                    CHK_STAT_2      PROC    NEAR
0855 B8 0873 R                  MOV     AX,OFFSET CS_BACK       ; LOAD NEC_OUTPUT ERROR ADDRESS
0858 50                         PUSH    AX
0859 E8 087C R                  CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
085C 72 14                      JC      J34                     ; IF ERROR, RETURN IT
085E B4 08                      MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
0860 E8 07BD R                  CALL    NEC_OUTPUT
0863 E8 08A4 R                  CALL    RESULTS                 ; READ IN THE RESULTS
0866 72 0A                      JC      J34
0868 A0 0042 R                  MOV     AL,@NEC_STATUS          ; GET THE FIRST STATUS BYTE
086B 24 60                      AND     AL,01100000B            ; ISOLATE THE BITS
086D 3C 60                      CMP     AL,01100000B            ; TEST FOR CORRECT VALUE
086F 74 03                      JZ      J35                     ; IF ERROR, GO MARK IT
0871 F8                         CLC                             ; GOOD RETURN
0872                    J34:
0872 58                         POP     AX                      ; THROW AWAY ERROR RETURN
0873                    CS_BACK:
0873 C3                         RET

0874                    J35:
0874 80 0E 0041 R 40            OR      @DSKETTE_STATUS,BAD_SEEK
0879 F9                         STC                             ; ERROR RETURN CODE
087A EB F6                      JMP     SHORT J34
087C                    CHK_STAT_2      ENDP
                        ;--------------------------------------------------------------------------------
                        ; WAIT_INT:     THIS ROUTINE WAITS FOR AN INTERRUPT TO OCCUR A TIME OUT ROUTINE
                        ;               TAKES PLACE DURING THE WAIT, SO THAT AN ERROR MAY BE RETURNED
                        ;               IF THE DRIVE IS NOT READY.
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                        ;--------------------------------------------------------------------------------
087C                    WAIT_INT        PROC    NEAR
087C FB                         STI                             ; TURN ON INTERRUPTS, JUST IN CASE
087D F8                         CLC                             ; CLEAR TIMEOUT INDICATOR
087E B8 9001                    MOV     AX,09001H               ; LOAD WAIT CODE AND TYPE
0881 CD 15                      INT     15H                     ; PERFORM OTHER FUNCTION
0883 72 11                      JC      J36A                    ; BYPASS TIMING LOOP IF TIMEOUT DONE

0885 B3 04                      MOV     BL,4                    ; CLEAR THE COUNTERS
0887 33 C9                      XOR     CX,CX                   ; FOR 2 SECOND WAIT
0889                    J36:
0889 F6 06 003E R 80            TEST    @SEEK_STATUS,INT_FLAG   ; TEST FOR INTERRUPT OCCURRING
088E 75 0C                      JNZ     J37
0890 E2 F7                      LOOP    J36                     ; COUNT DOWN WHILE WAITING
0892 FE CB                      DEC     BL                      ; SECOND LEVEL COUNTER
0894 75 F3                      JNZ     J36

0896 80 0E 0041 R 80    J36A:   OR      @DSKETTE_STATUS,TIME_OUT        ; NOTHING HAPPENED
089B F9                         STC                             ; ERROR RETURN
089C                    J37:
089C 9C                         PUSHF                           ; SAVE CURRENT CARRY
089D 80 26 003E R 7F            AND     @SEEK_STATUS,NOT INT_FLAG       ; TURN OFF INTERRUPT FLAG
08A2 9D                         POPF                            ; RECOVER CARRY
08A3 C3                         RET                             ; GOOD RETURN CODE
08A4                    WAIT_INT        ENDP
                        ;--------------------------------------------------------------------------------
                        ; RESULTS:      THIS ROUTINE WILL READ ANYTHING THAT THE NEC CONTROLLER RETURNS
                        ;               FOLLOWING AN INTERRUPT.
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                        ;               AX,BX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------------
08A4                    RESULTS PROC    NEAR
08A4 57                         PUSH    DI
08A5 BF 0042 R                  MOV     DI,OFFSET @NEC_STATUS   ; POINTER TO DATA AREA
08A8 B3 07                      MOV     BL,7                    ; MAX STATUS BYTES
08AA BA 03F4                    MOV     DX,03F4H                ; STATUS PORT

                        ;-----  WAIT FOR REQUEST FOR MASTER

08AD B7 02              R10:    MOV     BH,2                    ; HIGH ORDER COUNTER
08AF 33 C9                      XOR     CX,CX                   ; COUNTER
08B1                    J39:                                    ; WAIT FOR MASTER
08B1 EC                         IN      AL,DX                   ; GET STATUS
08B2 24 C0                      AND     AL,11000000B            ; KEEP ONLY STATUS AND DIRECTION
08B4 3C C0                      CMP     AL,11000000B            ; STATUS 1 AND DIRECTION 0 ?
08B6 74 0E                      JZ      J42                     ; STATUS AND DIRECTION OK
08B8 E2 F7                      LOOP    J39                     ; LOOP TILL TIMEOUT

08BA FE CF                      DEC     BH                      ; DECREMENT HIGH ORDER COUNTER
08BC 75 F3                      JNZ     J39                     ; REPEAT TILL DELAY DONE

08BE 80 0E 0041 R 80            OR      @DSKETTE_STATUS,TIME_OUT
08C3 F9                         STC                             ; SET ERROR RETURN
08C4 EB 1B                      JMP     SHORT POPRES            ; POP REGISTERS AND RETURN

                        ;-----  READ IN THE STATUS

08C6                    J42:
08C6 42                         INC     DX                      ; POINT AT DATA PORT
08C7 EC                         IN      AL,DX                   ; GET THE DATA
08C8 88 05                      MOV     [DI],AL                 ; STORE THE BYTE
08CA 47                         INC     DI                      ; INCREMENT THE POINTER

08CB B9 0002                    MOV     CX,2                    ; MINIMUM 12 MICROSECONDS FOR NEC
08CE E8 0000 E                  CALL    WAITF                   ; WAIT 15 TO 30 MICROSECONDS
08D1 4A                         DEC     DX                      ; POINT AT STATUS PORT
08D2 EC                         IN      AL,DX                   ; GET STATUS
08D3 A8 10                      TEST    AL,00010000B            ; TEST FOR NEC STILL BUSY
08D5 74 0A                      JZ      POPRES                  ; RESULTS DONE ?

08D7 FE CB                      DEC     BL                      ; DECREMENT THE STATUS COUNTER
08D9 75 D2                      JNZ     R10                     ; GO BACK FOR MORE
08DB 80 0E 0041 R 20            OR      @DSKETTE_STATUS,BAD_NEC ; TOO MANY STATUS BYTES
08E0 F9                         STC                             ; SET ERROR FLAG

                        ;-----  RESULT OPERATION IS DONE
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                        POPRES:
                                POP     DI
                                RET                             ; RETURN WITH CARRY SET
                        RESULTS ENDP
                        ;--------------------------------------------------------------------------------
                        ; READ_DSKCHNG: READS THE STATE OF THE DISK CHANGE LINE.
                        ;
                        ; ON ENTRY:     DI = DRIVE #
                        ;
                        ; ON EXIT:      DI = DRIVE #
                        ;               ZERO FLAG = 0 : DISK CHANGE LINE INACTIVE
                        ;               ZERO FLAG = 1 : DISK CHANGE LINE ACTIVE
                        ;               AX,CX,DX DESTROYED
                        ;--------------------------------------------------------------------------------
                        READ_DSKCHNG    PROC    NEAR
                                CALL    MOTOR_ON                ; TURN ON THE MOTOR IF OFF
                                MOV     DX,03F7H                ; ADDRESS DIGITAL INPUT REGISTER
                                IN      AL,DX                   ; INPUT DIGITAL INPUT REGISTER
                                TEST    AL,DSK_CHG              ; CHECK FOR DISK CHANGE LINE ACTIVE
                                RET                             ; RETURN TO CALLER WITH ZERO FLAG SET
                        READ_DSKCHNG    ENDP
                        ;--------------------------------------------------------------------------------
                        ; DRIVE_DET:    DETERMINES WHETHER DRIVE IS 80 OR 40 TRACKS AND UPDATES STATE
                        ;               INFORMATION ACCORDINGLY.
                        ;
                        ; ON ENTRY:     DI = DRIVE #
                        ;--------------------------------------------------------------------------------
                        DRIVE_DET       PROC    NEAR
                                CALL    MOTOR_ON                ; TURN ON MOTOR IF NOT ALREADY ON
                                CALL    RECAL                   ; RECALIBRATE DRIVE
                                JC      DD_BAC                  ; ASSUME NO DRIVE PRESENT
                                MOV     CH,TRK_SLAP             ; SEEK TO TRACK 48
                                CALL    SEEK                    ; "
                                JC      DD_BAC                  ; ERROR NO DRIVE
                                MOV     CH,QUIET_SEEK+1         ; SEEK TO TRACK 10
                        SK_GIN:
                                DEC     CH                      ; DECREMENT TO NEXT TRACK
                                PUSH    CX                      ; SAVE TRACK
                                CALL    SEEK                    ; "
                                JC      POP_BAC                 ; POP AND RETURN
                                MOV     AX,OFFSET DD_BAC        ; LOAD NEC OUTPUT ERROR ADDRESS
                                PUSH    AX                      ; "
                                MOV     AH,SENSE_DRV_ST         ; SENSE DRIVE STATUS COMMAND BYTE
                                CALL    NEC_OUTPUT              ; OUTPUT TO NEC
                                MOV     AX,DI                   ; AL = DRIVE
                                MOV     AH,AL                   ; AH = DRIVE
                                CALL    NEC_OUTPUT              ; OUTPUT TO NEC
                                CALL    RESULTS                 ; GO GET STATUS
                                POP     AX                      ; THROW AWAY ERROR ADDRESS
                                POP     CX                      ; RESTORE TRACK
                                TEST    @NEC_STATUS,HOME        ; TRACK 0 ?
                                JZ      SK_GIN                  ; GO TILL TRACK 0
                                OR      CH,CH                   ; IS HOME AT TRACK 0 ?
                                JZ      IS_80                   ; MUST BE 80 TRACK DRIVE

                        ;       DRIVE IS A 360; SET DRIVE TO DETERMINED;
                        ;       SET MEDIA TO DETERMINED AT RATE 250.

                                OR      @DSK_STATE[DI],DRV_DET+MED_DET+RATE_250
                                RET                             ; ALL INFORMATION SET

                        IS_80:
                                OR      @DSK_STATE[DI],TRK_CAPA ; SETUP 80 TRACK CAPABILITY
                        DD_BAC:
                                RET

                        POP_BAC:
                                POP     CX                      ; THROW AWAY
                                RET

                        DRIVE_DET       ENDP
```

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                        PAGE
                        ;--- HARDWARE INT  08 H -- ( IRQ LEVEL  6 ) ----------------------------------
                        ;
                        ; DISK_INT       THIS ROUTINE HANDLES THE DISKETTE INTERRUPT.
                        ;
                        ; ON EXIT:       THE INTERRUPT FLAG IS SET IN @SEEK_STATUS.
                        ;
                        ;--------------------------------------------------------------------------------

0934                    DISK_INT_1      PROC    FAR                     ; ENTRY POINT FOR ORG 0EF57H
0934 FB                         STI                                     ; RE-ENABLE INTERRUPTS
0935 50                         PUSH    AX                              ; SAVE WORK REGISTER
0936 1E                         PUSH    DS                              ; SAVE REGISTERS
0937 E8 0000 E                  CALL    DDS                             ; SETUP DATA ADDRESSING
093A 80 0E 003E R 80            OR      @SEEK_STATUS,INT_FLAG           ; TURN ON INTERRUPT OCCURRED
093F 1F                         POP     DS                              ; RESTORE USER (DS)
0940 B0 20                      MOV     AL,EOI                          ; END OF INTERRUPT MARKER
0942 E6 20                      OUT     INTA00,AL                       ; INTERRUPT CONTROL PORT
0944 B8 9101                    MOV     AX,09101H                       ; INTERRUPT POST CODE AND TYPE
0947 CD 15                      INT     15H                             ; GO PERFORM OTHER TASK
0949 58                         POP     AX                              ; RECOVER REGISTER
094A CF                         IRET                                    ; RETURN FROM INTERRUPT

094B                    DISK_INT_1      ENDP


                        ;--------------------------------------------------------------------------------
                        ; DSKETTE_SETUP: THIS ROUTINE DOES A PRELIMINARY CHECK TO SEE WHAT TYPE OF
                        ;                DISKETTE DRIVES ARE ATTACH TO THE SYSTEM.
                        ;--------------------------------------------------------------------------------

094B                    DSKETTE_SETUP PROC      NEAR
094B 50                         PUSH    AX                              ; SAVE REGISTERS
094C 53                         PUSH    BX
094D 51                         PUSH    CX
094E 52                         PUSH    DX
094F 57                         PUSH    DI
0950 1E                         PUSH    DS
0951 E8 0000 E                  CALL    DDS                             ; POINT DATA SEGMENT TO BIOS DATA AREA
0954 80 0E 00A0 R 01            OR      @RTC_WAIT_FLAG,01               ; NO RTC WAIT, FORCE USE OF LOOP
0959 33 FF                      XOR     DI,DI                           ; INITIALIZE DRIVE POINTER
095B C7 06 0090 R 0000          MOV     WORD PTR @DSK_STATE,0           ; INITIALIZE STATES
0961 80 26 008B R 33            AND     @LASTRATE,NOT_STRT_MSK+SEND_MSK ; CLEAR START & SEND
0966 80 0E 008B R C0            OR      @LASTRATE,SEND_MSK              ; INITIALIZE SENT TO IMPOSSIBLE
096B C6 06 003E R 00            MOV     @SEEK_STATUS,0                  ; INDICATE RECALIBRATE NEEDED
0970 C6 06 0040 R 00            MOV     @MOTOR_COUNT,0                  ; INITIALIZE MOTOR COUNT
0975 C6 06 003F R 00            MOV     @MOTOR_STATUS,0                 ; INITIALIZE DRIVES TO OFF STATE
097A C6 06 0041 R 00            MOV     @DSKETTE_STATUS,0               ; NO ERRORS

097F                    SUP0:
097F E8 08ED R                  CALL    DRIVE_DET                       ; DETERMINE DRIVE
0982 E8 02EE R                  CALL    XLAT_OLD                        ; TRANSLATE STATE TO COMPATIBLE MODE
0985 47                         INC     DI                              ; POINT TO NEXT DRIVE
0986 83 FF 02                   CMP     DI,MAX_DRV                      ; SEE IF DONE
0989 75 F4                      JNZ     SUP0                            ; REPEAT FOR EACH DRIVE
098B C6 06 003E R 00            MOV     @SEEK_STATUS,0                  ; FORCE RECALIBRATE
0990 80 26 00A0 R FE            AND     @RTC_WAIT_FLAG,0FEH             ; ALLOW FOR RTC WAIT
0995 E8 0620 R                  CALL    SETUP_END                       ; VARIOUS CLEANUPS
0998 1F                         POP     DS                              ; RESTORE CALLERS REGISTERS
0999 5F                         POP     DI
099A 5A                         POP     DX
099B 59                         POP     CX
099C 5B                         POP     BX
099D 58                         POP     AX
099E C3                         RET

099F                    DSKETTE_SETUP ENDP

099F                    CODE    ENDS
                                END
```

SECTION 5

```
                        PAGE 118,121
                        TITLE DISK ----- 06/10/85  FIXED DISK BIOS
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  DISK_IO
                                PUBLIC  DISK_SETUP
                                PUBLIC  HD_INT

                                EXTRN   CMOS_READ:NEAR
                                EXTRN   CMOS_WRITE:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   E_MSG:NEAR
                                EXTRN   FT780:NEAR
                                EXTRN   F1781:NEAR
                                EXTRN   F1782:NEAR
                                EXTRN   F1790:NEAR
                                EXTRN   F1791:NEAR
                                EXTRN   FD_TBL:NEAR

                        ;--- INT 13H ------------------------------------------------------------------------
                        ;                                                                                   :
                        ; FIXED DISK I/O INTERFACE                                                          :
                        ;                                                                                   :
                        ;       THIS INTERFACE PROVIDES ACCESS TO 5 1/4" FIXED DISKS THROUGH                :
                        ;       THE IBM FIXED DISK CONTROLLER.                                              :
                        ;                                                                                   :
                        ;       THE  BIOS  ROUTINES  ARE  MEANT  TO  BE  ACCESSED  THROUGH                  :
                        ;       SOFTWARE  INTERRUPTS  ONLY.    ANY  ADDRESSES  PRESENT  IN                 :
                        ;       THESE  LISTINGS  ARE  INCLUDED  ONLY  FOR  COMPLETENESS,                    :
                        ;       NOT  FOR  REFERENCE.   APPLICATIONS  WHICH  REFERENCE  ANY                  :
                        ;       ABSOLUTE  ADDRESSES  WITHIN  THE  CODE  SEGMENTS  OF  BIOS                  :
                        ;       VIOLATE  THE  STRUCTURE  AND  DESIGN  OF  BIOS.                             :
                        ;                                                                                   :
                        ;-----------------------------------------------------------------------------------:
                        ;                                                                                   :
                        ; INPUT  (AH)= HEX COMMAND VALUE                                                    :
                        ;                                                                                   :
                        ;       (AH)= 00H  RESET DISK (DL = 80H,81H) / DISKETTE                             :
                        ;       (AH)= 01H  READ THE STATUS OF THE LAST DISK OPERATION INTO (AL)             :
                        ;                    NOTE: DL < 80H - DISKETTE                                      :
                        ;                          DL > 80H - DISK                                          :
                        ;       (AH)= 02H  READ THE DESIRED SECTORS INTO MEMORY                             :
                        ;       (AH)= 03H  WRITE THE DESIRED SECTORS FROM MEMORY                            :
                        ;       (AH)= 04H  VERIFY THE DESIRED SECTORS                                       :
                        ;       (AH)= 05H  FORMAT THE DESIRED TRACK                                         :
                        ;       (AH)= 06H  UNUSED                                                           :
                        ;       (AH)= 07H  UNUSED                                                           :
                        ;       (AH)= 08H  RETURN THE CURRENT DRIVE PARAMETERS                              :
                        ;       (AH)= 09H  INITIALIZE DRIVE PAIR CHARACTERISTICS                            :
                        ;                    INTERRUPT 41 POINTS TO DATA BLOCK FOR DRIVE 0                  :
                        ;                    INTERRUPT 46 POINTS TO DATA BLOCK FOR DRIVE 1                  :
                        ;       (AH)= 0AH  READ LONG                                                        :
                        ;       (AH)= 0BH  WRITE LONG  (READ & WRITE LONG ENCOMPASS 512 + 4 BYTES ECC)      :
                        ;       (AH)= 0CH  SEEK                                                             :
                        ;       (AH)= 0DH  ALTERNATE DISK RESET (SEE DL)                                    :
                        ;       (AH)= 0EH  UNUSED                                                           :
                        ;       (AH)= 0FH  UNUSED                                                           :
                        ;       (AH)= 10H  TEST DRIVE READY                                                 :
                        ;       (AH)= 11H  RECALIBRATE                                                      :
                        ;       (AH)= 12H  UNUSED                                                           :
                        ;       (AH)= 13H  UNUSED                                                           :
                        ;       (AH)= 14H  CONTROLLER INTERNAL DIAGNOSTIC                                   :
                        ;       (AH)= 15H  READ DASD TYPE                                                   :
                        ;                                                                                   :
                        ;-----------------------------------------------------------------------------------:
                        ;                                                                                   :
                        ;       REGISTERS USED FOR FIXED DISK OPERATIONS                                    :
                        ;                                                                                   :
                        ;               (DL)    -  DRIVE NUMBER      (80H-81H FOR DISK, VALUE CHECKED)      :
                        ;               (DH)    -  HEAD NUMBER       (0-15 ALLOWED, NOT VALUE CHECKED)      :
                        ;               (CH)    -  CYLINDER NUMBER   (0-1023, NOT VALUE CHECKED)(SEE CL)    :
                        ;               (CL)    -  SECTOR NUMBER     (1-17, NOT VALUE CHECKED)              :
                        ;                                                                                   :
                        ;                       NOTE: HIGH 2 BITS OF CYLINDER NUMBER ARE PLACED             :
                        ;                             IN THE HIGH 2 BITS OF THE CL REGISTER                 :
                        ;                             (10 BITS TOTAL)                                       :
                        ;                                                                                   :
                        ;               (AL)    -  NUMBER OF SECTORS (MAXIMUM POSSIBLE RANGE 1-80H,         :
                        ;                                             FOR READ/WRITE LONG 1-79H)            :
                        ;                                                                                   :
                        ;               (ES:BX) -  ADDRESS OF BUFFER FOR READS AND WRITES,                  :
                        ;                          (NOT REQUIRED FOR VERIFY)                                :
                        ;                                                                                   :
                        ;               FORMAT (AH=5) ES:BX POINTS TO A 512 BYTE BUFFER.  THE FIRST         :
                        ;                       2*(SECTORS/TRACK) BYTES CONTAIN F,N FOR EACH SECTOR.        :
                        ;                       F = 00H FOR A GOOD SECTOR                                   :
                        ;                           80H FOR A BAD SECTOR                                    :
                        ;                       N = SECTOR NUMBER                                           :
                        ;                       FOR AN INTERLEAVE OF 2 AND 17 SECTORS/TRACK                 :
                        ;                       THE TABLE SHOULD BE:                                        :
                        ;                                                                                   :
                        ;                  DB   00H,01H,00H,0AH,00H,02H,00H,0BH,00H,03H,00H,0CH             :
                        ;                  DB   00H,04H,00H,0DH,00H,05H,00H,0EH,00H,06H,00H,0FH             :
                        ;                  DB   00H,07H,00H,10H,00H,08H,00H,11H,00H,09H                     :
                        ;                                                                                   :
                        ;-----------------------------------------------------------------------------------:
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; OUTPUT                                                                        :
                        ;       AH = STATUS OF CURRENT OPERATION                                        :
                        ;            STATUS BITS ARE DEFINED IN THE EQUATES BELOW                       :
                        ;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN)                           :
                        ;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)                          :
                        ;                                                                               :
                        ;       NOTE:   ERROR 11H  INDICATES THAT THE DATA READ HAD A RECOVERABLE       :
                        ;               ERROR WHICH WAS CORRECTED BY THE ECC ALGORITHM.  THE DATA        :
                        ;               IS PROBABLY GOOD,  HOWEVER THE BIOS ROUTINE INDICATES AN        :
                        ;               ERROR TO ALLOW THE CONTROLLING PROGRAM A CHANCE TO DECIDE        :
                        ;               FOR  ITSELF.  THE  ERROR  MAY  NOT  RECUR  IF THE DATA IS       :
                        ;               REWRITTEN.                                                      :
                        ;                                                                               :
                        ;       IF DRIVE PARAMETERS WERE REQUESTED (DL >= 80H),                         :
                        ;          INPUT:                                                               :
                        ;            (DL) = DRIVE NUMBER                                                :
                        ;          OUTPUT:                                                              :
                        ;            (DL) = NUMBER OF CONSECUTIVE ACKNOWLEDGING DRIVES ATTACHED (1-2)   :
                        ;                   (CONTROLLER CARD ZERO TALLY ONLY)                           :
                        ;            (DH) = MAXIMUM USEABLE VALUE FOR HEAD NUMBER                       :
                        ;            (CH) = MAXIMUM USEABLE VALUE FOR CYLINDER NUMBER                   :
                        ;            (CL) = MAXIMUM USEABLE VALUE FOR SECTOR NUMBER                     :
                        ;                   AND CYLINDER NUMBER HIGH BITS                               :
                        ;                                                                               :
                        ;       IF READ DASD TYPE WAS REQUESTED,                                        :
                        ;                                                                               :
                        ;       AH = 0 - NOT PRESENT                                                    :
                        ;            1 - DISKETTE - NO CHANGE LINE AVAILABLE                            :
                        ;            2 - DISKETTE - CHANGE LINE AVAILABLE                               :
                        ;            3 - FIXED DISK                                                     :
                        ;       CX,DX = NUMBER OF 512 BYTE BLOCKS WHEN AH = 3                           :
                        ;                                                                               :
                        ;       REGISTERS WILL BE PRESERVED EXCEPT WHEN THEY ARE USED TO RETURN         :
                        ;       INFORMATION.                                                            :
                        ;                                                                               :
                        ;       NOTE: IF AN ERROR IS REPORTED BY THE DISK CODE, THE APPROPRIATE         :
                        ;             ACTION IS TO RESET THE DISK, THEN RETRY THE OPERATION.            :
                        ;                                                                               :
                        ;--------------------------------------------------------------------------------

= 00FF                  SENSE_FAIL      EQU     0FFH            ; NOT IMPLEMENTED
= 00E0                  NO_ERR          EQU     0E0H            ; STATUS ERROR/ERROR REGISTER=0
= 00CC                  WRITE_FAULT     EQU     0CCH            ; WRITE FAULT ON SELECTED DRIVE
= 00BB                  UNDEF_ERR       EQU     0BBH            ; UNDEFINED ERROR OCCURRED
= 00AA                  NOT_RDY         EQU     0AAH            ; DRIVE NOT READY
= 0080                  TIME_OUT        EQU     80H             ; ATTACHMENT FAILED TO RESPOND
= 0040                  BAD_SEEK        EQU     40H             ; SEEK OPERATION FAILED
= 0020                  BAD_CNTLR       EQU     20H             ; CONTROLLER HAS FAILED
= 0011                  DATA_CORRECTED  EQU     11H             ; ECC CORRECTED DATA ERROR
= 0010                  BAD_ECC         EQU     10H             ; BAD ECC ON DISK READ
= 000B                  BAD_TRACK       EQU     0BH             ; NOT IMPLEMENTED
= 000A                  BAD_SECTOR      EQU     0AH             ; BAD SECTOR FLAG DETECTED
= 0009                  DMA_BOUNDARY    EQU     09H             ; DATA EXTENDS TOO FAR
= 0007                  INIT_FAIL       EQU     07H             ; DRIVE PARAMETER ACTIVITY FAILED
= 0005                  BAD_RESET       EQU     05H             ; RESET FAILED
= 0004                  RECORD_NOT_FND  EQU     04H             ; REQUESTED SECTOR NOT FOUND
= 0002                  BAD_ADDR_MARK   EQU     02H             ; ADDRESS MARK NOT FOUND
= 0001                  BAD_CMD         EQU     01H             ; BAD COMMAND PASSED TO DISK I/O


                        ;--------------------------------------------------------
                        ;                                                       :
                        ; FIXED DISK PARAMETER TABLE                            :
                        ;                                                       :
                        ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:      :
                        ;                                                       :
                        ;  +0    (1 WORD) - MAXIMUM NUMBER OF CYLINDERS          :
                        ;  +2    (1 BYTE) - MAXIMUM NUMBER OF HEADS              :
                        ;  +3    (1 WORD) - NOT USED/SEE PC-XT                   :
                        ;  +5    (1 WORD) - STARTING WRITE PRECOMPENSATION CYL   :
                        ;  +7    (1 BYTE) - MAXIMUM ECC DATA BURST LENGTH        :
                        ;  +8    (1 BYTE) - CONTROL BYTE                         :
                        ;                   BIT    7 DISABLE RETRIES -OR-       :
                        ;                   BIT    6 DISABLE RETRIES            :
                        ;                   BIT    3 MORE THAN 8 HEADS          :
                        ;  +9    (3 BYTES)- NOT USED/SEE PC-XT                   :
                        ; +12    (1 WORD) - LANDING ZONE                         :
                        ; +14    (1 BYTE) - NUMBER OF SECTORS/TRACK              :
                        ; +15    (1 BYTE) - RESERVED FOR FUTURE USE              :
                        ;                                                       :
                        ;        - TO DYNAMICALLY DEFINE A SET OF PARAMETERS    :
                        ;          BUILD A TABLE FOR UP TO 15 TYPES AND PLACE   :
                        ;          THE CORRESPONDING VECTOR INTO INTERRUPT 41   :
                        ;          FOR DRIVE 0 AND INTERRUPT 46 FOR DRIVE 1.   :
                        ;                                                       :
                        ;--------------------------------------------------------
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                        PAGE
                        ;--------------------------------------------------------
                        ;                                                       :
                        ; HARDWARE SPECIFIC VALUES                              :
                        ;                                                       :
                        ;  -  CONTROLLER I/O PORT                               :
                        ;                                                       :
                        ;       > WHEN READ FROM:                               :
                        ;         HF_PORT+0 - READ DATA (FROM CONTROLLER TO CPU) :
                        ;         HF_PORT+1 - GET ERROR REGISTER                :
                        ;         HF_PORT+2 - GET SECTOR COUNT                  :
                        ;         HF_PORT+3 - GET SECTOR NUMBER                 :
                        ;         HF_PORT+4 - GET CYLINDER LOW                  :
                        ;         HF_PORT+5 - GET CYLINDER HIGH (2 BITS)        :
                        ;         HF_PORT+6 - GET SIZE/DRIVE/HEAD               :
                        ;         HF_PORT+7 - GET STATUS REGISTER               :
                        ;                                                       :
                        ;       > WHEN WRITTEN TO:                              :
                        ;         HF_PORT+0 - WRITE DATA (FROM CPU TO CONTROLLER) :
                        ;         HF_PORT+1 - SET PRECOMPENSATION CYLINDER      :
                        ;         HF_PORT+2 - SET SECTOR COUNT                  :
                        ;         HF_PORT+3 - SET SECTOR NUMBER                 :
                        ;         HF_PORT+4 - SET CYLINDER LOW                  :
                        ;         HF_PORT+5 - SET CYLINDER HIGH (2 BITS)        :
                        ;         HF_PORT+6 - SET SIZE/DRIVE/HEAD               :
                        ;         HF_PORT+7 - SET COMMAND REGISTER              :
                        ;                                                       :
                        ;--------------------------------------------------------

= 01F0                  HF_PORT         EQU     01F0H           ; DISK PORT
= 03F6                  HF_REG_PORT     EQU     03F6H

                        ;-----          STATUS REGISTER

= 0001                  ST_ERROR        EQU     00000001B       ;
= 0002                  ST_INDEX        EQU     00000010B       ;
= 0004                  ST_CORRCTD      EQU     00000100B       ; ECC CORRECTION SUCCESSFUL
= 0008                  ST_DRQ          EQU     00001000B       ;
= 0010                  ST_SEEK_COMPL   EQU     00010000B       ; SEEK COMPLETE
= 0020                  ST_WRT_FLT      EQU     00100000B       ; WRITE FAULT
= 0040                  ST_READY        EQU     01000000B       ;
= 0080                  ST_BUSY         EQU     10000000B       ;

                        ;-----          ERROR REGISTER

= 0001                  ERR_DAM         EQU     00000001B       ; DATA ADDRESS MARK NOT FOUND
= 0002                  ERR_TRK_0       EQU     00000010B       ; TRACK 0 NOT FOUND ON RECAL
= 0004                  ERR_ABORT       EQU     00000100B       ; ABORTED COMMAND
                        ;               EQU     00001000B       ; NOT USED
= 0010                  ERR_ID          EQU     00010000B       ; ID NOT FOUND
                        ;               EQU     00100000B       ; NOT USED
= 0040                  ERR_DATA_ECC    EQU     01000000B
= 0080                  ERR_BAD_BLOCK   EQU     10000000B


= 0010                  RECAL_CMD       EQU     00010000B       ; DRIVE RECAL    (10H)
= 0020                  READ_CMD        EQU     00100000B       ;       READ     (20H)
= 0030                  WRITE_CMD       EQU     00110000B       ;       WRITE    (30H)
= 0040                  VERIFY_CMD      EQU     01000000B       ;       VERIFY   (40H)
= 0050                  FMTTRK_CMD      EQU     01010000B       ; FORMAT TRACK   (50H)
= 0060                  INIT_CMD        EQU     01100000B       ;    INITIALIZE  (60H)
= 0070                  SEEK_CMD        EQU     01110000B       ;       SEEK     (70H)
= 0090                  DIAG_CMD        EQU     10010000B       ; DIAGNOSTIC     (90H)
= 0091                  SET_PARM_CMD    EQU     10010001B       ; DRIVE PARMS    (91H)
= 0001                  NO_RETRIES      EQU     00000001B       ; CMD MODIFIER   (01H)
= 0002                  ECC_MODE        EQU     00000010B       ; CMD MODIFIER   (02H)
= 0008                  BUFFER_MODE     EQU     00001000B       ; CMD MODIFIER   (08H)

= 0002                  MAX_FILE        EQU     2
= 0002                  S_MAX_FILE      EQU     2

= 0025                  DELAY_1         EQU     25H             ; DELAY FOR OPERATION COMPLETE
= 0600                  DELAY_2         EQU     0600H           ; DELAY FOR READY
= 0100                  DELAY_3         EQU     0100H           ; DELAY FOR DATA REQUEST

= 0008                  HF_FAIL         EQU     08H             ; CMOS FLAG IN BYTE 0EH

                        ;-----          COMMAND BLOCK REFERENCE

=                       @CMD_BLOCK      EQU     BYTE PTR [BP]-8 ; @CMD_BLOCK REFERENCES BLOCK HEAD IN SS
                                                                ;  (BP) POINTS TO COMMAND BLOCK TAIL
                                                                ;       AS DEFINED BY THE "ENTER" PARMS
```

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                        PAGE
                        ;--------------------------------------------------------
                        ; FIXED DISK I/O SETUP                                  :
                        ;                                                      :
                        ;  -  ESTABLISH TRANSFER VECTORS FOR THE FIXED DISK    :
                        ;  -  PERFORM POWER ON DIAGNOSTICS                     :
                        ;     SHOULD AN ERROR OCCUR A "1701" MESSAGE IS DISPLAYED :
                        ;                                                      :
                        ;--------------------------------------------------------
                                ASSUME  CS:CODE,DS:ABS0                 ; WORK OFF DS REGISTER

0000                    DISK_SETUP      PROC    NEAR
0000 FA                         CLI
0001 B8 ---- R                  MOV     AX,ABS0                         ; GET ABSOLUTE SEGMENT
0004 8E D8                      MOV     DS,AX                           ; SET SEGMENT REGISTER
0006 A1 004C R                  MOV     AX,WORD PTR @ORG_VECTOR         ; GET DISKETTE VECTOR
0009 A3 0100 R                  MOV     WORD PTR @DISK_VECTOR,AX        ;  INTO INT 40H
000C A1 004E R                  MOV     AX,WORD PTR @ORG_VECTOR+2
000F A3 0102 R                  MOV     WORD PTR @DISK_VECTOR+2,AX
0012 C7 06 004C R 01A9 R        MOV     WORD PTR @ORG_VECTOR,OFFSET DISK_IO     ; FIXED DISK HANDLER
0018 8C 0E 004E R               MOV     WORD PTR @ORG_VECTOR+2,CS
001C C7 06 01D8 R 06CD R        MOV     WORD PTR @HDISK_INT,OFFSET HD_INT       ; FIXED DISK INTERRUPT
0022 8C 0E 01DA R               MOV     WORD PTR @HDISK_INT+2,CS
0026 C7 06 0104 R 0000 E        MOV     WORD PTR @HF_TBL_VEC,OFFSET FD_TBL      ; PARM TABLE DRIVE 80
002C 8C 0E 0106 R               MOV     WORD PTR @HF_TBL_VEC+2,CS
0030 C7 06 0118 R 0000 E        MOV     WORD PTR @HF1_TBL_VEC,OFFSET FD_TBL     ; PARM TABLE DRIVE 81
0036 8C 0E 011A R               MOV     WORD PTR @HF1_TBL_VEC+2,CS
003A E4 A1                      IN      AL,INTB01               ; TURN ON SECOND INTERRUPT CHIP
003C 24 BF                      AND     AL,0BFH
003E EB 00                      JMP     $+2
0040 E6 A1                      OUT     INTB01,AL
0042 E4 21                      IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
0044 24 FB                      AND     AL,0FBH                 ;  SECOND CHIP
0046 EB 00                      JMP     $+2
0048 E6 21                      OUT     INTA01,AL

004A FB                         STI
                                ASSUME  DS:DATA,ES:ABS0
004B 1E                         PUSH    DS                      ; MOVE ABS0 POINTER TO
004C 07                         POP     ES                      ; EXTRA SEGMENT POINTER
004D E8 0000 E                  CALL    DDS                     ; ESTABLISH DATA SEGMENT
0050 C6 06 0074 R 00            MOV     @DISK_STATUS1,0         ; RESET THE STATUS INDICATOR
0055 C6 06 0075 R 00            MOV     @HF_NUM,0               ; ZERO NUMBER OF FIXED DISKS
005A C6 06 0076 R 00            MOV     @CONTROL_BYTE,0
005F B0 8E                      MOV     AL,CMOS_DIAG+NMI
0061 E8 0000 E                  CALL    CMOS_READ               ; CHECK CMOS VALIDITY
0064 8A E0                      MOV     AH,AL                   ; SAVE CMOS FLAG
0066 24 C0                      AND     AL,BAD_BAT+BAD_CKSUM    ; CHECK FOR VALID CMOS
0068 74 03                      JZ      L1
006A E9 00F8 R                  JMP     POD_DONE                ; CMOS NOT VALID -- NO FIXED DISKS
006D                    L1:
006D 80 E4 F7                   AND     AH,NOT HF_FAIL          ; ALLOW FIXED DISK IPL
0070 B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; WRITE IT BACK
0072 E8 0000 E                  CALL    CMOS_WRITE
0075 B0 92                      MOV     AL,CMOS_DISK+NMI
0077 E8 0000 E                  CALL    CMOS_READ
007A C6 06 0077 R 00            MOV     @PORT_OFF,0             ; ZERO CARD OFFSET
007F 8A D8                      MOV     BL,AL                   ; SAVE FIXED DISK BYTE
0081 25 00F0                    AND     AX,00F0H                ; GET FIRST DRIVE TYPE AS OFFSET
0084 74 72                      JZ      POD_DONE                ; NO FIXED DISKS

0086 3C F0                      CMP     AL,0F0H                 ; CHECK FOR EXTENDED DRIVE TYPE BYTE USE
0088 75 10                      JNE     L2                      ; USE DRIVE TYPE 1 --> 14 IF NOT IN USE

008A B0 99                      MOV     AL,CMOS_DISK_1+NMI      ; GET EXTENDED TYPE FOR DRIVE C:
008C E8 0000 E                  CALL    CMOS_READ               ; FROM CMOS
008F 3C 00                      CMP     AL,0                    ; IS TYPE SET TO ZERO
0091 74 65                      JE      POD_DONE                ; EXIT IF NOT VALID AND NO FIXED DISKS
0093 3C 2F                      CMP     AL,47                   ; IS TYPE WITHIN VALID RANGE
0095 77 61                      JA      POD_DONE                ; EXIT WITH NO FIXED DISKS IF NOT VALID
0097 C1 E0 04                   SHL     AX,4                    ; ADJUST TYPE TO HIGH NIBBLE
009A                    L2:
009A 05 FFF0 E                  ADD     AX,OFFSET FD_TBL-16D    ; COMPUTE OFFSET OF FIRST DRIVE TABLE
009D 26: A3 0104 R              MOV     WORD PTR @HF_TBL_VEC,AX ; SAVE IN VECTOR POINTER
00A1 C6 06 0075 R 01            MOV     @HF_NUM,1               ; AT LEAST ONE DRIVE
00A6 8A C3                      MOV     AL,BL
00A8 C0 E0 04                   SHL     AL,4                    ; GET SECOND DRIVE TYPE
00AB 74 2A                      JZ      SHORT L4                ; ONLY ONE DRIVE
00AD B4 00                      MOV     AH,0

00AF 3C F0                      CMP     AL,0F0H                 ; CHECK FOR EXTENDED DRIVE TYPE BYTE USE
00B1 75 10                      JNE     L3                      ; USE DRIVE TYPE 1 --> 14 IF NOT IN USE

00B3 B0 9A                      MOV     AL,CMOS_DISK_2+NMI      ; GET EXTENDED TYPE FOR DRIVE D:
00B5 E8 0000 E                  CALL    CMOS_READ               ; FROM CMOS
00B8 3C 00                      CMP     AL,0                    ; IS TYPE SET TO ZERO
00BA 74 1B                      JE      L4                      ; SKIP IF SECOND FIXED DISK NOT VALID
00BC 3C 2F                      CMP     AL,47                   ; IS TYPE WITHIN VALID RANGE
00BE 77 17                      JA      L4                      ; SKIP IF NOT VALID
00C0 C1 E0 04                   SHL     AX,4                    ; ADJUST TYPE TO HIGH NIBBLE
00C3                    L3:
00C3 05 FFF0 E                  ADD     AX,OFFSET FD_TBL-16D    ; COMPUTE OFFSET FOR SECOND FIXED DISK
00C6 8B D8                      MOV     BX,AX
00C8 2E: 83 3F 00               CMP     WORD PTR CS:[BX],0      ; CHECK FOR ZERO CYLINDERS IN TABLE
00CC 74 09                      JE      L4                      ; SKIP DRIVE IF NOT A VALID TABLE ENTRY
00CE 26: A3 0118 R              MOV     WORD PTR @HF1_TBL_VEC,AX
00D2 C6 06 0075 R 02            MOV     @HF_NUM,2               ; TWO DRIVES
00D7                    L4:
00D7 B2 80                      MOV     DL,80H                  ; CHECK THE CONTROLLER
00D9 B4 14                      MOV     AH,14H                  ; USE CONTROLLER DIAGNOSTIC COMMAND
00DB CD 13                      INT     13H                     ; CALL BIOS WITH DIAGNOSTIC COMMAND
00DD 72 1A                      JC      CTL_ERRX                ;  DISPLAY ERROR MESSAGE IF BAD RETURN
00DF A1 006C R                  MOV     AX,@TIMER_LOW           ; GET START TIMER COUNTS
00E2 8B D8                      MOV     BX,AX
00E4 05 0444                    ADD     AX,6*182                ; 60 SECONDS* 18.2
00E7 8B C8                      MOV     CX,AX
00E9 E8 0104 R                  CALL    HD_RESET_1              ; SET UP DRIVE 0
00EC 80 3E 0075 R 01            CMP     @HF_NUM,1               ; WERE THERE TWO DRIVES?
00F1 76 05                      JBE     POD_DONE                ; NO-ALL DONE
00F3 B2 81                      MOV     DL,81H                  ; SET UP DRIVE 1
00F5 E8 0104 R                  CALL    HD_RESET_1
00F8                    POD_DONE:
00F8 C3                         RET
```

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                        ;----- POD ERROR

                        CTL_ERRX:
00F9 BE 0000 E                  MOV     SI,OFFSET F1782         ; CONTROLLER ERROR
00FC E8 017C R                  CALL    SET_FAIL                ; DO NOT IPL FROM DISK
00FF E8 0000 E                  CALL    E_MSG                   ; DISPLAY ERROR AND SET (BP) ERROR FLAG
0102 EB F4                      JMP     POD_DONE

                        HD_RESET_1      PROC    NEAR
0104 53                         PUSH    BX                      ; SAVE TIMER LIMITS
0105 51                         PUSH    CX
0106 B4 09              RES_1:  MOV     AH,09H                  ; SET DRIVE PARAMETERS
0108 CD 13                      INT     13H
010A 72 06                      JC      RES_2
010C B4 11                      MOV     AH,11H                  ; RECALIBRATE DRIVE
010E CD 13                      INT     13H
0110 73 19                      JNC     RES_CK                  ; DRIVE OK
0112 E8 018A R          RES_2:  CALL    POD_TCHK                ; CHECK TIME OUT
0115 73 EF                      JNC     RES_1
0117 BE 0000 E          RES_FL: MOV     SI,OFFSET F1781         ; INDICATE DISK 1 FAILURE
011A F6 C2 01                   TEST    DL,1
011D 75 57                      JNZ     RES_E1
011F BE 0000 E                  MOV     SI,OFFSET F1780         ; INDICATE DISK 0 FAILURE
0122 E8 017C R                  CALL    SET_FAIL                ; DO NOT TRY TO IPL DISK 0
0125 EB 4F                      JMP     SHORT RES_E1
0127 B4 00              RES_RS: MOV     AH,00H                  ; RESET THE DRIVE
0129 CD 13                      INT     13H
012B B4 08              RES_CK: MOV     AH,08H                  ; GET MAX CYLINDER,HEAD,SECTOR
012D 8A DA                      MOV     BL,DL                   ; SAVE DRIVE CODE
012F CD 13                      INT     13H
0131 72 38                      JC      RES_ER
0133 89 0E 0042 R               MOV     WORD PTR @NEC_STATUS,CX ; SAVE MAX CYLINDER, SECTOR
0137 8A D3                      MOV     DL,BL                   ; RESTORE DRIVE CODE
0139 B8 0401            RES_3:  MOV     AX,0401H                ; VERIFY THE LAST SECTOR
013C CD 13                      INT     13H
013E 73 39                      JNC     RES_OK                  ; VERIFY OK
0140 80 FC 0A                   CMP     AH,BAD_SECTOR           ; OK ALSO IF JUST ID READ
0143 74 34                      JE      RES_OK
0145 80 FC 11                   CMP     AH,DATA_CORRECTED
0148 74 2F                      JE      RES_OK
014A 80 FC 10                   CMP     AH,BAD_ECC
014D 74 2A                      JE      RES_OK
014F E8 018A R                  CALL    POD_TCHK                ; CHECK FOR TIME OUT
0152 72 17                      JC      RES_ER                  ; FAILED
0154 8B 0E 0042 R               MOV     CX,WORD PTR @NEC_STATUS ; GET SECTOR ADDRESS, AND CYLINDER
0158 8A C1                      MOV     AL,CL                   ; SEPARATE OUT SECTOR NUMBER
015A 24 3F                      AND     AL,3FH
015C FE C8                      DEC     AL                      ; TRY PREVIOUS ONE
015E 74 C7                      JZ      RES_RS                  ; WE'VE TRIED ALL SECTORS ON TRACK
0160 80 E1 C0                   AND     CL,0C0H                 ; KEEP CYLINDER BITS
0163 0A C8                      OR      CL,AL                   ; MERGE SECTOR WITH CYLINDER BITS
0165 89 0E 0042 R               MOV     WORD PTR @NEC_STATUS,CX ; SAVE CYLINDER, NEW SECTOR NUMBER
0169 EB CE                      JMP     RES_3                   ; TRY AGAIN
016B BE 0000 E          RES_ER: MOV     SI,OFFSET F1791         ; INDICATE DISK 1 ERROR
016E F6 C2 01                   TEST    DL,1
0171 75 03                      JNZ     RES_E1
0173 BE 0000 E                  MOV     SI,OFFSET F1790         ; INDICATE DISK 0 ERROR
0176                    RES_E1:
0176 E8 0000 E                  CALL    E_MSG                   ; DISPLAY ERROR AND SET (BP) ERROR FLAG
0179                    RES_OK:
0179 59                         POP     CX                      ; RESTORE TIMER LIMITS
017A 5B                         POP     BX
017B C3                         RET
017C                    HD_RESET_1      ENDP

                        SET_FAIL        PROC    NEAR
017C B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; GET CMOS ERROR BYTE
017F E8 0000 E                  CALL    CMOS_READ
0182 0C 08                      OR      AL,HF_FAIL              ; SET DO NOT IPL FROM DISK FLAG
0184 86 E0                      XCHG    AH,AL                   ; SAVE IT
0186 E8 0000 E                  CALL    CMOS_WRITE              ; PUT IT OUT
0189 C3                         RET
018A                    SET_FAIL        ENDP

                        POD_TCHK        PROC NEAR               ; CHECK FOR 30 SECOND TIME OUT
018A 58                         POP     AX                      ; SAVE RETURN
018B 59                         POP     CX                      ; GET TIME OUT LIMITS
018C 5B                         POP     BX
018D 53                         PUSH    BX                      ; AND SAVE THEM AGAIN
018E 51                         PUSH    CX
018F 50                         PUSH    AX                      ; RESTORE RETURN
0190 A1 006C R                  MOV     AX,@TIMER_LOW           ; AX = CURRENT TIME
                                                                ; BX = START TIME
                                                                ; CX = END TIME
0193 3B D9                      CMP     BX,CX
0195 72 06                      JB      TCHK1                   ; START < END
0197 3B D8                      CMP     BX,AX
0199 72 0C                      JB      TCHKG                   ; END < START < CURRENT
019B EB 04                      JMP     SHORT TCHK2             ; END, CURRENT < START
019D 3B C3              TCHK1:  CMP     AX,BX
019F 72 04                      JB      TCHKNG                  ; CURRENT < START < END
01A1 3B C1              TCHK2:  CMP     AX,CX
01A3 72 02                      JB      TCHKG                   ; START < CURRENT < END
                                                                ; OR CURRENT < END < START
01A5 F9                 TCHKNG: STC                             ; CARRY SET INDICATES TIME OUT
01A6 C3                         RET
01A7 F8                 TCHKG:  CLC                             ; INDICATE STILL TIME
01A8 C3                         RET
01A9                    POD_TCHK        ENDP

01A9                    DISK_SETUP      ENDP
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                        PAGE
                        ;--------------------------------------
                        ;       FIXED DISK BIOS ENTRY POINT     :
                        ;--------------------------------------

01A9                    DISK_IO PROC    FAR
                                ASSUME  DS:DATA,ES:NOTHING
01A9 80 FA 80                   CMP     DL,80H                  ; TEST FOR FIXED DISK DRIVE
01AC 73 05                      JAE     A1                      ; YES, HANDLE HERE
01AE CD 40                      INT     40H                     ; DISKETTE HANDLER
01B0                    RET_2:
01B0 CA 0002                    RET     2                       ; BACK TO CALLER

01B3                    A1:
01B3 FB                         STI                             ; ENABLE INTERRUPTS
01B4 0A E4                      OR      AH,AH
01B6 75 09                      JNZ     A2
01B8 CD 40                      INT     40H                     ; RESET NEC WHEN AH=0
01BA 2A E4                      SUB     AH,AH
01BC 80 FA 81                   CMP     DL,(80H + S_MAX_FILE - 1)
01BF 77 EF                      JA      RET_2
01C1                    A2:
01C1 80 FC 08                   CMP     AH,08H                  ; GET PARAMETERS IS A SPECIAL CASE
01C4 75 03                      JNZ     A3
01C6 E9 0393 R                  JMP     GET_PARM_N
01C9 80 FC 15           A3:     CMP     AH,15H                  ; READ DASD TYPE IS ALSO
01CC 75 03                      JNZ     A4
01CE E9 0353 R                  JMP     READ_DASD_TYPE

01D1                    A4:                                     ;       SAVE REGISTERS DURING OPERATION
01D1 C8 0008 00                 ENTER   8,0                     ; SAVE (BP) AND MAKE ROOM FOR @CMD_BLOCK
01D5 53                         PUSH    BX                      ;  IN THE STACK. THE COMMAND BLOCK IS:
01D6 51                         PUSH    CX                      ;   @CMD_BLOCK == BYTE PTR [BP]-8
01D7 52                         PUSH    DX
01D8 1E                         PUSH    DS
01D9 06                         PUSH    ES
01DA 56                         PUSH    SI
01DB 57                         PUSH    DI
01DC 0A E4                      OR      AH,AH                   ; CHECK FOR RESET
01DE 75 02                      JNZ     A5
01E0 B2 80                      MOV     DL,80H                  ; FORCE DRIVE 80 FOR RESET
01E2 E8 0225 R          A5:     CALL    DISK_IO_CONT            ; PERFORM THE OPERATION
01E5 E8 0000 E                  CALL    DDS                     ; ESTABLISH SEGMENT
01E8 8A 26 0074 R               MOV     AH,@DISK_STATUS1        ; GET STATUS FROM OPERATION
01EC 80 FC 01                   CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
01EF F5                         CMC                             ;  SUCCESS OR FAILURE
01F0 5F                         POP     DI                      ; RESTORE REGISTERS
01F1 5E                         POP     SI
01F2 07                         POP     ES
01F3 1F                         POP     DS
01F4 5A                         POP     DX
01F5 59                         POP     CX
01F6 5B                         POP     BX
01F7 C9                         LEAVE                           ; ADJUST (SP) AND RESTORE (BP)
01F8 CA 0002                    RET     2                       ; THROW AWAY SAVED FLAGS
01FB                    DISK_IO ENDP

01FB                    M1      LABEL   WORD                    ; FUNCTION TRANSFER TABLE
01FB 02C1 R                     DW      DISK_RESET              ; 000H
01FD 0315 R                     DW      RETURN_STATUS           ; 001H
01FF 031E R                     DW      DISK_READ               ; 002H
0201 0325 R                     DW      DISK_WRITE              ; 003H
0203 032C R                     DW      DISK_VERF               ; 004H
0205 033E R                     DW      FMT_TRK                 ; 005H
0207 02B9 R                     DW      BAD_COMMAND             ; 006H  FORMAT BAD SECTORS
0209 02B9 R                     DW      BAD_COMMAND             ; 007H  FORMAT DRIVE
020B 02B9 R                     DW      BAD_COMMAND             ; 008H  RETURN PARAMETERS
020D 03F1 R                     DW      INIT_DRV                ; 009H
020F 0423 R                     DW      RD_LONG                 ; 00AH
0211 042A R                     DW      WR_LONG                 ; 00BH
0213 0431 R                     DW      DISK_SEEK               ; 00CH
0215 02C1 R                     DW      DISK_RESET              ; 00DH
0217 02B9 R                     DW      BAD_COMMAND             ; 00EH  READ BUFFER
0219 02B9 R                     DW      BAD_COMMAND             ; 00FH  WRITE BUFFER
021B 044F R                     DW      TST_RDY                 ; 010H
021D 0466 R                     DW      HDISK_RECAL             ; 011H
021F 02B9 R                     DW      BAD_COMMAND             ; 012H  MEMORY DIAGNOSTIC
0221 02B9 R                     DW      BAD_COMMAND             ; 013H  DRIVE DIAGNOSTIC
0223 048E R                     DW      CTLR_DIAGNOSTIC         ; 014H  CONTROLLER DIAGNOSTIC
= 002A                  M1L     EQU     $-M1

0225                    DISK_IO_CONT    PROC    NEAR
0225 E8 0000 E                  CALL    DDS                     ; ESTABLISH SEGMENT
0228 80 FC 01                   CMP     AH,01H                  ; RETURN STATUS
022B 75 03                      JNZ     SU0
022D E9 0315 R                  JMP     RETURN_STATUS
0230                    SU0:
0230 C6 06 0074 R 00            MOV     @DISK_STATUS1,0         ; RESET THE STATUS INDICATOR
0235 53                         PUSH    BX                      ; SAVE DATA ADDRESS
0236 8A 1E 0075 R               MOV     BL,@HF_NUM              ; GET NUMBER OF DRIVES
023A 50                         PUSH    AX
023B B0 E2 7F                   AND     DL,7FH                  ; GET DRIVE AS 0 OR 1
023E 3A DA                      CMP     BL,DL
0240 76 75                      JBE     BAD_COMMAND_POP         ; INVALID DRIVE
0242 06                         PUSH    ES
0243 E8 06B7 R                  CALL    GET_VEC                 ; GET DISK PARAMETERS
0246 26: 8B 47 05               MOV     AX,WORD PTR ES:[BX][5]  ; GET WRITE PRE-COMPENSATION CYLINDER
024A C1 E8 02                   SHR     AX,2
024D 88 46 F8                   MOV     @CMD_BLOCK,AL
0250 26: 8A 47 08               MOV     AL,BYTE PTR ES:[BX][8]  ; GET CONTROL BYTE MODIFIER
0254 52                         PUSH    DX
0255 BA 03F6                    MOV     DX,HF_REG_PORT
0258 EE                         OUT     DX,AL                   ; SET EXTRA HEAD OPTION
0259 5A                         POP     DX
025A 07                         POP     ES
025B 8A 26 0076 R               MOV     AH,@CONTROL_BYTE        ; SET EXTRA HEAD OPTION IN
025F 80 E4 C0                   AND     AH,0C0H                 ; CONTROL BYTE
0262 0A E0                      OR      AH,AL
0264 88 26 0076 R               MOV     @CONTROL_BYTE,AH
0268 58                         POP     AX
0269 88 46 F9                   MOV     @CMD_BLOCK+1,AL         ; SECTOR COUNT
026C 50                         PUSH    AX
026D 8A C1                      MOV     AL,CL                   ; GET SECTOR NUMBER
026F 24 3F                      AND     AL,3FH
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0271 88 46 FA                   MOV     @CMD_BLOCK+2,AL
0274 88 6E FB                   MOV     @CMD_BLOCK+3,CH         ; GET CYLINDER NUMBER
0277 8A C1                      MOV     AL,CL
0279 C0 E8 06                   SHR     AL,6
027C 88 46 FC                   MOV     @CMD_BLOCK+4,AL         ; CYLINDER HIGH ORDER 2 BITS
027F 8A C2                      MOV     AL,DL                   ; DRIVE NUMBER
0281 C0 E0 04                   SHL     AL,4
0284 80 E6 0F                   AND     DH,0FH                  ; HEAD NUMBER
0287 0A C6                      OR      AL,DH
0289 0C A0                      OR      AL,80H OR 20H           ; ECC AND 512 BYTE SECTORS
028B 88 46 FD                   MOV     @CMD_BLOCK+5,AL         ; ECC/SIZE/DRIVE/HEAD
028E 58                         POP     AX
028F 50                         PUSH    AX
0290 8A C4                      MOV     AL,AH                   ; GET INTO LOW BYTE
0292 32 E4                      XOR     AH,AH                   ; ZERO HIGH BYTE
0294 D1 E0                      SAL     AX,1                    ; *2 FOR TABLE LOOKUP
0296 8B F0                      MOV     SI,AX                   ; PUT INTO SI FOR BRANCH
0298 3D 002A                    CMP     AX,MIL                  ; TEST WITHIN RANGE
029B 73 1A                      JNB     BAD_COMMAND_POP
029D 58                         POP     AX                      ; RESTORE AX
029E 5B                         POP     BX                      ; AND DATA ADDRESS
029F 51                         PUSH    CX
02A0 50                         PUSH    AX                      ; ADJUST ES:BX
02A1 8B CB                      MOV     CX,BX                   ; GET 3 HIGH ORDER NIBBLES OF BX
02A3 C1 E9 04                   SHR     CX,4
02A6 8C C0                      MOV     AX,ES
02A8 03 C1                      ADD     AX,CX
02AA 8E C0                      MOV     ES,AX
02AC 81 E3 000F                 AND     BX,000FH                ; ES:BX CHANGED TO ES:000X
02B0 58                         POP     AX
02B1 59                         POP     CX
02B2 2E: FF A4 01FB R           JMP     WORD PTR CS:[SI + OFFSET M1]
02B7                    BAD_COMMAND_POP:
02B7 58                         POP     AX
02B8 5B                         POP     BX
02B9                    BAD_COMMAND:
02B9 C6 06 0074 R 01            MOV     @DISK_STATUS1,BAD_CMD   ; COMMAND ERROR
02BE B0 00                      MOV     AL,0
02C0 C3                         RET
02C1                    DISK_IO_CONT    ENDP

                        ;--------------------------------------
                        ;       RESET THE DISK SYSTEM  (AH=00H) :
                        ;--------------------------------------

02C1                    DISK_RESET      PROC    NEAR
02C1 FA                         CLI
02C2 E4 A1                      IN      AL,INTB01               ; GET THE MASK REGISTER
02C4 EB 00                      JMP     $+2
02C6 24 BF                      AND     AL,0BFH                 ; ENABLE FIXED DISK INTERRUPT
02C8 E6 A1                      OUT     INTB01,AL
02CA FB                         STI                             ; START INTERRUPTS
02CB B0 04                      MOV     AL,04H
02CD BA 03F6                    MOV     DX,HF_REG_PORT
02D0 EE                         OUT     DX,AL                   ; RESET
02D1 B9 000A                    MOV     CX,10                   ; DELAY COUNT
02D4 49                 DRD:    DEC     CX
02D5 75 FD                      JNZ     DRD                     ; WAIT 4.8 MICRO-SEC
02D7 A0 0076 R                  MOV     AL,@CONTROL_BYTE
02DA 24 0F                      AND     AL,0FH                  ; SET HEAD OPTION
02DC EE                         OUT     DX,AL                   ; TURN RESET OFF
02DD E8 05E6 R                  CALL    NOT_BUSY
02E0 75 2D                      JNZ     DRERR                   ; TIME OUT ON RESET
02E2 BA 01F1                    MOV     DX,HF_PORT+1
02E5 EC                         IN      AL,DX                   ; GET RESET STATUS
02E6 3C 01                      CMP     AL,1
02E8 75 25                      JNZ     DRERR                   ; BAD RESET STATUS
02EA 80 66 FD EF                AND     @CMD_BLOCK+5,0EFH       ; SET TO DRIVE 0
02EE 2A D2                      SUB     DL,DL
02F0 E8 03F1 R                  CALL    INIT_DRV                ; SET MAX HEADS
02F3 E8 0466 R                  CALL    HDISK_RECAL             ; RECAL TO RESET SEEK SPEED
02F6 80 3E 0075 R 01            CMP     @HF_NUM,1               ; CHECK FOR DRIVE 1
02FB 76 0C                      JBE     DRE
02FD 80 4E FD 10                OR      @CMD_BLOCK+5,010H       ; SET TO DRIVE 1
0301 B2 01                      MOV     DL,1
0303 E8 03F1 R                  CALL    INIT_DRV                ; SET MAX HEADS
0306 E8 0466 R                  CALL    HDISK_RECAL             ; RECAL TO RESET SEEK SPEED
0309 C6 06 0074 R 00    DRE:    MOV     @DISK_STATUS1,0         ; IGNORE ANY SET UP ERRORS
030E C3                         RET
030F C6 06 0074 R 05    DRERR:  MOV     @DISK_STATUS1,BAD_RESET ; CARD FAILED
0314 C3                         RET
0315                    DISK_RESET      ENDP

                        ;--------------------------------------
                        ;       DISK STATUS ROUTINE  (AH = 01H) :
                        ;--------------------------------------

0315                    RETURN_STATUS   PROC    NEAR
0315 A0 0074 R                  MOV     AL,@DISK_STATUS1        ; OBTAIN PREVIOUS STATUS
0318 C6 06 0074 R 00            MOV     @DISK_STATUS1,0         ; RESET STATUS
031D C3                         RET
031E                    RETURN_STATUS   ENDP
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                        PAGE
                        ;--------------------------------------
                        ;       DISK READ ROUTINE     (AH = 02H) :
                        ;--------------------------------------

031E                    DISK_READ       PROC    NEAR
031E C6 46 FE 20                MOV     @CMD_BLOCK+6,READ_CMD
0322 E9 04C6 R                  JMP     COMMAND1
0325                    DISK_READ       ENDP

                        ;--------------------------------------
                        ;       DISK WRITE ROUTINE    (AH = 03H) :
                        ;--------------------------------------

0325                    DISK_WRITE      PROC    NEAR
0325 C6 46 FE 30                MOV     @CMD_BLOCK+6,WRITE_CMD
0329 E9 0505 R                  JMP     COMMAND0
032C                    DISK_WRITE      ENDP

                        ;--------------------------------------
                        ;       DISK VERIFY           (AH = 04H) :
                        ;--------------------------------------

032C                    DISK_VERF       PROC    NEAR
032C C6 46 FE 40                MOV     @CMD_BLOCK+6,VERIFY_CMD
0330 E8 054F R                  CALL    COMMAND
0333 75 08                      JNZ     VERF_EXIT               ; CONTROLLER STILL BUSY
0335 E8 05B5 R                  CALL    WAIT
0338 75 03                      JNZ     VERF_EXIT               ; TIME OUT
033A E8 0623 R                  CALL    CHECK_STATUS
033D                    VERF_EXIT:
033D C3                         RET
033E                    DISK_VERF       ENDP

                        ;--------------------------------------
                        ;       FORMATTING            (AH = 05H) :
                        ;--------------------------------------

033E                    FMT_TRK PROC    NEAR                    ; FORMAT TRACK  (AH = 005H)
033E C6 46 FE 50                MOV     @CMD_BLOCK+6,FMTTRK_CMD
0342 06                         PUSH    ES
0343 53                         PUSH    BX
0344 E8 06B7 R                  CALL    GET_VEC                 ; GET DISK PARAMETERS ADDRESS
0347 26: 8A 47 0E               MOV     AL,ES:[BX][14]          ; GET SECTORS/TRACK
034B 88 46 F9                   MOV     @CMD_BLOCK+1,AL         ; SET SECTOR COUNT IN COMMAND
034E 5B                         POP     BX
034F 07                         POP     ES
0350 E9 050A R                  JMP     CMD_OF                  ; GO EXECUTE THE COMMAND
0353                    FMT_TRK ENDP


                        ;--------------------------------------
                        ;       READ DASD TYPE        (AH = 15H) :
                        ;--------------------------------------

0353                    READ_DASD_TYPE  LABEL   NEAR
0353                    READ_D_T        PROC    FAR             ; GET DRIVE PARAMETERS
0353 1E                         PUSH    DS                      ; SAVE REGISTERS
0354 06                         PUSH    ES
0355 53                         PUSH    BX
                                ASSUME  DS:DATA
0356 E8 0000 E                  CALL    DDS                     ; ESTABLISH ADDRESSING
0359 C6 06 0074 R 00            MOV     @DISK_STATUS1,0
035E 8A 1E 0075 R               MOV     BL,@HF_NUM              ; GET NUMBER OF DRIVES
0362 80 E2 7F                   AND     DL,7FH                  ; GET DRIVE NUMBER
0365 3A DA                      CMP     BL,DL
0367 76 22                      JBE     RDT_NOT_PRESENT         ; RETURN DRIVE NOT PRESENT
0369 E8 06B7 R                  CALL    GET_VEC                 ; GET DISK PARAMETER ADDRESS
036C 26: 8A 47 02               MOV     AL,ES:[BX][2]           ; HEADS
0370 26: 8A 4F 0E               MOV     CL,ES:[BX][14]
0374 F6 E9                      IMUL    CL                      ; * NUMBER OF SECTORS
0376 26: 8B 0F                  MOV     CX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
0379 49                         DEC     CX                      ; LEAVE ONE FOR DIAGNOSTICS
037A F7 E9                      IMUL    CX                      ; NUMBER OF SECTORS
037C 8B CA                      MOV     CX,DX                   ; HIGH ORDER HALF
037E 8B D0                      MOV     DX,AX                   ; LOW ORDER HALF
0380 2B C0                      SUB     AX,AX
0382 B4 03                      MOV     AH,03H                  ; INDICATE FIXED DISK
0384 5B                 RDT2:   POP     BX                      ; RESTORE REGISTERS
0385 07                         POP     ES
0386 1F                         POP     DS
0387 F8                         CLC                             ; CLEAR CARRY
0388 CA 0002                    RET     2
038B                    RDT_NOT_PRESENT:
038B 2B C0                      SUB     AX,AX                   ; DRIVE NOT PRESENT RETURN
038D 8B C8                      MOV     CX,AX                   ; ZERO BLOCK COUNT
038F 8B D0                      MOV     DX,AX
0391 EB F1                      JMP     RDT2
0393                    READ_D_T        ENDP
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                        ;--------------------------------------
                        ;       GET PARAMETERS          (AH = 08H) :
                        ;--------------------------------------

0393                    GET_PARM_N      LABEL   NEAR
0393                    GET_PARM        PROC    FAR             ; GET DRIVE PARAMETERS
0393 1E                         PUSH    DS                      ; SAVE REGISTERS
0394 06                         PUSH    ES
0395 53                         PUSH    BX
                                ASSUME  DS:ABS0
0396 B8 ---- R                  MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
0399 8E D8                      MOV     DS,AX
039B F6 C2 01                   TEST    DL,1                    ; CHECK FOR DRIVE 1
039E 74 06                      JZ      G0
03A0 C4 1E 0118 R               LES     BX,@HF1_TBL_VEC
03A4 EB 04                      JMP     SHORT G1
03A6 C4 1E 0104 R       G0:     LES     BX,@HF_TBL_VEC
                                ASSUME  DS:DATA
03AA                    G1:
03AA E8 0000 E                  CALL    DDS                     ; ESTABLISH SEGMENT
03AD 80 EA 80                   SUB     DL,80H
03B0 80 FA 02                   CMP     DL,MAX_FILE             ; TEST WITHIN RANGE
03B3 73 2C                      JAE     G4
03B5 C6 06 0074 R 00            MOV     @DISK_STATUS1,0
03BA 26: 8B 07                  MOV     AX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
03BD 2D 0002                    SUB     AX,2                    ; ADJUST FOR 0-N
03C0 8A E8                      MOV     CH,AL
03C2 25 0300                    AND     AX,0300H                ; HIGH TWO BITS OF CYLINDER
03C5 D1 E8                      SHR     AX,1
03C7 D1 E8                      SHR     AX,1
03C9 26: 0A 47 0E               OR      AL,ES:[BX][14]          ; SECTORS
03CD 8A C8                      MOV     CL,AL
03CF 26: 8A 77 02               MOV     DH,ES:[BX][2]           ; HEADS
03D3 FE CE                      DEC     DH                      ; 0-N RANGE
03D5 8A 16 0075 R               MOV     DL,@HF_NUM              ; DRIVE COUNT
03D9 2B C0                      SUB     AX,AX
03DB                    G5:
03DB 5B                         POP     BX                      ; RESTORE REGISTERS
03DC 07                         POP     ES
03DD 1F                         POP     DS
03DE CA 0002                    RET     2
03E1                    G4:
03E1 C6 06 0074 R 07            MOV     @DISK_STATUS1,INIT_FAIL ; OPERATION FAILED
03E6 B4 07                      MOV     AH,INIT_FAIL
03E8 2A C0                      SUB     AL,AL
03EA 2B D2                      SUB     DX,DX
03EC 2B C9                      SUB     CX,CX
03EE F9                         STC                             ; SET ERROR FLAG
03EF EB EA                      JMP     G5
03F1                    GET_PARM        ENDP

                        ;--------------------------------------
                        ;       INITIALIZE DRIVE        (AH = 09H) :
                        ;--------------------------------------

03F1                    INIT_DRV        PROC    NEAR
03F1 C6 46 FE 91                MOV     @CMD_BLOCK+6,SET_PARM_CMD
03F5 E8 06B7 R                  CALL    GET_VEC                 ; ES:BX -> PARAMETER BLOCK
03F8 26: 8A 47 02               MOV     AL,ES:[BX][2]           ; GET NUMBER OF HEADS
03FC FE C8                      DEC     AL                      ; CONVERT TO 0-INDEX
03FE 8A 66 FD                   MOV     AH,@CMD_BLOCK+5         ; GET SDH REGISTER
0401 80 E4 F0                   AND     AH,0F0H                 ; CHANGE HEAD NUMBER
0404 0A E0                      OR      AH,AL                   ;  TO MAX HEAD
0406 88 66 FD                   MOV     @CMD_BLOCK+5,AH
0409 26: 8A 47 0E               MOV     AL,ES:[BX][14]          ; MAX SECTOR NUMBER
040D 88 46 F9                   MOV     @CMD_BLOCK+1,AL
0410 2B C0                      SUB     AX,AX
0412 88 46 FB                   MOV     @CMD_BLOCK+3,AL         ; ZERO FLAGS
0415 E8 054F R                  CALL    COMMAND                 ; TELL CONTROLLER
0418 75 08                      JNZ     INIT_EXIT               ; CONTROLLER BUSY ERROR
041A E8 05E6 R                  CALL    NOT_BUSY                ; WAIT FOR IT TO BE DONE
041D 75 03                      JNZ     INIT_EXIT               ; TIME OUT
041F E8 0623 R                  CALL    CHECK_STATUS
0422                    INIT_EXIT:
0422 C3                         RET
0423                    INIT_DRV        ENDP

                        ;--------------------------------------
                        ;       READ LONG               (AH = 0AH) :
                        ;--------------------------------------

0423                    RD_LONG         PROC    NEAR
0423 C6 46 FE 22                MOV     @CMD_BLOCK+6,READ_CMD OR ECC_MODE
0427 E9 04C6 R                  JMP     COMMAND1
042A                    RD_LONG         ENDP

                        ;--------------------------------------
                        ;       WRITE LONG              (AH = 0BH) :
                        ;--------------------------------------

042A                    WR_LONG         PROC    NEAR
042A C6 46 FE 32                MOV     @CMD_BLOCK+6,WRITE_CMD OR ECC_MODE
042E E9 0505 R                  JMP     COMMAND0
0431                    WR_LONG         ENDP

                        ;--------------------------------------
                        ;       SEEK                    (AH = 0CH) :
                        ;--------------------------------------

0431                    DISK_SEEK       PROC    NEAR
0431 C6 46 FE 70                MOV     @CMD_BLOCK+6,SEEK_CMD
0435 E8 054F R                  CALL    COMMAND
0438 75 14                      JNZ     DS_EXIT                 ; CONTROLLER BUSY ERROR
043A E8 05B5 R                  CALL    WAIT
043D 75 0F                      JNZ     DS_EXIT                 ; TIME OUT ON SEEK
043F E8 0623 R                  CALL    CHECK_STATUS
0442 80 3E 0074 R 40            CMP     @DISK_STATUS1,BAD_SEEK
0447 75 05                      JNE     DS_EXIT
0449 C6 06 0074 R 00            MOV     @DISK_STATUS1,0
044E                    DS_EXIT:
044E C3                         RET

044F                    DISK_SEEK       ENDP
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                        ;--------------------------------------
                        ;       TEST DISK READY         (AH = 10H) :
                        ;--------------------------------------

044F                    TST_RDY PROC    NEAR
044F E8 05E6 R                  CALL    NOT_BUSY                ; WAIT FOR CONTROLLER
0452 75 11                      JNZ     TR_EX
0454 8A 46 FD                   MOV     AL,@CMD_BLOCK+5         ; SELECT DRIVE
0457 BA 01F6                    MOV     DX,HF_PORT+6
045A EE                         OUT     DX,AL
045B E8 0635 R                  CALL    CHECK_ST                ; CHECK STATUS ONLY
045E 75 05                      JNZ     TR_EX
0460 C6 06 0074 R 00            MOV     @DISK_STATUS1,0         ; WIPE OUT DATA CORRECTED ERROR
0465 C3                 TR_EX:  RET
0466                    TST_RDY ENDP

                        ;--------------------------------------
                        ;       RECALIBRATE             (AH = 11H) :
                        ;--------------------------------------

0466                    HDISK_RECAL     PROC    NEAR
0466 C6 46 FE 10                MOV     @CMD_BLOCK+6,RECAL_CMD
046A E8 054F R                  CALL    COMMAND                 ; START THE OPERATION
046D 75 19                      JNZ     RECAL_EXIT              ; ERROR
046F E8 05B5 R                  CALL    WAIT                    ; WAIT FOR COMPLETION
0472 74 05                      JZ      RECAL_X                 ; TIME OUT ONE OK ?
0474 E8 05B5 R                  CALL    WAIT                    ; WAIT FOR COMPLETION LONGER
0477 75 0F                      JNZ     RECAL_EXIT              ; TIME OUT TWO TIMES IS ERROR
0479                    RECAL_X:
0479 E8 0623 R                  CALL    CHECK_STATUS
047C 80 3E 0074 R 40            CMP     @DISK_STATUS1,BAD_SEEK  ; SEEK NOT COMPLETE
0481 75 05                      JNE     RECAL_EXIT              ; IS OK
0483 C6 06 0074 R 00            MOV     @DISK_STATUS1,0
0488                    RECAL_EXIT:
0488 80 3E 0074 R 00            CMP     @DISK_STATUS1,0
048D C3                         RET
048E                    HDISK_RECAL     ENDP

                        ;--------------------------------------
                        ;       CONTROLLER DIAGNOSTIC (AH = 14H) :
                        ;--------------------------------------

048E                    CTLR_DIAGNOSTIC PROC    NEAR
048E FA                         CLI                             ; DISABLE INTERRUPTS WHILE CHANGING MASK
048F E4 A1                      IN      AL,INTB01               ; TURN ON SECOND INTERRUPT CHIP
0491 24 BF                      AND     AL,0BFH
0493 EB 00                      JMP     $+2
0495 E6 A1                      OUT     INTB01,AL
0497 E4 21                      IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
0499 24 FB                      AND     AL,0FBH                 ;  SECOND CHIP
049B EB 00                      JMP     $+2
049D E6 21                      OUT     INTA01,AL
049F FB                         STI
04A0 E8 05E6 R                  CALL    NOT_BUSY                ; WAIT FOR CARD
04A3 75 1A                      JNZ     CD_ERR                  ; BAD CARD
04A5 BA 01F7                    MOV     DX,HF_PORT+7
04A8 B0 90                      MOV     AL,DIAG_CMD             ; START DIAGNOSE
04AA EE                         OUT     DX,AL
04AB E8 05E6 R                  CALL    NOT_BUSY                ; WAIT FOR IT TO COMPLETE
04AE B4 80                      MOV     AH,TIME_OUT
04B0 75 0F                      JNZ     CD_EXIT                 ; TIME OUT ON DIAGNOSTIC
04B2 BA 01F1                    MOV     DX,HF_PORT+1            ; GET ERROR REGISTER
04B5 EC                         IN      AL,DX
04B6 A2 008D R                  MOV     @HF_ERROR,AL            ; SAVE IT
04B9 B4 00                      MOV     AH,0
04BB 3C 01                      CMP     AL,1                    ; CHECK FOR ALL OK
04BD 74 02                      JE      SHORT CD_EXIT
04BF B4 20              CD_ERR: MOV     AH,BAD_CNTLR
04C1                    CD_EXIT:
04C1 88 26 0074 R               MOV     @DISK_STATUS1,AH
04C5 C3                         RET
04C6                    CTLR_DIAGNOSTIC ENDP

                        ;--------------------------------------
                        ; COMMAND1                             :
                        ;       REPEATEDLY INPUTS DATA TILL     :
                        ;       NSECTOR RETURNS ZERO            :
                        ;--------------------------------------

04C6                    COMMAND1:
04C6 E8 0694 R                  CALL    CHECK_DMA               ; CHECK 64K BOUNDARY ERROR
04C9 72 39                      JC      CMD_ABORT
04CB 8B FB                      MOV     DI,BX
04CD E8 054F R                  CALL    COMMAND                 ; OUTPUT COMMAND
04D0 75 32                      JNZ     CMD_ABORT
04D2                    CMD_11:
04D2 E8 05B5 R                  CALL    WAIT                    ; WAIT FOR DATA REQUEST INTERRUPT
04D5 75 2D                      JNZ     TM_OUT                  ; TIME OUT
04D7 B9 0100                    MOV     CX,256D                 ; SECTOR SIZE IN WORDS
04DA BA 01F0                    MOV     DX,HF_PORT
04DD FA                         CLI
04DE FC                         CLD
04DF F3/ 6D                     REP     INSW                    ; GET THE SECTOR
04E1 FB                         STI
04E2 F6 46 FE 02                TEST    @CMD_BLOCK+6,ECC_MODE   ; CHECK FOR NORMAL INPUT
04E6 74 12                      JZ      CMD_13
04E8 E8 060D R                  CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
04EB 72 17                      JC      TM_OUT
04ED BA 01F0                    MOV     DX,HF_PORT
04F0 B9 0004                    MOV     CX,4                    ; GET ECC BYTES
04F3 EC                 CMD_12: IN      AL,DX
04F4 26: 88 05                  MOV     ES:BYTE PTR [DI],AL     ; GO SLOW FOR BOARD
04F7 47                         INC     DI
04F8 E2 F9                      LOOP    CMD_12
04FA E8 0623 R          CMD_13: CALL    CHECK_STATUS
04FD 75 05                      JNZ     CMD_ABORT               ; ERROR RETURNED
04FF FE 4E F9                   DEC     @CMD_BLOCK+1            ; CHECK FOR MORE
0502 75 CE                      JNZ     SHORT CMD_11
0504                    CMD_ABORT:
0504                    TM_OUT:
0504 C3                         RET
```

SECTION 5

```
                        PAGE
                        ;--------------------------------------
                        ; COMMANDO                            :
                        ;       REPEATEDLY OUTPUTS DATA TILL  :
                        ;       NSECTOR RETURNS ZERO          :
                        ;--------------------------------------
0505                    COMMANDO:
0505 E8 0694 R                  CALL    CHECK_DMA               ; CHECK 64K BOUNDARY ERROR
0508 72 FA                      JC      CMD_ABORT
050A 8B F3              CMD_OF: MOV     SI,BX
050C E8 054F R                  CALL    COMMAND                 ; OUTPUT COMMAND
050F 75 F3                      JNZ     CMD_ABORT
0511 E8 060D R                  CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
0514 72 EE                      JC      TM_OUT                  ; TOO LONG
0516 1E                 CMD_01: PUSH    DS
0517 06                         PUSH    ES                      ; MOVE ES TO DS
0518 1F                         POP     DS
0519 B9 0100                    MOV     CX,256D                 ; PUT THE DATA OUT TO THE CARD
051C BA 01F0                    MOV     DX,HF_PORT
051F FA                         CLI
0520 FC                         CLD
0521 F3/ 6F                     REP     OUTSW
0523 FB                         STI
0524 1F                         POP     DS                      ; RESTORE DS
0525 F6 46 FE 02                TEST    @CMD_BLOCK+6,ECC_MODE   ; CHECK FOR NORMAL OUTPUT
0529 74 12                      JZ      CMD_03
052B E8 060D R                  CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
052E 72 D4                      JC      TM_OUT
0530 BA 01F0                    MOV     DX,HF_PORT
0533 B9 0004                    MOV     CX,4                    ; OUTPUT THE ECC BYTES
0536 26: 8A 04          CMD_02: MOV     AL,ES:BYTE PTR [SI]
0539 EE                         OUT     DX,AL
053A 46                         INC     SI
053B E2 F9                      LOOP    CMD_02
053D                    CMD_03:
053D E8 05B5 R                  CALL    WAIT                    ; WAIT FOR SECTOR COMPLETE INTERRUPT
0540 75 C2                      JNZ     TM_OUT                  ; ERROR RETURNED
0542 E8 0623 R                  CALL    CHECK_STATUS
0545 75 BD                      JNZ     CMD_ABORT
0547 F6 06 008C R 08            TEST    @HF_STATUS,ST_DRQ       ; CHECK FOR MORE
054C 75 C8                      JNZ     SHORT CMD_01
054E C3                         RET

                        ;--------------------------------------------------------
                        ; COMMAND                                               :
                        ;       THIS ROUTINE OUTPUTS THE COMMAND BLOCK          :
                        ; OUTPUT                                                :
                        ;       BL = STATUS                                     :
                        ;       BH = ERROR REGISTER                             :
                        ;--------------------------------------------------------

                        COMMAND PROC    NEAR
054F 53                         PUSH    BX                      ; WAIT FOR SEEK COMPLETE AND READY
0550 B9 0600                    MOV     CX,DELAY_2              ; SET INITIAL DELAY BEFORE TEST
0553                    COMMAND1:
0553 51                         PUSH    CX                      ; SAVE LOOP COUNT
0554 E8 044F R                  CALL    TST_RDY                 ; CHECK DRIVE READY
0557 59                         POP     CX
0558 74 0B                      JZ      COMMAND2                ; DRIVE IS READY
055A 80 3E 0074 R 80            CMP     @DISK_STATUS1,TIME_OUT  ; TST_RDY TIMED OUT--GIVE UP
055F 74 48                      JZ      CMD_TIMEOUT
0561 E2 F0                      LOOP    COMMAND1                ; KEEP TRYING FOR A WHILE
0563 EB 49                      JMP     SHORT COMMAND4          ; ITS NOT GOING TO GET READY
0565                    COMMAND2:
0565 5B                         POP     BX
0566 57                         PUSH    DI
0567 C6 06 008E R 00            MOV     @HF_INT_FLAG,0          ; RESET INTERRUPT FLAG
056C FA                         CLI                             ; INHIBIT INTERRUPTS WHILE CHANGING MASK
056D E4 A1                      IN      AL,INTB01               ; TURN ON SECOND INTERRUPT CHIP
056F 24 BF                      AND     AL,0BFH
0571 EB 00                      JMP     $+2
0573 E6 A1                      OUT     INTB01,AL
0575 E4 21                      IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
0577 24 FB                      AND     AL,0FBH                 ;  SECOND CHIP
0579 EB 00                      JMP     $+2
057B E6 21                      OUT     INTA01,AL
057D FB                         STI
057E 33 FF                      XOR     DI,DI                   ; INDEX THE COMMAND TABLE
0580 BA 01F1                    MOV     DX,HF_PORT+1            ; DISK ADDRESS
0583 F6 06 0076 R C0            TEST    @CONTROL_BYTE,0C0H      ; CHECK FOR RETRY SUPPRESSION
0588 74 11                      JZ      COMMAND3
058A 8A 46 FE                   MOV     AL,@CMD_BLOCK+6         ; YES-GET OPERATION CODE
058D 24 F0                      AND     AL,0F0H                 ; GET RID OF MODIFIERS
058F 3C 20                      CMP     AL,20H                  ; 20H-40H IS READ, WRITE, VERIFY
0591 72 08                      JB      COMMAND3
0593 3C 40                      CMP     AL,40H
0595 77 04                      JA      COMMAND3
0597 80 4E FE 01                OR      @CMD_BLOCK+6,NO_RETRIES ; VALID OPERATION FOR RETRY SUPPRESS
059B                    COMMAND3:
059B 8A 43 F8                   MOV     AL,[@CMD_BLOCK+DI]      ; GET THE COMMAND STRING BYTE
059E EE                         OUT     DX,AL                   ; GIVE IT TO CONTROLLER
059F 47                         INC     DI                      ; NEXT BYTE IN COMMAND BLOCK
05A0 42                         INC     DX                      ; NEXT DISK ADAPTER REGISTER
05A1 81 FA 01F8                 CMP     DX,HF_PORT+8            ; ALL DONE?
05A5 75 F4                      JNZ     COMMAND3                ; NO--GO DO NEXT ONE
05A7 5F                         POP     DI
05A8 C3                         RET                             ; ZERO FLAG IS SET
05A9                    CMD_TIMEOUT:
05A9 C6 06 0074 R 20            MOV     @DISK_STATUS1,BAD_CNTLR
05AE                    COMMAND4:
05AE 5B                         POP     BX
05AF 80 3E 0074 R 00            CMP     @DISK_STATUS1,0         ; SET CONDITION CODE FOR CALLER
05B4 C3                         RET
05B5                    COMMAND ENDP
```

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                        PAGE
                        ;--------------------------------------
                        ;       WAIT FOR INTERRUPT             :
                        ;--------------------------------------
05B5                    WAIT    PROC    NEAR
05B5 FB                         STI                     ; MAKE SURE INTERRUPTS ARE ON
05B6 2B C9                      SUB     CX,CX           ; SET INITIAL DELAY BEFORE TEST
05B8 F8                         CLC
05B9 B8 9000                    MOV     AX,9000H        ; DEVICE WAIT INTERRUPT
05BC CD 15                      INT     15H
05BE 72 0F                      JC      WT2             ; DEVICE TIMED OUT

05C0 B3 25                      MOV     BL,DELAY_1      ; SET DELAY COUNT

                        ;-----  WAIT LOOP

05C2 F6 06 008E R 80    WT1:    TEST    @HF_INT_FLAG,80H        ; TEST FOR INTERRUPT
05C7 E1 F9                      LOOPZ   WT1
05C9 75 0B                      JNZ     WT3             ; INTERRUPT--LETS GO
05CB FE CB                      DEC     BL
05CD 75 F3                      JNZ     WT1             ; KEEP TRYING FOR A WHILE

05CF C6 06 0074 R 80    WT2:    MOV     @DISK_STATUS1,TIME_OUT  ; REPORT TIME OUT ERROR
05D4 EB 0A                      JMP     SHORT WT4
05D6 C6 06 0074 R 00    WT3:    MOV     @DISK_STATUS1,0
05DB C6 06 008E R 00            MOV     @HF_INT_FLAG,0
05E0 80 3E 0074 R 00    WT4:    CMP     @DISK_STATUS1,0 ; SET CONDITION CODE FOR CALLER
05E5 C3                         RET
05E6                    WAIT    ENDP

                        ;--------------------------------------
                        ;       WAIT FOR CONTROLLER NOT BUSY   :
                        ;--------------------------------------
05E6                    NOT_BUSY        PROC    NEAR
05E6 FB                         STI                     ; MAKE SURE INTERRUPTS ARE ON
05E7 53                         PUSH    BX
05E8 B3 25                      MOV     BL,DELAY_1
05EA 2B C9                      SUB     CX,CX           ; SET INITIAL DELAY BEFORE TEST
05EC BA 01F7                    MOV     DX,HF_PORT+7
05EF EC                 NB1:    IN      AL,DX           ; CHECK STATUS
05F0 A8 80                      TEST    AL,ST_BUSY
05F2 E0 FB                      LOOPNZ  NB1
05F4 74 0B                      JZ      NB2             ; NOT BUSY--LETS GO
05F6 FE CB                      DEC     BL
05F8 75 F5                      JNZ     NB1             ; KEEP TRYING FOR A WHILE

05FA C6 06 0074 R 80            MOV     @DISK_STATUS1,TIME_OUT  ; REPORT TIME OUT ERROR
05FF EB 05                      JMP     SHORT NB3
0601 C6 06 0074 R 00    NB2:    MOV     @DISK_STATUS1,0
0606 5B                 NB3:    POP     BX
0607 80 3E 0074 R 00            CMP     @DISK_STATUS1,0 ; SET CONDITION CODE FOR CALLER
060C C3                         RET
060D                    NOT_BUSY        ENDP

                        ;--------------------------------------
                        ;       WAIT FOR DATA REQUEST          :
                        ;--------------------------------------
060D                    WAIT_DRQ        PROC    NEAR
060D B9 0100                    MOV     CX,DELAY_3
0610 BA 01F7                    MOV     DX,HF_PORT+7
0613 EC                 WQ_1:   IN      AL,DX           ; GET STATUS
0614 A8 08                      TEST    AL,ST_DRQ       ; WAIT FOR DRQ
0616 75 09                      JNZ     WQ_OK
0618 E2 F9                      LOOP    WQ_1            ; KEEP TRYING FOR A SHORT WHILE
061A C6 06 0074 R 80            MOV     @DISK_STATUS1,TIME_OUT  ; ERROR
061F F9                         STC
0620 C3                         RET
0621 F8                 WQ_OK:  CLC
0622 C3                         RET
0623                    WAIT_DRQ        ENDP
                        ;--------------------------------------
                        ;       CHECK FIXED DISK STATUS        :
                        ;--------------------------------------
0623                    CHECK_STATUS    PROC    NEAR
0623 E8 0635 R                  CALL    CHECK_ST        ; CHECK THE STATUS BYTE
0626 75 07                      JNZ     CHECK_S1        ; AN ERROR WAS FOUND
0628 A8 01                      TEST    AL,ST_ERROR     ; WERE THERE ANY OTHER ERRORS
062A 74 03                      JZ      CHECK_S1        ; NO ERROR REPORTED
062C E8 0669 R                  CALL    CHECK_ER        ; ERROR REPORTED
062F                    CHECK_S1:
062F 80 3E 0074 R 00            CMP     @DISK_STATUS1,0 ; SET STATUS FOR CALLER
0634 C3                         RET
0635                    CHECK_STATUS    ENDP
                        ;--------------------------------------
                        ;       CHECK FIXED DISK STATUS BYTE   :
                        ;--------------------------------------
0635                    CHECK_ST        PROC    NEAR
0635 BA 01F7                    MOV     DX,HF_PORT+7    ; GET THE STATUS
0638 EC                         IN      AL,DX
0639 A2 008C R                  MOV     @HF_STATUS,AL
063C B4 00                      MOV     AH,0
063E A8 80                      TEST    AL,ST_BUSY      ; IF STILL BUSY
0640 75 1A                      JNZ     CKST_EXIT       ;  REPORT OK
0642 B4 CC                      MOV     AH,WRITE_FAULT
0644 A8 20                      TEST    AL,ST_WRT_FLT   ; CHECK FOR WRITE FAULT
0646 75 14                      JNZ     CKST_EXIT
0648 B4 AA                      MOV     AH,NOT_RDY
064A A8 40                      TEST    AL,ST_READY     ; CHECK FOR NOT READY
064C 74 0E                      JZ      CKST_EXIT
064E B4 40                      MOV     AH,BAD_SEEK
0650 A8 10                      TEST    AL,ST_SEEK_COMPL        ; CHECK FOR SEEK NOT COMPLETE
0652 74 08                      JZ      CKST_EXIT
0654 B4 11                      MOV     AH,DATA_CORRECTED
0656 A8 04                      TEST    AL,ST_CORRCTD   ; CHECK FOR CORRECTED ECC
0658 75 02                      JNZ     CKST_EXIT
065A B4 00                      MOV     AH,0
065C                    CKST_EXIT:
065C 88 26 0074 R               MOV     @DISK_STATUS1,AH        ; SET ERROR FLAG
0660 80 FC 11                   CMP     AH,DATA_CORRECTED       ; KEEP GOING WITH DATA CORRECTED
0663 74 03                      JZ      CKST_EXT
0665 80 FC 00                   CMP     AH,0
0668                    CKST_EXI:
0668 C3                         RET
0669                    CHECK_ST        ENDP
```

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                        PAGE
                        ;--------------------------------------
                        ;       CHECK FIXED DISK ERROR REGISTER :
                        ;--------------------------------------
0669                    CHECK_ER        PROC    NEAR
0669 BA 01F1                    MOV     DX,HF_PORT+1            ; GET THE ERROR REGISTER
066C EC                         IN      AL,DX
066D A2 008D R                  MOV     @HF_ERROR,AL
0670 53                         PUSH    BX
0671 B9 0008                    MOV     CX,8                    ; TEST ALL 8 BITS
0674 D0 E0              CK1:    SHL     AL,1                    ; MOVE NEXT ERROR BIT TO CARRY
0676 72 02                      JC      CK2                     ; FOUND THE ERROR
0678 E2 FA                      LOOP    CK1                     ; KEEP TRYING
067A BB 068B R          CK2:    MOV     BX,OFFSET ERR_TBL       ; COMPUTE ADDRESS OF
067D 03 D9                      ADD     BX,CX                   ; ERROR CODE
067F 2E: 8A 27                  MOV     AH,BYTE PTR CS:[BX]     ; GET ERROR CODE
0682 88 26 0074 R       CKEX:   MOV     @DISK_STATUS1,AH        ; SAVE ERROR CODE
0686 5B                         POP     BX
0687 80 FC 00                   CMP     AH,0
068A C3                         RET
068B E0                 ERR_TBL DB      NO_ERR
068C 02 40 01 BB                DB      BAD_ADDR_MARK,BAD_SEEK,BAD_CMD,UNDEF_ERR
0690 04 BB 10 0A                DB      RECORD_NOT_FND,UNDEF_ERR,BAD_ECC,BAD_SECTOR
0694                    CHECK_ER        ENDP

                        ;--------------------------------------------------------
                        ; CHECK_DMA                                             :
                        ;  -CHECK ES:BX AND # SECTORS TO MAKE SURE THAT IT WILL  :
                        ;   FIT WITHOUT SEGMENT OVERFLOW.                        :
                        ;  -ES:BX HAS BEEN REVISED TO THE FORMAT SSSS:000X       :
                        ;  -OK IF # SECTORS < 80H (7FH IF LONG READ OR WRITE)    :
                        ;  -OK IF # SECTORS = 80H (7FH) AND BX <= 00H (04H)      :
                        ;  -ERROR OTHERWISE                                      :
                        ;--------------------------------------------------------
0694                    CHECK_DMA       PROC    NEAR
0694 50                         PUSH    AX                      ; SAVE REGISTERS
0695 B8 8000                    MOV     AX,8000H                ; AH = MAX # SECTORS   AL = MAX OFFSET
0698 F6 46 FE 02                TEST    @CMD_BLOCK+6,ECC_MODE
069C 74 03                      JZ      CKD1
069E B8 7F04                    MOV     AX,7F04H                ; ECC IS 4 MORE BYTES
06A1 3A 66 F9           CKD1:   CMP     AH,@CMD_BLOCK+1         ; NUMBER OF SECTORS
06A4 77 06                      JA      CKDOK                   ; IT WILL FIT
06A6 72 07                      JB      CKDERR                  ; TOO MANY
06A8 3A C3                      CMP     AL,BL                   ; CHECK OFFSET ON MAX SECTORS
06AA 72 03                      JB      CKDERR                  ; ERROR
06AC F8                 CKDOK:  CLC                             ; CLEAR CARRY
06AD 58                         POP     AX
06AE C3                         RET                             ; NORMAL RETURN
06AF F9                 CKDERR: STC                             ; INDICATE ERROR
06B0 C6 06 0074 R 09            MOV     @DISK_STATUS1,DMA_BOUNDARY
06B5 58                         POP     AX
06B6 C3                         RET
06B7                    CHECK_DMA       ENDP

                        ;--------------------------------------
                        ;       SET UP  ES:BX-> DISK PARMS      :
                        ;--------------------------------------
06B7                    GET_VEC PROC    NEAR
06B7 2B C0                      SUB     AX,AX                   ; GET DISK PARAMETER ADDRESS
06B9 8E C0                      MOV     ES,AX
                                ASSUME  ES:ABS0
06BB F6 C2 01                   TEST    DL,1
06BE 74 07                      JZ      GV_0
06C0 26: C4 1E 0118 R           LES     BX,@HF1_TBL_VEC         ; ES:BX -> DRIVE PARAMETERS
06C5 EB 05                      JMP     SHORT GV_EXIT
06C7                    GV_0:
06C7 26: C4 1E 0104 R           LES     BX,@HF_TBL_VEC          ; ES:BX -> DRIVE PARAMETERS
06CC                    GV_EXIT:
06CC C3                         RET
06CD                    GET_VEC ENDP

                        ;--- HARDWARE INT  76H -- ( IRQ LEVEL  14 ) ---------------------------------
                        ;                                                                            :
                        ;       FIXED DISK INTERRUPT ROUTINE                                         :
                        ;                                                                            :
                        ;--------------------------------------------------------------------------------

06CD                    HD_INT  PROC    NEAR
06CD 50                         PUSH    AX
06CE 1E                         PUSH    DS
06CF E8 0000 E                  CALL    DDS
06D2 C6 06 008E R FF            MOV     @HF_INT_FLAG,0FFH       ; ALL DONE
06D7 B0 20                      MOV     AL,EOI                  ; NON-SPECIFIC END OF INTERRUPT
06D9 E6 A0                      OUT     INTB00,AL               ; FOR CONTROLLER #2
06DB EB 00                      JMP     $+2                     ; WAIT
06DD E6 20                      OUT     INTA00,AL               ; FOR CONTROLLER #1
06DF 1F                         POP     DS
06E0 FB                         STI                             ; RE-ENABLE INTERRUPTS
06E1 B8 9100                    MOV     AX,9100H                ; DEVICE POST
06E4 CD 15                      INT     15H                     ;  INTERRUPT
06E6 58                         POP     AX
06E7 CF                         IRET                            ; RETURN FROM INTERRUPT

06E8                    HD_INT  ENDP

06E8 30 36 2F 31 30 2F          DB      '06/10/85'              ; RELEASE MARKER
     38 35
06F0                    CODE    ENDS
                                END
```

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                        PAGE 118,121
                        TITLE KYBD ----- 06/10/85  KEYBOARD BIOS
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  K16
                                PUBLIC  KEYBOARD_IO_1
                                PUBLIC  KB_INT_1
                                PUBLIC  SND_DATA

                                EXTRN   BEEP:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   START_1:NEAR
                                EXTRN   K10:BYTE
                                EXTRN   K11:BYTE
                                EXTRN   K12:BYTE
                                EXTRN   K13:BYTE
                                EXTRN   K14:BYTE
                                EXTRN   K15:BYTE
                                EXTRN   K6:BYTE
                                EXTRN   K6L:ABS
                                EXTRN   K7:BYTE
                                EXTRN   K8:BYTE
                                EXTRN   K9:BYTE

                        ;--- INT 16 H ----------------------------------------------------------------
                        ; KEYBOARD I/O                                                              :
                        ;       THESE ROUTINES PROVIDE READ KEYBOARD SUPPORT                        :
                        ; INPUT                                                                     :
                        ;       (AH)= 00H  READ THE NEXT ASCII CHARACTER ENTERED FROM THE KEYBOARD, :
                        ;                  RETURN THE RESULT IN (AL), SCAN CODE IN (AH).           :
                        ;       (AH)= 01H  SET THE ZERO FLAG TO INDICATE IF AN ASCII CHARACTER IS   :
                        ;                  AVAILABLE TO BE READ FROM THE KEYBOARD BUFFER.           :
                        ;                  (ZF)= 1 -- NO CODE AVAILABLE                             :
                        ;                  (ZF)= 0 -- CODE IS AVAILABLE   (AX)= CHARACTER           :
                        ;                  IF (ZF)= 0, THE NEXT CHARACTER IN THE BUFFER TO BE READ IS :
                        ;                  IN (AX), AND THE ENTRY REMAINS IN THE BUFFER.            :
                        ;       (AH)= 02H  RETURN THE CURRENT SHIFT STATUS IN (AL) REGISTER         :
                        ;                  THE BIT SETTINGS FOR THIS CODE ARE INDICATED IN THE      :
                        ;                  THE EQUATES FOR @KB_FLAG                                 :
                        ; OUTPUT                                                                    :
                        ;       AS NOTED ABOVE, ONLY (AX) AND FLAGS CHANGED                         :
                        ;       ALL REGISTERS RETAINED                                              :
                        ;-------------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    KEYBOARD_IO_1   PROC    FAR             ;>>> ENTRY POINT FOR ORG 0E82EH
0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS                      ; SAVE CURRENT DS
0002 53                         PUSH    BX                      ; SAVE BX TEMPORARILY
0003 E8 0000 E                  CALL    DDS                     ; ESTABLISH POINTER TO DATA REGION
0006 0A E4                      OR      AH,AH                   ; CHECK FOR (AH)= 00H
0008 74 0B                      JZ      K1B                     ; ASCII_READ
000A FE CC                      DEC     AH                      ; CHECK FOR (AH)= 01H
000C 74 45                      JZ      K2                      ; ASCII_STATUS
000E FE CC                      DEC     AH                      ; CHECK FOR (AH)= 02H
0010 74 67                      JZ      K3                      ; SHIFT_STATUS
0012 5B                         POP     BX                      ; RECOVER REGISTER
0013 1F                         POP     DS
0014 CF                         IRET                            ; INVALID COMMAND EXIT

                        ;-----  READ THE KEY TO FIGURE OUT WHAT TO DO

0015 8B 1E 001A R       K1B:    MOV     BX,@BUFFER_HEAD         ; GET POINTER TO HEAD OF BUFFER
0019 3B 1E 001C R               CMP     BX,@BUFFER_TAIL         ; TEST END OF BUFFER
001D 75 07                      JNE     K1C                     ; IF ANYTHING IN BUFFER SKIP INTERRUPT

001F B8 9002                    MOV     AX,09002H               ; MOVE IN WAIT CODE & TYPE
0022 CD 15                      INT     15H                     ; PERFORM OTHER FUNCTION
0024                    K1:                                     ; ASCII READ
0024 FB                         STI                             ; INTERRUPTS BACK ON DURING LOOP
0025 90                         NOP                             ; ALLOW AN INTERRUPT TO OCCUR
0026 FA                 K1C:    CLI                             ; INTERRUPTS BACK OFF
0027 8B 1E 001A R               MOV     BX,@BUFFER_HEAD         ; GET POINTER TO HEAD OF BUFFER
002B 3B 1E 001C R               CMP     BX,@BUFFER_TAIL         ; TEST END OF BUFFER
002F 53                         PUSH    BX                      ; SAVE ADDRESS
0030 9C                         PUSHF                           ; SAVE FLAG
0031 E8 0587 R                  CALL    MAKE_LED                ; GO GET MODE INDICATOR DATA BYTE
0034 8A 1E 0097 R               MOV     BL,@KB_FLAG_2           ; GET PREVIOUS BITS
0038 32 D8                      XOR     BL,AL                   ; SEE IF ANY DIFFERENT
003A 80 E3 07                   AND     BL,KB_LEDS              ; ISOLATE INDICATOR BITS
003D 74 04                      JZ      K1A                     ; IF NO CHANGE BYPASS UPDATE

003F E8 0549 R                  CALL    SND_LED1                ; GO TURN ON MODE INDICATORS
0042 FA                         CLI                             ; DISABLE INTERRUPTS
0043 9D                 K1A:    POPF                            ; RESTORE FLAGS
0044 5B                         POP     BX                      ; RESTORE ADDRESS
0045 74 DD                      JZ      K1                      ; LOOP UNTIL SOMETHING IN BUFFER

0047 8B 07                      MOV     AX,[BX]                 ; GET SCAN CODE AND ASCII CODE
0049 E8 007F R                  CALL    K4                      ; MOVE POINTER TO NEXT POSITION
004C 89 1E 001A R               MOV     @BUFFER_HEAD,BX         ; STORE VALUE IN VARIABLE

0050 5B                         POP     BX                      ; RECOVER REGISTER
0051 1F                         POP     DS                      ; RECOVER SEGMENT
0052 CF                         IRET                            ; RETURN TO CALLER

                        ;-----  ASCII STATUS

0053                    K2:
0053 FA                         CLI                             ; INTERRUPTS OFF
0054 8B 1E 001A R               MOV     BX,@BUFFER_HEAD         ; GET HEAD POINTER
0058 3B 1E 001C R               CMP     BX,@BUFFER_TAIL         ; IF EQUAL (Z=1) THEN NOTHING THERE
005C 8B 07                      MOV     AX,[BX]
005E 9C                         PUSHF                           ; SAVE FLAGS
005F 50                         PUSH    AX                      ; SAVE CODE
0060 E8 0587 R                  CALL    MAKE_LED                ; GO GET MODE INDICATOR DATA BYTE
0063 8A 1E 0097 R               MOV     BL,@KB_FLAG_2           ; GET PREVIOUS BITS
0067 32 D8                      XOR     BL,AL                   ; SEE IF ANY DIFFERENT
0069 80 E3 07                   AND     BL,KB_LEDS              ; ISOLATE INDICATOR BITS
006C 74 03                      JZ      SK2                     ; IF NO CHANGE BYPASS UPDATE

006E E8 0549 R                  CALL    SND_LED1                ; GO TURN ON MODE INDICATORS
0071 58                 SK2:    POP     AX                      ; RESTORE CODE
```

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0072 9D                         POPF                            ; RESTORE FLAGS
0073 FB                         STI                             ; INTERRUPTS BACK ON
0074 5B                         POP     BX                      ; RECOVER REGISTER
0075 1F                         POP     DS                      ; RECOVER SEGMENT
0076 CA 0002                    RET     2                       ; THROW AWAY FLAGS

                        ;-----  SHIFT STATUS

0079                    K3:
0079 A0 0017 R                  MOV     AL,@KB_FLAG             ; GET THE SHIFT STATUS FLAGS
007C 5B                         POP     BX                      ; RECOVER REGISTER
007D 1F                         POP     DS                      ; RECOVER REGISTERS
007E CF                         IRET                            ; RETURN TO CALLER
007F                    KEYBOARD_IO_1   ENDP

                        ;-----  INCREMENT A BUFFER POINTER

007F                    K4      PROC    NEAR
007F 43                         INC     BX                      ; MOVE TO NEXT WORD IN LIST
0080 43                         INC     BX
0081 3B 1E 0082 R               CMP     BX,@BUFFER_END          ; AT END OF BUFFER?
0085 75 04                      JNE     K5                      ; NO, CONTINUE
0087 8B 1E 0080 R               MOV     BX,@BUFFER_START        ; YES, RESET TO BUFFER BEGINNING
008B                    K5:
008B C3                         RET
008C                    K4      ENDP

                        ;--- HARDWARE INT  09 H -- ( IRQ LEVEL  1 ) ----------------------------------
                        ;                                                                              :
                        ;       KEYBOARD INTERRUPT ROUTINE                                             :
                        ;                                                                              :
                        ;------------------------------------------------------------------------------

008C                    KB_INT_1 PROC   FAR
008C FB                         STI                             ; ENABLE INTERRUPTS
008D 55                         PUSH    BP
008E 50                         PUSH    AX
008F 53                         PUSH    BX
0090 51                         PUSH    CX
0091 52                         PUSH    DX
0092 56                         PUSH    SI
0093 57                         PUSH    DI
0094 1E                         PUSH    DS
0095 06                         PUSH    ES
0096 FC                         CLD                             ; FORWARD DIRECTION
0097 E8 0000 E                  CALL    DDS                     ; SET UP ADDRESSING

                        ;-----  WAIT FOR KEYBOARD DISABLE COMMAND TO BE ACCEPTED

009A B0 AD                      MOV     AL,DIS_KBD              ; DISABLE THE KEYBOARD COMMAND
009C E8 0595 R                  CALL    SHIP_IT                 ; EXECUTE DISABLE
009F FA                         CLI                             ; DISABLE INTERRUPTS
00A0 2B C9                      SUB     CX,CX                   ; SET MAXIMUM TIMEOUT
00A2                    KB_INT_01:
00A2 E4 64                      IN      AL,STATUS_PORT          ; READ ADAPTER STATUS
00A4 A8 02                      TEST    AL,INPT_BUF_FULL        ; CHECK INPUT BUFFER FULL STATUS BIT
00A6 E0 FA                      LOOPNZ  KB_INT_01               ; WAIT FOR COMMAND TO BE ACCEPTED

                        ;-----  READ CHARACTER FROM KEYBOARD INTERFACE

00A8 E4 60                      IN      AL,PORT_A               ; READ IN THE CHARACTER

                        ;-----  SYSTEM HOOK   INT 15H - FUNCTION 4FH  (ON HARDWARE INTERRUPT LEVEL 9H)

00AA B4 4F                      MOV     AH,04FH                 ; SYSTEM INTERCEPT - KEY CODE FUNCTION
00AC F9                         STC                             ; SET CY= 1 (IN CASE OF IRET)
00AD CD 15                      INT     15H                     ; CASSETTE CALL   (AL)= KEY SCAN CODE
                                                                ;  RETURNS CY= 1 FOR INVALID FUNCTION
00AF 72 03                      JC      KB_INT_02               ; CONTINUE IF CARRY FLAG SET ((AL)=CODE)

00B1 E9 02EE R                  JMP     K26                     ; EXIT IF SYSTEM HANDLED SCAN CODE
                                                                ;  EXIT HANDLES HARDWARE EOI AND ENABLE

                        ;-----  CHECK FOR A RESEND COMMAND TO KEYBOARD

00B4                    KB_INT_02:                              ;       (AL)= SCAN CODE
00B4 FB                         STI                             ; ENABLE INTERRUPTS AGAIN
00B5 3C FE                      CMP     AL,KB_RESEND            ; IS THE INPUT A RESEND
00B7 74 0D                      JE      KB_INT_4                ; GO IF RESEND

                        ;-----  CHECK FOR RESPONSE TO A COMMAND TO KEYBOARD

00B9 3C FA                      CMP     AL,KB_ACK               ; IS THE INPUT AN ACKNOWLEDGE
00BB 75 12                      JNZ     KB_INT_2                ; GO IF NOT

                        ;-----  A COMMAND TO THE KEYBOARD WAS ISSUED

00BD FA                         CLI                             ; DISABLE INTERRUPTS
00BE 80 0E 0097 R 10            OR      @KB_FLAG_2,KB_FA        ; INDICATE ACK RECEIVED
00C3 E9 02EE R                  JMP     K26                     ; RETURN IF NOT (ACK RETURNED FOR DATA)

                        ;-----  RESEND THE LAST BYTE

00C6                    KB_INT_4:
00C6 FA                         CLI                             ; DISABLE INTERRUPTS
00C7 80 0E 0097 R 20            OR      @KB_FLAG_2,KB_FE        ; INDICATE RESEND RECEIVED
00CC E9 02EE R                  JMP     K26                     ; RETURN IF NOT (ACK RETURNED FOR DATA)

00CF                    KB_INT_2:

                        ;-----  UPDATE MODE INDICATORS IF CHANGE IN STATE

00CF 50                         PUSH    AX                      ; SAVE DATA IN
00D0 E8 0587 R                  CALL    MAKE_LED                ; GO GET MODE INDICATOR DATA BYTE
00D3 8A 1E 0097 R               MOV     BL,@KB_FLAG_2           ; GET PREVIOUS BITS
00D7 32 D8                      XOR     BL,AL                   ; SEE IF ANY DIFFERENT
00D9 80 E3 07                   AND     BL,KB_LEDS              ; ISOLATE INDICATOR BITS
00DC 74 03                      JZ      UP0                     ; IF NO CHANGE BYPASS UPDATE

00DE E8 0536 R                  CALL    SND_LED                 ; GO TURN ON MODE INDICATORS
00E1 58                 UP0:    POP     AX                      ; RESTORE DATA IN
00E2 8A E0                      MOV     AH,AL                   ; SAVE SCAN CODE IN AH ALSO

                        ;-----  TEST FOR OVERRUN SCAN CODE FROM KEYBOARD
```

```
                                        CMP     AL,KB_OVER_RUN          ; IS THIS AN OVERRUN CHAR
00E4 3C FF                              JNZ     K16                     ; NO, TEST FOR SHIFT KEY
00E6 75 0D                              JMP     K62                     ; BUFFER_FULL_BEEP
00E8 E9 04EB R

                        ;-----  THIS CODE CONTAINS THE KBX SUPPORT FOR INT 09H

                        ;       EQUATES
                        F11_M   EQU     217                     ; FUNC 11 MAKE
= 00D9                  F11_B   EQU     215                     ; FUNC 11 BREAK
= 00D7                  F12_M   EQU     218                     ; FUNC 12 MAKE
= 00DA                  F12_B   EQU     216                     ; FUNC 12 BREAK
= 00D8                  K102_M  EQU     86                      ; KEY 102 MAKE
= 0056                  K102_B  EQU     214                     ; KEY 102 BREAK
= 00D6

= 0052                  INS_M   EQU     82                      ; INSERT KEY MAKE
= 0053                  DEL_M   EQU     83                      ; DELETE KEY MAKE
= 004B                  LEFT_M  EQU     75                      ; CURSOR LEFT MAKE
= 004D                  RIGHT_M EQU     77                      ; CURSOR RIGHT MAKE
= 0048                  UP_M    EQU     72                      ; CURSOR UP MAKE
= 0050                  DN_M    EQU     80                      ; CURSOR DOWN MAKE
= 0049                  PGUP_M  EQU     73                      ; PG UP MAKE
= 0051                  PGDN_M  EQU     81                      ; PG DN MAKE
= 0047                  HOME_M  EQU     71                      ; HOME MAKE
= 004F                  END_M   EQU     79                      ; END MAKE

= 0085                  FUNC11  EQU     133                     ; FUNCTION 11 KEY
= 00E0                  HC      EQU     224                     ; HIDDEN CODE

                        ;-----  TABLE OF KEYPAD CURSOR & CONTROL KEYS

00EB 48 50 52 53 4B 4D  K_TAB1  DB      UP_M,DN_M,INS_M,DEL_M,LEFT_M,RIGHT_M
00F1 49 51 47 4F        DB      PGUP_M,PGDN_M,HOME_M,END_M
= 000A                  L_TAB1  EQU     $-K_TAB1

00F5                    K16:
00F5 24 7F                      AND     AL,07FH                 ; REMOVE BREAK BIT
00F7 0E                         PUSH    CS
00F8 07                         POP     ES                      ; ESTABLISH ADDRESS OF TABLES

00F9 F6 06 0096 R C0            TEST    @KB_FLAG_3,RD_ID+LC_AB  ; ARE WE DOING A READ ID?
00FE 74 33                      JZ      NOT_ID                  ; CONTINUE IF NOT
0100 79 11                      JNS     TST_ID_2                ; IS THE RD_ID FLAG ON?
0102 80 FC AB                   CMP     AH,TD_1                 ; IS THIS THE 1ST ID CHARACTER?
0105 75 05                      JNE     RST_RD_ID
0107 80 0E 0096 R 40            OR      @KB_FLAG_3,LC_AB        ; INDICATE 1ST ID WAS OK
010C                    RST_RD_ID:
010C 80 26 0096 R 7F            AND     @KB_FLAG_3,NOT RD_ID    ; RESET THE READ ID FLAG
0111 EB 4B                      JMP     SHORT DO_EXT

0113                    TST_ID_2:
0113 80 26 0096 R BF            AND     @KB_FLAG_3,NOT LC_AB    ; RESET FLAG
0118 80 FC 41                   CMP     AH,TD_2                 ; IS THIS THE 2ND ID CHARACTER?
011B 75 41                      JNE     DO_EXT                  ; LEAVE IF NOT

                        ;-----  A READ ID SAID THAT IT WAS KBX

011D 80 0E 0096 R 01            OR      @KB_FLAG_3,KBX          ; INDICATE KBX WAS FOUND
0122 F6 06 0096 R 20            TEST    @KB_FLAG_3,SET_NUM_LK   ; SHOULD WE SET NUM LOCK?
0127 74 35                      JZ      DO_EXT                  ; EXIT IF NOT
0129 80 0E 0017 R 20            OR      @KB_FLAG,NUM_STATE      ; FORCE NUM LOCK ON
012E E8 0536 R                  CALL    SND_LED                 ; GO SET THE NUM LOCK INDICATOR
0131 EB T0                      JMP     SHORT EXIT
0133                    NOT_ID:
0133 F6 06 0096 R 02            TEST    @KB_FLAG_3,LC_HC        ; WAS THE LAST CHARACTER A HIDDEN CODE
0138 74 5F                      JZ      NOT_LC_HC               ; JUMP IF NOT

                        ;-----  THE LAST CHARACTER WAS A HIDDEN CODE

013A 80 26 0096 R FD            AND     @KB_FLAG_3,NOT LC_HC    ; RESET LAST CHAR HIDDEN CODE FLAG
013F 3C 52                      CMP     AL,INS_M                ; WAS IT THE INSERT KEY?
0141 74 05                      JE      NOT_1
0143 F6 C4 80                   TEST    AH,80H                  ; IS THIS A BREAK CODE
0146 75 5B                      JNZ     EXIT                    ; IGNORE BREAK ON REST OF THESE KEYS
0148                    NOT_1:
0148 BF 00EB R                  MOV     DI,OFFSET K_TAB1        ; TEST FOR ONE OF THE KEYPAD CURSOR FUNC
014B B9 000A                    MOV     CX,L_TAB1               ;
014E F2/ AE                     REPNE   SCASB                   ; SCAN FOR THE KEY
0150 75 54                      JNE     NOT_CUR                 ; GO ON IF NOT FOUND
0152 F6 06 0018 R 08            TEST    @KB_FLAG_1,HOLD_STATE   ; ARE WE IN HOLD STATE?
0157 74 07                      JZ      N_HLD
0159 80 26 0018 R F7            AND     @KB_FLAG_1,NOT HOLD_STATE       ; EXIT HOLD STATE
015E                    DO_EXT:
015E EB 43                      JMP     SHORT EXIT              ; IGNORE THIS KEY
0160                    N_HLD:
0160 F6 06 0017 R 08            TEST    @KB_FLAG,ALT_SHIFT      ; IS ALT DOWN?
0165 74 0E                      JZ      NOT_ALT
0167 F6 06 0017 R 04            TEST    @KB_FLAG,CTL_SHIFT      ; HOW ABOUT CTRL?
016C 74 35                      JZ      EXIT                    ; IGNORE ALL IF ONLY ALT DOWN
016E 3C 53                      CMP     AL,DEL_M                ; WAS IT THE DELETE KEY?
0170 75 31                      JNE     EXIT                    ; IGNORE IF NOT
0172 E9 030D R                  JMP     K29                     ; GO DO THE CTL, ALT, DEL RESET

0175                    NOT_ALT:
0175 F6 06 0017 R 04            TEST    @KB_FLAG,CTL_SHIFT      ; IS CTL DOWN?
017A 75 15                      JNZ     CTL_ON                  ; SPECIAL CASE IF SO
017C 3C 52                      CMP     AL,INS_M                ; IS THIS THE INSERT KEY?
017E 75 0E                      JNE     N_INS

                        ;-----  SPECIAL HANDLING FOR INSERT KEY

0180 8A C4                      MOV     AL,AH                   ; RECOVER SCAN CODE
0182 B4 80                      MOV     AH,INS_SHIFT            ; AH = MASK FOR INSERT
0184 A8 80                      TEST    AL,80H                  ; WAS THIS A BREAK CODE?
0186 75 03                      JNZ     B_C
0188 E9 028F R                  JMP     K22                     ; GO HANDLE INSERT SHIFT
018B                    B_C:
018B E9 02D2 R                  JMP     K24                     ; HANDLE BREAK
018E                    N_INS:
018E E9 0453 R                  JMP     K49                     ; HANDLE & IGNORE NUMLOCK
0191                    CTL_ON:
0191 80 F9 05                   CMP     CL,5                    ; WAS IT INS, DEL, UP OR DOWN?
0194 77 0D                      JA      EXIT                    ; IGNORE IF SO
0196 E9 0401 R                  JMP     K42                     ; GO HANDLE CTRL CASE
```

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                                ;--------------------------------------------------------------------------
0199                            NOT_LC_HC:                              ; LAST CHARACTER WAS NOT A HIDDEN CODE
0199 80 FC E0                           CMP     AH,HC                   ; IS THIS CHARACTER A HIDDEN CODE?
019C 75 08                              JNE     NOT_CUR
019E 80 0E 0096 R 03                    OR      @KB_FLAG_3,LC_HC+KBX    ; SET LAST CHAR WAS A HIDDEN CODE & KBX
01A3                            EXIT:
01A3 E9 02EE R                          JMP     K26                     ; THROW AWAY THIS CODE
                                ;--------------------------------------------------------------------------
01A6                            NOT_CUR:
01A6 80 FC D9                           CMP     AH,F11_M                ; WAS IT F11?
01A9 75 04                              JNE     T_F12                   ; HANDLE IF SO
01AB B1 85                              MOV     CL,FUNC11               ; SET BASE FUNCTION 11
01AD EB 07                              JMP     SHORT DO_FN
01AF                            T_F12:
01AF 80 FC DA                           CMP     AH,F12_M                ; WAS IT F12?
01B2 75 43                              JNE     T_SYS_KEY               ; GO TEST FOR SYSTEM KEY
01B4 B1 86                              MOV     CL,FUNC11+1             ; SET BASE FUNCTION 12
01B6                            DO_FN:
01B6 80 FC D7                           CMP     AH,F11_B                ; IS THIS A BREAK CODE
01B9 74 E8                              JE      EXIT                    ; IGNORE BREAK CODES
01BB 80 FC D8                           CMP     AH,F12_B                ; IS THIS A BREAK CODE
01BE 74 E3                              JE      EXIT                    ; IGNORE BREAK CODES
01C0 F6 06 0018 R 08                    TEST    @KB_FLAG_1,HOLD_STATE   ; ARE WE IN HOLD STATE?
01C5 74 07                              JZ      N_HLDI
01C7 80 26 0018 R F7                    AND     @KB_FLAG_1,NOT HOLD_STATE       ; EXIT HOLD STATE
01CC EB D5                              JMP     SHORT EXIT              ; IGNORE THIS KEY
01CE                            N_HLDI:
01CE 8A E1                              MOV     AH,CL
                                ;
01D0 F6 06 0017 R 08                    TEST    @KB_FLAG,ALT_SHIFT      ; ARE WE IN ALT
01D5 74 05                              JZ      T_CTL
01D7 80 C4 06                           ADD     AH,6                    ; CNVT TO ALT FN 11-12
01DA EB 16                              JMP     SHORT SET_FN
01DC                            T_CTL:
01DC F6 06 0017 R 04                    TEST    @KB_FLAG,CTL_SHIFT      ; ARE WE IN CTRL
01E1 74 05                              JZ      T_SHF
01E3 80 C4 04                           ADD     AH,4                    ; CNVT TO CTRL FN 11-12
01E6 EB 0A                              JMP     SHORT SET_FN
01E8                            T_SHF:
01E8 F6 06 0017 R 03                    TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT ; IS EITHER SHIFT ON?
01ED 74 03                              JZ      SET_FN
01EF 80 C4 02                           ADD     AH,2                    ; CNVT TO SHIFT FN 11-12
01F2                            SET_FN:
01F2 2A C0                              SUB     AL,AL                   ; FORCE PSEUDO SCAN CODE
01F4 E9 04BA R                          JMP     K61                     ; PUT IT INTO BUFFER
                                ;
                                ;-----  TEST FOR SYSTEM KEY
                                ;
01F7                            T_SYS_KEY:
01F7 3C 54                              CMP     AL,SYS_KEY              ; IS IT THE SYSTEM KEY?
01F9 75 3D                              JNZ     K16A                    ; CONTINUE IF NOT
                                ;
01FB F6 C4 80                           TEST    AH,080H                 ; CHECK IF THIS A BREAK CODE
01FE 75 21                              JNZ     K16C                    ; DO NOT TOUCH SYSTEM INDICATOR IF TRUE
                                ;
0200 F6 06 0018 R 04                    TEST    @KB_FLAG_1,SYS_SHIFT    ; SEE IF IN SYSTEM KEY HELD DOWN
0205 75 17                              JNZ     K16B                    ; IF YES, DON'T PROCESS SYSTEM INDICATOR
                                ;
0207 80 0E 0018 R 04                    OR      @KB_FLAG_1,SYS_SHIFT    ; INDICATE SYSTEM KEY DEPRESSED
020C B0 20                              MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
020E E6 20                              OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                        ; INTERRUPT-RETURN-NO-EOI
0210 B0 AE                              MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
0212 E8 0595 R                          CALL    SHIP_IT                 ; EXECUTE ENABLE
0215 B8 8500                            MOV     AX,08500H               ; FUNCTION VALUE FOR MAKE OF SYSTEM KEY
0218 FB                                 STI                             ; MAKE SURE INTERRUPTS ENABLED
0219 CD 15                              INT     15H                     ; USER INTERRUPT
021B E9 02F8 R                          JMP     K27A                    ; END PROCESSING
021E                            K16B:
021E E9 02EE R                          JMP     K26                     ; IGNORE SYSTEM KEY
0221                            K16C:
0221 80 26 0018 R FB                    AND     @KB_FLAG_1,NOT SYS_SHIFT; TURN OFF SHIFT KEY HELD DOWN
0226 B0 20                              MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
0228 E6 20                              OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                        ; INTERRUPT-RETURN-NO-EOI
022A B0 AE                              MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
022C E8 0595 R                          CALL    SHIP_IT                 ; EXECUTE ENABLE
022F B8 8501                            MOV     AX,08501H               ; FUNCTION VALUE FOR BREAK OF SYSTEM KEY
0232 FB                                 STI                             ; MAKE SURE INTERRUPTS ENABLED
0233 CD 15                              INT     15H                     ; USER INTERRUPT
0235 E9 02F8 R                          JMP     K27A                    ; IGNORE SYSTEM KEY
0238                            K16A:
0238 BF 0000 E                          MOV     DI,OFFSET K6            ; SHIFT KEY TABLE
023B B9 0000 E                          MOV     CX,OFFSET K6L           ; LENGTH
023E F2/ AE                             REPNE   SCASB                   ; LOOK THROUGH THE TABLE FOR A MATCH
0240 8A C4                              MOV     AL,AH                   ; RECOVER SCAN CODE
0242 74 03                              JE      K17                     ; JUMP IF MATCH FOUND
0244 E9 02DA R                          JMP     K25                     ; IF NO MATCH, THEN SHIFT NOT FOUND
                                ;
                                ;-----  SHIFT KEY FOUND
0247                            K17:
0247 81 EF 0001 E                       SUB     DI,OFFSET K6+1          ; ADJUST PTR TO SCAN CODE MATCH
024B 2E: 8A A5 0000 E                   MOV     AH,CS:K7[DI]            ; GET MASK INTO AH
0250 A8 80                              TEST    AL,80H                  ; TEST FOR BREAK KEY
0252 74 02                              JZ      K17C                    ; BREAK_SHIFT_FOUND
0254 EB 5D                              JMP     SHORT K23               ; CONTINUE
                                ;
                                ;-----  DETERMINE SET OR TOGGLE
0256                            K17C:
0256 80 FC 10                           CMP     AH,SCROLL_SHIFT
0259 73 07                              JAE     K18                     ; IF SCROLL SHIFT OR ABOVE, TOGGLE KEY
                                ;
                                ;-----  PLAIN SHIFT KEY, SET SHIFT ON
                                ;
025B 08 26 0017 R                       OR      @KB_FLAG,AH             ; TURN ON SHIFT BIT
025F E9 02EE R                          JMP     K26                     ; INTERRUPT_RETURN
                                ;
                                ;-----  TOGGLED SHIFT KEY, TEST FOR 1ST MAKE OR NOT
                                ;
0262                            K18:                                    ; SHIFT-TOGGLE
0262 F6 06 0017 R 04                    TEST    @KB_FLAG, CTL_SHIFT     ; CHECK CTL SHIFT STATE
0267 75 71                              JNZ     K25                     ; JUMP IF CTL STATE
                                ;
0269 3C 52                              CMP     AL, INS_KEY             ; CHECK FOR INSERT KEY
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026B 75 22                      JNZ     K22                     ; JUMP IF NOT INSERT KEY
026D F6 06 0017 R 08            TEST    @KB_FLAG, ALT_SHIFT     ; CHECK FOR ALTERNATE SHIFT
0272 75 66                      JNZ     K25                     ; JUMP IF ALTERNATE SHIFT

0274 F6 06 0017 R 20            TEST    @KB_FLAG, NUM_STATE     ; CHECK FOR BASE STATE
0279 75 0D                      JNZ     K21                     ; JUMP IF NUM LOCK IS ON
027B F6 06 0017 R 03            TEST    @KB_FLAG, LEFT_SHIFT+ RIGHT_SHIFT
0280 74 0D                      JZ      K22                     ; JUMP IF BASE STATE

0282                    K20:                                    ; NUMERIC ZERO, NOT INSERT KEY
0282 B8 5230                    MOV     AX, 5230H               ; PUT OUT AN ASCII ZERO
0285 E9 048A R                  JMP     K57                     ; BUFFER_FILL
0288                    K21:                                    ; MIGHT BE NUMERIC
0288 F6 06 0017 R 03            TEST    @KB_FLAG, LEFT_SHIFT+ RIGHT_SHIFT
028D 74 F3                      JZ      K20                     ; JUMP NUMERIC, NOT INSERT

028F                    K22:                                    ; SHIFT TOGGLE KEY HIT; PROCESS IT
028F 84 26 0018 R               TEST    AH,@KB_FLAG_1           ; IS KEY ALREADY DEPRESSED
0293 74 02                      JZ      K22A0                   ; GO IF NOT
0295 EB 57                      JMP     SHORT K26               ; JUMP IF KEY ALREADY DEPRESSED
0297                    K22A0:
0297 08 26 0018 R               OR      @KB_FLAG_1,AH           ; INDICATE THAT THE KEY IS DEPRESSED
029B 30 26 0017 R               XOR     @KB_FLAG,AH             ; TOGGLE THE SHIFT STATE

                        ;-----  TOGGLE LED IF CAPS OR NUM KEY DEPRESSED

029F F6 C4 70                   TEST    AH,CAPS_SHIFT+NUM_SHIFT+SCROLL_SHIFT ; SHIFT TOGGLE?
02A2 74 05                      JZ      K22B                    ; GO IF NOT

02A4 50                         PUSH    AX                      ; SAVE SCAN CODE AND SHIFT MASK
02A5 E8 0536 R                  CALL    SND_LED                 ; GO TURN MODE INDICATORS ON
02A8 58                         POP     AX                      ; RESTORE SCAN CODE
02A9                    K22B:
02A9 3C 52                      CMP     AL,INS_KEY              ; TEST FOR 1ST MAKE OF INSERT KEY
02AB 75 41                      JNE     K26                     ; JUMP IF NOT INSERT KEY
02AD B8 5200                    MOV     AX,INS_KEY*H            ; SET SCAN CODE INTO AH, 0 INTO AL
02B0 E9 048A R                  JMP     K57                     ; PUT INTO OUTPUT BUFFER

                        ;-----  BREAK SHIFT FOUND

02B3                    K23:                                    ; BREAK-SHIFT-FOUND
02B3 80 FC 10                   CMP     AH,SCROLL_SHIFT         ; IS THIS A TOGGLE KEY
02B6 73 1A                      JAE     K24                     ; YES, HANDLE BREAK TOGGLE
02B8 F6 D4                      NOT     AH                      ; INVERT MASK
02BA 20 26 0017 R               AND     @KB_FLAG,AH             ; TURN OFF SHIFT BIT
02BE 3C B8                      CMP     AL,ALT_KEY+80H          ; IS THIS ALTERNATE SHIFT RELEASE
02C0 75 2C                      JNE     K26                     ; INTERRUPT_RETURN

                        ;-----  ALTERNATE SHIFT KEY RELEASED, GET THE VALUE INTO BUFFER

02C2 A0 0019 R                  MOV     AL,@ALT_INPUT
02C5 B4 00                      MOV     AH,0                    ; SCAN CODE OF 0
02C7 88 26 0019 R               MOV     @ALT_INPUT,AH           ; ZERO OUT THE FIELD
02CB 3C 00                      CMP     AL,0                    ; WAS THE INPUT=0
02CD 74 1F                      JE      K26                     ; INTERRUPT_RETURN
02CF E9 0493 R                  JMP     K58                     ; IT WASN'T, SO PUT IN BUFFER

02D2                    K24:                                    ; BREAK-TOGGLE
02D2 F6 D4                      NOT     AH                      ; INVERT MASK
02D4 20 26 0018 R               AND     @KB_FLAG_1,AH           ; INDICATE NO LONGER DEPRESSED
02D8 EB 14                      JMP     SHORT K26               ; INTERRUPT_RETURN

                        ;-----  TEST FOR HOLD STATE

02DA                    K25:                                    ; NO-SHIFT-FOUND
02DA 3C 80                      CMP     AL,80H                  ; TEST FOR BREAK KEY
02DC 73 10                      JAE     K26                     ; NOTHING FOR BREAK CHARS FROM HERE ON
02DE F6 06 0018 R 08            TEST    @KB_FLAG_1,HOLD_STATE   ; ARE WE IN HOLD STATE
02E3 74 1E                      JZ      K28                     ; BRANCH AROUND TEST IF NOT
02E5 3C 45                      CMP     AL,NUM_KEY
02E7 74 05                      JE      K26                     ; CAN'T END HOLD ON NUM_LOCK
02E9 80 26 0018 R F7            AND     @KB_FLAG_1,NOT HOLD_STATE       ; TURN OFF THE HOLD STATE BIT

02EE                    K26:                                    ; INTERRUPT-RETURN
02EE FA                         CLI                             ; TURN OFF INTERRUPTS
02EF B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
02F1 E6 20                      OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
02F3                    K27:                                    ; INTERRUPT-RETURN-NO-EOI
02F3 B0 AE                      MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
02F5 E8 0595 R                  CALL    SHIP_IT                 ; EXECUTE ENABLE
02F8                    K27A:
02F8 FA                         CLI                             ; DISABLE INTERRUPTS
02F9 07                         POP     ES                      ; RESTORE REGISTERS
02FA 1F                         POP     DS
02FB 5F                         POP     DI
02FC 5E                         POP     SI
02FD 5A                         POP     DX
02FE 59                         POP     CX
02FF 5B                         POP     BX
0300 58                         POP     AX
0301 5D                         POP     BP
0302 CF                         IRET                            ; RETURN, INTERRUPTS ON WITH FLAG CHANGE

                        ;-----  NOT IN  HOLD STATE

0303                    K28:                                    ; NO-HOLD-STATE
0303 F6 06 0017 R 08            TEST    @KB_FLAG,ALT_SHIFT      ; ARE WE IN ALTERNATE SHIFT
0308 75 03                      JNZ     K29                     ; JUMP IF ALTERNATE SHIFT
030A E9 03A5 R                  JMP     K38                     ; JUMP IF NOT ALTERNATE

                        ;-----  TEST FOR CONTROL KEY AND RESET KEY SEQUENCE (CTL ALT DEL)

030D                    K29:                                    ; TEST-RESET
030D F6 06 0017 R 04            TEST    @KB_FLAG,CTL_SHIFT      ; ARE WE IN CONTROL SHIFT ALSO
0312 74 39                      JZ      K31                     ; NO_RESET
0314 3C 45                      CMP     AL,NUM_KEY              ; CHECK FOR INVALID NUM_LOCK KEY
0316 74 D6                      JE      K26                     ; THROW AWAY IF (ALT-CTL)+NUM_LOCK
0318 3C 46                      CMP     AL,SCROLL_KEY           ; CHECK FOR INVALID SCROLL_LOCK KEY
031A 74 D2                      JE      K26                     ; THROW AWAY IF (ALT-CTL)+SCROLL_LOCK
031C 3C 53                      CMP     AL,DEL_KEY              ; CTL-ALT STATE, TEST FOR DELETE KEY
031E 75 2D                      JNE     K31                     ; NO_RESET

                        ;-----  CTL-ALT-DEL HAS BEEN FOUND
```

```
0320 C7 06 0072 R 1234          MOV     @RESET_FLAG,1234H       ; SET FLAG FOR RESET FUNCTION
0326 E9 0000 E                  JMP     START_T                 ; JUMP TO POWER ON DIAGNOSTICS

                        ;-----  ALT-INPUT-TABLE
0329                    K30     LABEL   BYTE
0329 52 4F 50 51 4B 4C          DB      82,79,80,81,75,76
032F 4D 47 48 49                DB      77,71,72,73             ; 10 NUMBERS ON KEYPAD

                        ;-----  SUPER-SHIFT-TABLE
0333 10 11 12 13 14 15          DB      16,17,18,19,20,21       ; A-Z TYPEWRITER CHARS
0339 16 17 18 19 1E 1F          DB      22,23,24,25,30,31
033F 20 21 22 23 24 25          DB      32,33,34,35,36,37
0345 26 2C 2D 2E 2F 30          DB      38,44,45,46,47,48
034B 31 32                      DB      49,50

                        ;-----  IN ALTERNATE SHIFT, RESET NOT FOUND

034D                    K31:                                    ; NO-RESET
034D 3C 39                      CMP     AL,57                   ; TEST FOR SPACE KEY
034F 75 05                      JNE     K32                     ; NOT THERE
0351 B0 20                      MOV     AL,' '                  ; SET SPACE CHAR
0353 E9 048A R                  JMP     K57                     ; BUFFER_FILL

                        ;-----  LOOK FOR KEY PAD ENTRY

0356                    K32:                                    ; ALT-KEY-PAD
0356 BF 0329 R                  MOV     DI,OFFSET K30           ; ALT-INPUT-TABLE
0359 B9 000A                    MOV     CX,10                   ; LOOK FOR ENTRY USING KEYPAD
035C F2/ AE                     REPNE   SCASB                   ; LOOK FOR MATCH
035E 75 13                      JNE     K33                     ; NO ALT KEYPAD
0360 81 EF 032A R               SUB     DI,OFFSET K30+1         ; DI NOW HAS ENTRY VALUE
0364 A0 0019 R                  MOV     AL,@ALT_INPUT           ; GET THE CURRENT BYTE
0367 B4 0A                      MOV     AH,10                   ; MULTIPLY BY 10
0369 F6 E4                      MUL     AH
036B 03 C7                      ADD     AX,DI                   ; ADD IN THE LATEST ENTRY
036D A2 0019 R                  MOV     @ALT_INPUT,AL           ; STORE IT AWAY
0370 E9 02EE R                  JMP     K26                     ; THROW AWAY THAT KEYSTROKE

                        ;-----  LOOK FOR SUPERSHIFT ENTRY

0373                    K33:                                    ; NO-ALT-KEYPAD
0373 C6 06 0019 R 00            MOV     @ALT_INPUT,0            ; ZERO ANY PREVIOUS ENTRY INTO INPUT
0378 B9 001A                    MOV     CX,26                   ; (DI),(ES) ALREADY POINTING
037B F2/ AE                     REPNE   SCASB                   ; LOOK FOR MATCH IN ALPHABET
037D 75 05                      JNE     K34                     ; NOT FOUND, FUNCTION KEY OR OTHER
037F B0 00                      MOV     AL,0                    ; ASCII CODE OF ZERO
0381 E9 048A R                  JMP     K57                     ; PUT IT IN THE BUFFER

                        ;-----  LOOK FOR TOP ROW OF ALTERNATE SHIFT

0384                    K34:                                    ; ALT-TOP-ROW
0384 3C 02                      CMP     AL,2                    ; KEY WITH '1' ON IT
0386 72 0C                      JB      K35                     ;  NOT ONE OF INTERESTING KEYS
0388 3C 0E                      CMP     AL,14                   ;  IS IT IN THE REGION
038A 73 08                      JAE     K35                     ;  ALT-FUNCTION
038C 80 C4 76                   ADD     AH,118                  ;  CONVERT PSEUDO SCAN CODE TO RANGE
038F B0 00                      MOV     AL,0                    ;  INDICATE AS SUCH
0391 E9 048A R                  JMP     K57                     ;  BUFFER_FILL

                        ;-----  TRANSLATE ALTERNATE SHIFT PSEUDO SCAN CODES

0394                    K35:                                    ; ALT-FUNCTION
0394 3C 3B                      CMP     AL,59                   ; TEST FOR IN TABLE
0396 73 03                      JAE     K37                     ; ALT-CONTINUE
0398                    K36:                                    ; CLOSE-RETURN
0398 E9 02EE R                  JMP     K26                     ; IGNORE THE KEY
039B                    K37:                                    ; ALT-CONTINUE
039B 3C 47                      CMP     AL,71                   ; IN KEYPAD REGION
039D 73 F9                      JAE     K36                     ; IF SO, IGNORE
039F BB 0000 E                  MOV     BX,OFFSET K13           ; ALT SHIFT PSEUDO SCAN TABLE
03A2 E9 04E1 R                  JMP     K63                     ; TRANSLATE THAT

                        ;-----  NOT IN ALTERNATE SHIFT

03A5                    K38:                                    ; NOT-ALT-SHIFT
03A5 F6 06 0017 R 04            TEST    @KB_FLAG,CTL_SHIFT      ; ARE WE IN CONTROL SHIFT
03AA 74 62                      JZ      K44                     ; NOT-CTL-SHIFT

                        ;-----  CONTROL SHIFT, TEST SPECIAL CHARACTERS
                        ;-----  TEST FOR BREAK AND PAUSE KEYS

03AC 3C 46                      CMP     AL,SCROLL_KEY           ; TEST FOR BREAK
03AE 75 1D                      JNE     K39                     ; NO-BREAK
03B0 8B 1E 0080 R               MOV     BX,@BUFFER_START        ; RESET BUFFER TO EMPTY
03B4 89 1E 001A R               MOV     @BUFFER_HEAD,BX
03B8 89 1E 001C R               MOV     @BUFFER_TAIL,BX
03BC C6 06 0071 R 80            MOV     @BIOS_BREAK,80H         ; TURN ON @BIOS_BREAK BIT

                        ;-----  ENABLE KEYBOARD

03C1 B0 AE                      MOV     AL,ENA_KBD              ; ENABLE KEYBOARD
03C3 E8 0595 R                  CALL    SHIP_IT                 ; EXECUTE ENABLE
03C6 CD 1B                      INT     1BH                     ; BREAK INTERRUPT VECTOR
03C8 2B C0                      SUB     AX,AX                   ; PUT OUT DUMMY CHARACTER
03CA E9 048A R                  JMP     K57                     ; BUFFER_FILL

03CD                    K39:                                    ; NO-BREAK
03CD 3C 45                      CMP     AL,NUM_KEY              ; LOOK FOR PAUSE KEY
03CF 75 26                      JNE     K41                     ; NO-PAUSE
03D1 80 0E 0018 R 08            OR      @KB_FLAG_1,HOLD_STATE   ; TURN ON THE HOLD FLAG

                        ;-----  ENABLE KEYBOARD

03D6 B0 AE                      MOV     AL,ENA_KBD              ; ENABLE KEYBOARD
03D8 E8 0595 R                  CALL    SHIP_IT                 ; EXECUTE ENABLE
03DB B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT TO CONTROL PORT
03DD E6 20                      OUT     INTA00,AL               ; ALLOW FURTHER KEYSTROKE INTERRUPTS

                        ;-----  DURING PAUSE INTERVAL, TURN COLOR CRT BACK ON

03DF 80 3E 0049 R 07            CMP     @CRT_MODE,7             ; IS THIS THE MONOCHROME CARD
03E4 74 07                      JE      K40                     ; YES, NOTHING TO DO
03E6 BA 03D8                    MOV     DX,03D8H                ; PORT FOR COLOR CARD
03E9 A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE CURRENT MODE
03EC EE                         OUT     DX,AL                   ; SET THE CRT MODE, SO THAT CRT IS ON
```

```
                        ;-----  SUSPEND SYSTEM OPERATION (LOOP) TILL NEXT KEY CLEARS HOLD STATE FLAG

03ED                    K40:                                    ; PAUSE-LOOP
03ED F6 06 0018 R 08            TEST    @KB_FLAG_1,HOLD_STATE   ; CHECK HOLD STATE FLAG
03F2 75 F9                      JNZ     K40                     ; LOOP UNTIL FLAG TURNED OFF

03F4 E9 02F8 R                  JMP     K27A                    ; INTERRUPT_RETURN_NO_EOI

                        ;-----  TEST SPECIAL CASE KEY 55

03F7                    K41:                                    ; NO-PAUSE
03F7 3C 37                      CMP     AL,55
03F9 75 06                      JNE     K42                     ; NOT-KEY-55
03FB B8 7200                    MOV     AX,114*H                ; START/STOP PRINTING SWITCH
03FE E9 048A R                  JMP     K57                     ; BUFFER_FILL

                        ;-----  SET UP TO TRANSLATE CONTROL SHIFT

0401                    K42:                                    ; NOT-KEY-55
0401 BB 0000 E                  MOV     BX,OFFSET K8            ; SET UP TO TRANSLATE CTL
0404 3C 3B                      CMP     AL,59                   ; IS IT IN TABLE
0406 72 7E                      JB      K56                     ; YES, GO TRANSLATE CHAR
                                                                ; CTL-TABLE-TRANSLATE
0408 BB 0000 E                  MOV     BX,OFFSET K9            ; CTL TABLE SCAN
040B E9 04E1 R                  JMP     K63                     ; TRANSLATE_SCAN

                        ;-----  NOT IN CONTROL SHIFT

040E                    K44:                                    ; NOT-CTL-SHIFT
040E 3C 47                      CMP     AL,71                   ; TEST FOR KEYPAD REGION
0410 73 33                      JAE     K48                     ; HANDLE KEYPAD REGION
0412 F6 06 0017 R 03            TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT
0417 74 62                      JZ      K54                     ; TEST FOR SHIFT STATE

                        ;-----  UPPER CASE, HANDLE SPECIAL CASES

0419 3C 0F                      CMP     AL,15                   ; BACK TAB KEY
041B 75 05                      JNE     K45                     ; NOT-BACK-TAB
041D B8 0F00                    MOV     AX,15*H                 ; SET PSEUDO SCAN CODE
0420 EB 68                      JMP     SHORT K57               ; BUFFER_FILL

0422                    K45:                                    ; NOT-BACK-TAB
0422 3C 37                      CMP     AL,55                   ; PRINT SCREEN KEY
0424 75 10                      JNE     K46                     ; NOT-PRINT-SCREEN

                        ;-----  ISSUE INTERRUPT TO INDICATE PRINT SCREEN FUNCTION

0426 B0 AE                      MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
0428 E8 0595 R                  CALL    SHIP_IT                 ; EXECUTE ENABLE
042B B0 20                      MOV     AL,EOI                  ; END OF CURRENT INTERRUPT
042D E6 20                      OUT     INTA00,AL               ;  SO FURTHER THINGS CAN HAPPEN
042F 55                         PUSH    BP                      ; SAVE POINTER
0430 CD 05                      INT     05H                     ; ISSUE PRINT SCREEN INTERRUPT
0432 5D                         POP     BP                      ; RESTORE POINTER
0433 E9 02F3 R                  JMP     K27                     ; GO BACK WITHOUT EOI OCCURRING

0436                    K46:                                    ; NOT-PRINT-SCREEN
0436 3C 3B                      CMP     AL,59                   ; FUNCTION KEYS
0438 72 06                      JB      K47                     ; NOT-UPPER-FUNCTION
043A BB 0000 E                  MOV     BX,OFFSET K12           ; UPPER CASE PSEUDO SCAN CODES
043D E9 04E1 R                  JMP     K63                     ; TRANSLATE_SCAN

0440                    K47:                                    ; NOT-UPPER-FUNCTION
0440 BB 0000 E                  MOV     BX,OFFSET K11           ; POINT TO UPPER CASE TABLE
0443 EB 41                      JMP     SHORT K56               ; OK, TRANSLATE THE CHAR

                        ;-----  KEYPAD KEYS, MUST TEST NUM LOCK FOR DETERMINATION

0445                    K48:                                    ; KEYPAD-REGION
0445 F6 06 0017 R 20            TEST    @KB_FLAG,NUM_STATE      ; ARE WE IN NUM_LOCK
044A 75 21                      JNZ     K52                     ; TEST FOR SURE
044C F6 06 0017 R 03            TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT ; ARE WE IN SHIFT STATE
0451 75 21                      JNZ     K53                     ; IF SHIFTED, REALLY NUM STATE

                        ;-----  BASE CASE FOR KEYPAD

0453                    K49:                                    ; BASE-CASE

0453 3C 4A                      CMP     AL,74                   ; SPECIAL CASE FOR A COUPLE OF KEYS
0455 74 0C                      JE      K50                     ; MINUS
0457 3C 4E                      CMP     AL,78
0459 74 0D                      JE      K51
045B 2C 47                      SUB     AL,71                   ; CONVERT ORIGIN
045D BB 0000 E                  MOV     BX,OFFSET K15           ; BASE CASE TABLE
0460 E9 04E3 R                  JMP     K64                     ; CONVERT TO PSEUDO SCAN
0463                    K50:
0463 B8 4A2D                    MOV     AX,74*H+'-'             ; MINUS
0466 EB 22                      JMP     SHORT K57               ; BUFFER_FILL
0468                    K51:
0468 B8 4E2B                    MOV     AX,78*H+'+'             ; PLUS
046B EB 1D                      JMP     SHORT K57               ; BUFFER_FILL

                        ;-----  MIGHT BE NUM LOCK, TEST SHIFT STATUS

046D                    K52:                                    ; ALMOST-NUM-STATE
046D F6 06 0017 R 03            TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT
0472 75 DF                      JNZ     K49                     ; SHIFTED TEMP OUT OF NUM STATE

0474                    K53:                                    ; REALLY_NUM_STATE
0474 2C 46                      SUB     AL,70                   ; CONVERT ORIGIN
0476 BB 0000 E                  MOV     BX,OFFSET K14           ; NUM STATE TABLE
0479 EB 0B                      JMP     SHORT K56               ; TRANSLATE_CHAR

                        ;-----  PLAIN OLD LOWER CASE

047B                    K54:                                    ; NOT-SHIFT
047B 3C 3B                      CMP     AL,59                   ; TEST FOR FUNCTION KEYS
047D 72 04                      JB      K55                     ; NOT-LOWER-FUNCTION
047F B0 00                      MOV     AL,0                    ; SCAN CODE IN AH ALREADY
0481 EB 07                      JMP     SHORT K57               ; BUFFER_FILL

0483                    K55:                                    ; NOT-LOWER-FUNCTION
0483 BB 0000 E                  MOV     BX,OFFSET K10           ; LC TABLE
```

```
                        ;-----  TRANSLATE THE CHARACTER
                        K56:                                    ; TRANSLATE-CHAR
                                DEC     AL                      ; CONVERT ORIGIN
                                XLAT    CS:K11                  ; CONVERT THE SCAN CODE TO ASCII

                        ;-----  PUT CHARACTER INTO BUFFER

                        K57:                                    ; BUFFER-FILL
                                CMP     AL,-1                   ; IS THIS AN IGNORE CHAR
                                JE      K59                     ; YES, DO NOTHING WITH IT
                                CMP     AH,-1                   ; LOOK FOR -1 PSEUDO SCAN
                                JE      K59                     ; NEAR_INTERRUPT_RETURN

                        ;-----  HANDLE THE CAPS LOCK PROBLEM

                        K58:                                    ; BUFFER-FILL-NOTEST
                                TEST    @KB_FLAG,CAPS_STATE     ; ARE WE IN CAPS LOCK STATE
                                JZ      K61                     ; SKIP IF NOT

                        ;-----  IN CAPS LOCK STATE

                                TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT ; TEST FOR SHIFT STATE
                                JZ      K60                     ; IF NOT SHIFT, CONVERT LOWER TO UPPER

                        ;-----  CONVERT ANY UPPER CASE TO LOWER CASE

                                CMP     AL,'A'                  ; FIND OUT IF ALPHABETIC
                                JB      K61                     ; NOT_CAPS_STATE
                                CMP     AL,'Z'
                                JA      K61                     ; NOT_CAPS_STATE
                                ADD     AL,'a'-'A'              ; CONVERT TO LOWER CASE
                                JMP     SHORT K61               ; NOT_CAPS_STATE

                        K59:                                    ; NEAR-INTERRUPT-RETURN
                                JMP     K26                     ; INTERRUPT_RETURN

                        ;-----  CONVERT ANY LOWER CASE TO UPPER CASE

                        K60:                                    ; LOWER-TO-UPPER
                                CMP     AL,'a'                  ; FIND OUT IF ALPHABETIC
                                JB      K61                     ; NOT_CAPS_STATE
                                CMP     AL,'z'
                                JA      K61                     ; NOT_CAPS_STATE
                                SUB     AL,'a'-'A'              ; CONVERT TO UPPER CASE

                        K61:                                    ; NOT-CAPS-STATE
                                MOV     BX,@BUFFER_TAIL         ; GET THE END POINTER TO THE BUFFER
                                MOV     SI,BX                   ; SAVE THE VALUE
                                CALL    K4                      ; ADVANCE THE TAIL
                                CMP     BX,@BUFFER_HEAD         ; HAS THE BUFFER WRAPPED AROUND
                                JE      K62                     ; BUFFER_FULL_BEEP
                                MOV     [SI],AX                 ; STORE THE VALUE
                                MOV     @BUFFER_TAIL,BX         ; MOVE THE POINTER UP
                                CLI                             ; TURN OFF INTERRUPTS
                                MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
                                OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
                                CALL    SHIP_IT                 ; EXECUTE ENABLE
                                MOV     AX,09102H               ; MOVE IN POST CODE & TYPE
                                INT     15H                     ; PERFORM OTHER FUNCTION
                                JMP     K27A                    ; INTERRUPT_RETURN


                        ;-----  TRANSLATE SCAN FOR PSEUDO SCAN CODES

                        K63:                                    ; TRANSLATE-SCAN
                                SUB     AL,59                   ; CONVERT ORIGIN TO FUNCTION KEYS
                        K64:                                    ; TRANSLATE-SCAN-ORGD
                                XLAT    CS:K9                   ; CTL TABLE SCAN
                                MOV     AH,AL                   ; PUT VALUE INTO AH
                                MOV     AL,0                    ; ZERO ASCII CODE
                                JMP     K57                     ; PUT IT INTO THE BUFFER

                        KB_INT_1        ENDP

                        K62:
                                MOV     AL,EOI                  ; ENABLE INTERRUPT CONTROLLER CHIP
                                OUT     INTA00,AL               ;
                                MOV     CX,678                  ; DIVISOR FOR 1760 HZ
                                MOV     BL,4                    ; SHORT BEEP COUNT (1/16 + 1/64 DELAY)
                                CALL    BEEP                    ; GO TO COMMON BEEP HANDLER
                                JMP     K27                     ; EXIT

                        ;--------------------------------------------------------------------------
                        ;  SND_DATA                                                              :
                        ;                                                                        :
                        ;       THIS ROUTINES HANDLES TRANSMISSION OF COMMAND AND DATA BYTES      :
                        ;       TO THE KEYBOARD AND RECEIPT OF ACKNOWLEDGEMENTS.  IT ALSO        :
                        ;       HANDLES ANY RETRIES IF REQUIRED                                  :
                        ;                                                                        :
                        ;--------------------------------------------------------------------------

                        SND_DATA_PROC   NEAR
                                PUSH    AX                      ; SAVE REGISTERS
                                PUSH    BX
                                PUSH    CX
                                MOV     BH,AL                   ; SAVE TRANSMITTED BYTE FOR RETRIES
                                MOV     BL,3                    ; LOAD RETRY COUNT
                        SD0:
                                CLI                             ; DISABLE INTERRUPTS
                                AND     @KB_FLAG_2,NOT (KB_FE+KB_FA) ; CLEAR ACK AND RESEND FLAGS

                        ;-----  WAIT FOR ANY PENDING COMMAND TO BE ACCEPTED

                                SUB     CX,CX                   ; MAXIMUM WAIT COUNT
                        SD1:
                                IN      AL,STATUS_PORT          ; READ KEYBOARD PROCESSOR STATUS PORT
                                TEST    AL,INPT_BUF_FULL        ; CHECK FOR ANY PENDING COMMAND
                                LOOPNZ  SD1                     ; WAIT FOR COMMAND TO BE ACCEPTED

                                MOV     AL,BH                   ; REESTABLISH BYTE TO TRANSMIT
                                OUT     PORT_A,AL               ; SEND BYTE
```

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0513 FB                         STI                             ; ENABLE INTERRUPTS
0514 B9 1A00                    MOV     CX,01A00H               ; LOAD COUNT FOR 10 ms+
0517                    SD3:
0517 F6 06 0097 R 30            TEST    @KB_FLAG_2,KB_FE+KB_FA  ; SEE IF EITHER BIT SET
051C 75 0D                      JNZ     SD7                     ; IF SET, SOMETHING RECEIVED GO PROCESS

051E E2 F7                      LOOP    SD3                     ; OTHERWISE WAIT
0520                    SD5:
0520 FE CB                      DEC     BL                      ; DECREMENT RETRY COUNT
0522 75 DD                      JNZ     SD0                     ; RETRY TRANSMISSION

0524 80 0E 0097 R 80            OR      @KB_FLAG_2,KB_ERR       ; TURN ON TRANSMIT ERROR FLAG
0529 EB 07                      JMP     SHORT SD9               ; RETRIES EXHAUSTED FORGET TRANSMISSION
052B                    SD7:
052B F6 06 0097 R 10            TEST    @KB_FLAG_2,KB_FA        ; SEE IF THIS IS AN ACKNOWLEDGE
0530 74 EE                      JZ      SD5                     ; IF NOT, GO RESEND
0532                    SD9:
0532 59                         POP     CX                      ; RESTORE REGISTERS
0533 5B                         POP     BX
0534 58                         POP     AX
0535 C3                         RET                             ; RETURN, GOOD TRANSMISSION
0536                    SND_DATA ENDP

                        ;--------------------------------------------------------------------------
                        ;  SND_LED                                                               :
                        ;  SND_LED1                                                              :
                        ;                                                                        :
                        ;       THIS ROUTINES TURNS ON THE MODE INDICATORS.                      :
                        ;                                                                        :
                        ;--------------------------------------------------------------------------
0536                    SND_LED PROC    NEAR
0536 FA                         CLI                             ; TURN OFF INTERRUPTS
0537 F6 06 0097 R 40            TEST    @KB_FLAG_2,KB_PR_LED    ; CHECK FOR MODE INDICATOR UPDATE
053C 75 47                      JNZ     SL9                     ; DON'T UPDATE AGAIN IF UPDATE UNDERWAY

053E 80 0E 0097 R 40            OR      @KB_FLAG_2,KB_PR_LED    ; TURN ON UPDATE IN PROCESS
0543 B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
0545 E6 20                      OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
0547 EB 0D                      JMP     SHORT SL3               ; GO SEND MODE INDICATOR COMMAND

0549                    SND_LED1:
0549 FA                         CLI                             ; TURN OFF INTERRUPTS
054A F6 06 0097 R 40            TEST    @KB_FLAG_2,KB_PR_LED    ; CHECK FOR MODE INDICATOR UPDATE
054F 75 34                      JNZ     SL9                     ; DON'T UPDATE AGAIN IF UPDATE UNDERWAY

0551 80 0E 0097 R 40            OR      @KB_FLAG_2,KB_PR_LED    ; TURN ON UPDATE IN PROCESS
0556                    SL3:
0556 B0 ED                      MOV     AL,LED_CMD              ; LED CMD BYTE
0558 E8 04FA R                  CALL    SND_DATA                ; SEND DATA TO KEYBOARD
055B FA                         CLI                             ;
055C E8 0587 R                  CALL    MAKE_LED                ; GO FORM INDICATOR DATA BYTE
055F 80 26 0097 R F8            AND     @KB_FLAG_2,NOT KB_LEDS  ; CLEAR MODE INDICATOR BITS
0564 08 06 0097 R               OR      @KB_FLAG_2,AL           ; SAVE INDICATORS STATES FOR NEXT TIME
0568 F6 06 0097 R 80            TEST    @KB_FLAG_2,KB_ERR       ; TRANSMIT ERROR DETECTED
056D 75 0B                      JNZ     SL5                     ; IF SO, BYPASS SECOND BYTE TRANSMISSION

056F E8 04FA R                  CALL    SND_DATA                ; SEND DATA TO KEYBOARD
0572 FA                         CLI                             ; TURN OFF INTERRUPTS
0573 F6 06 0097 R 80            TEST    @KB_FLAG_2,KB_ERR       ; TRANSMIT ERROR DETECTED
0578 74 06                      JZ      SL7                     ; IF NOT, DON'T SEND AN ENABLE COMMAND
057A                    SL5:
057A B0 F4                      MOV     AL,KB_ENABLE            ; GET KEYBOARD CSA ENABLE COMMAND
057C E8 04FA R                  CALL    SND_DATA                ; SEND DATA TO KEYBOARD
057F FA                         CLI                             ; TURN OFF INTERRUPTS
0580                    SL7:
0580 80 26 0097 R 3F            AND     @KB_FLAG_2,NOT(KB_PR_LED+KB_ERR) ; TURN OFF MODE INDICATOR
0585                    SL9:                                    ; UPDATE AND TRANSMIT ERROR FLAG
0585 FB                         STI                             ; ENABLE INTERRUPTS
0586 C3                         RET                             ; RETURN TO CALLER
0587                    SND_LED ENDP

                        ;--------------------------------------------------------------------------
                        ;  MAKE_LED                                                              :
                        ;                                                                        :
                        ;       THIS ROUTINES FORMS THE DATA BYTE NECESSARY TO TURN ON/OFF        :
                        ;       THE MODE INDICATORS                                              :
                        ;                                                                        :
                        ;--------------------------------------------------------------------------
0587                    MAKE_LED PROC   NEAR
0587 51                         PUSH    CX                      ; SAVE CX
0588 A0 0017 R                  MOV     AL,@KB_FLAG             ; GET CAPS & NUM LOCK INDICATORS
058B 24 70                      AND     AL,CAPS_STATE+NUM_STATE+SCROLL_STATE ; ISOLATE INDICATORS
058D B1 04                      MOV     CL,4                    ; SHIFT COUNT
058F D2 C0                      ROL     AL,CL                   ; SHIFT BITS OVER TO TURN ON INDICATORS
0591 24 07                      AND     AL,07H                  ; MAKE SURE ONLY MODE BITS ON
0593 59                         POP     CX
0594 C3                         RET                             ; RETURN TO CALLER
0595                    MAKE_LED ENDP
                        ;--------------------------------------------------------------------------
                        ;  SHIP_IT                                                               :
                        ;                                                                        :
                        ;       THIS ROUTINES HANDLES TRANSMISSION OF COMMAND AND DATA BYTES      :
                        ;       TO THE KEYBOARD CONTROLLER.                                      :
                        ;                                                                        :
                        ;--------------------------------------------------------------------------
0595                    SHIP_IT PROC    NEAR
0595 50                         PUSH    AX                      ; SAVE DATA TO SEND
                        ;-----  WAIT FOR COMMAND TO ACCEPTED

0596 FA                         CLI                             ; DISABLE INTERRUPTS TILL DATA SENT
0597 2B C9                      SUB     CX,CX                   ; CLEAR TIMEOUT COUNTER
0599                    SI0:
0599 E4 64                      IN      AL,STATUS_PORT          ; READ KYBOARD CONTROLLER STATUS
059B A8 02                      TEST    AL,INPT_BUF_FULL        ; CHECK FOR ITS INPUT BUFFER BUSY
059D E0 FA                      LOOPNZ  SI0                     ; WAIT FOR COMMAND TO BE ACCEPTED

059F 58                         POP     AX                      ; GET DATA TO SEND
05A0 E6 64                      OUT     STATUS_PORT,AL          ; SEND TO KEYBOARD CONTROLLER
05A2 FB                         STI                             ; ENABLE INTERRUPTS AGAIN
05A3 C3                         RET                             ; RETURN TO CALLER
05A4                    SHIP_IT ENDP
05A4                    CODE    ENDS
                                END
```

SECTION 5

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                        PAGE 118,121
                        TITLE PRT ------ 06/10/85  PRINTER ADAPTER BIOS
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  PRINTER_IO_1
                                EXTRN   DDS:NEAR

                        ;--- INT  17 H ----------------------------------------------------------------------
                        ; PRINTER_IO                                                                        :
                        ;       THIS ROUTINE PROVIDES COMMUNICATION WITH THE PRINTER                        :
                        ; INPUT                                                                             :
                        ;       (AH)= 00H  PRINT THE CHARACTER IN (AL)                                      :
                        ;                  ON RETURN, (AH)= 1 IF CHARACTER NOT BE PRINTED (TIME OUT)        :
                        ;                  OTHER BITS SET AS ON NORMAL STATUS CALL                          :
                        ;       (AH)= 01H  INITIALIZE THE PRINTER PORT                                      :
                        ;                  RETURNS WITH (AH) SET WITH PRINTER STATUS                        :
                        ;       (AH)= 02H  READ THE PRINTER STATUS INTO (AH)                                :
                        ;                  7       6       5       4       3       2-1     0                :
                        ;                  |       |       |       |       |       |       |_ TIME OUT      :
                        ;                  |       |       |       |       |       |                        :
                        ;                  |       |       |       |       |       |_ UNUSED                :
                        ;                  |       |       |       |       |                                :
                        ;                  |       |       |       |       |_ 1 = I/O ERROR                 :
                        ;                  |       |       |       |                                        :
                        ;                  |       |       |       |_ 1 = SELECTED                          :
                        ;                  |       |       |                                                :
                        ;                  |       |       |_ 1 = OUT OF PAPER                              :
                        ;                  |       |                                                        :
                        ;                  |       |_ 1 = ACKNOWLEDGE                                       :
                        ;                  |                                                                :
                        ;                  |_ 1 = NOT BUSY                                                  :
                        ;                                                                                   :
                        ;       (DX) = PRINTER TO BE USED (0,1,2) CORRESPONDING TO ACTUAL VALUES            :
                        ;              IN @PRINTER_BASE AREA                                                :
                        ; DATA AREA @PRINTER_BASE CONTAINS THE BASE ADDRESS OF THE PRINTER CARD(S)          :
                        ; AVAILABLE (LOCATED AT BEGINNING OF DATA SEGMENT, 408H ABSOLUTE, 3 WORDS)          :
                        ;                                                                                   :
                        ; DATA AREA @PRINT_TIM_OUT (BYTE) MAY BE CHANGE TO CAUSE DIFFERENT                  :
                        ; TIME OUT WAITS. DEFAULT=20 * 4                                                    :
                        ;                                                                                   :
                        ; REGISTERS     (AH) IS MODIFIED WITH STATUS INFORMATION                            :
                        ;               ALL OTHERS UNCHANGED                                                :
                        ;-------------------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    PRINTER_IO_1    PROC    FAR                     ; ENTRY POINT FOR ORG 0EFD2H
0000 FB                         STI                                     ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS                              ; SAVE SEGMENT
0002 56                         PUSH    SI
0003 52                         PUSH    DX
0004 51                         PUSH    CX
0005 53                         PUSH    BX
0006 E8 0000 E                  CALL    DDS                             ; ADDRESS DATA SEGMENT
0009 8B F2                      MOV     SI,DX                           ; GET PRINTER PARAMETER
000B 8A 9C 0078 R               MOV     BL,@PRINT_TIM_OUT[SI]           ; LOAD TIMEOUT VALUE
000F D1 E6                      SHL     SI,1                            ; WORD OFFSET INTO TABLE INTO (SI)
0011 8B 94 0008 R               MOV     DX,@PRINTER_BASE[SI]            ; GET BASE ADDRESS FOR PRINTER CARD
0015 0B D2                      OR      DX,DX                           ; TEST DX = ZERO, INDICATING NO PRINTER
0017 74 0C                      JZ      B10                             ; EXIT,  NO PRINTER ADAPTER AT OFFSET
0019 0A E4                      OR      AH,AH                           ; TEST FOR (AH)= 00H
001B 74 0E                      JZ      B20                             ;  PRINT CHARACTER IN (AL)
001D FE CC                      DEC     AH                              ; TEST FOR (AH)= 01H
001F 74 58                      JZ      B80                             ;  INITIALIZE PRINTER
0021 FE CC                      DEC     AH                              ; TEST FOR (AH)= 02H
0023 74 3F                      JZ      B50                             ;  GET PRINTER STATUS
0025                    B10:
0025 5B                         POP     BX                              ; RETURN
0026 59                         POP     CX
0027 5A                         POP     DX
0028 5E                         POP     SI                              ; RECOVER REGISTERS
0029 1F                         POP     DS
002A CF                         IRET                                    ; RETURN TO CALLING PROGRAM

                        ;-----  PRINT THE CHARACTER IN (AL)

002B                    B20:
002B 50                         PUSH    AX                              ; SAVE VALUE TO PRINT
002C EE                         OUT     DX,AL                           ; OUTPUT CHARACTER TO DATA PORT
002D 42                         INC     DX                              ; POINT TO STATUS PORT

                        ;-----  CHECK FOR PRINTER BUSY

002E 53                         PUSH    BX                              ; SAVE TIMEOUT BASE COUNT
002F EC                         IN      AL,DX                           ; GET STATUS PORT VALUE
0030 A8 80                      TEST    AL,80H                          ; IS THE PRINTER CURRENTLY BUSY
0032 75 05                      JNZ     B25                             ; SKIP SYSTEM DEVICE BUSY CALL IF NOT

                        ;-----  INT 15 H -- DEVICE BUSY

0034 B8 90FE                    MOV     AX,90FEH                        ; FUNCTION 90 PRINTER ID
0037 CD 15                      INT     15H                             ; SYSTEM CALL

                        ;-----  WAIT BUSY

0039                    B25:                                            ; ADJUST OUTER LOOP COUNT
0039 2A FF                      SUB     BH,BH                           ; CLEAR (BH)
003B C1 D3 02                   RCL     BX,2                            ; MULTIPLY BY 4
003E                    B30:
003E 2B C9                      SUB     CX,CX                           ; INNER LOOP (64K)
0040                    B35:
0040 EC                         IN      AL,DX                           ; GET STATUS
0041 8A E0                      MOV     AH,AL                           ; STATUS TO (AH) ALSO
0043 A8 80                      TEST    AL,80H                          ; IS THE PRINTER CURRENTLY BUSY
0045 75 0E                      JNZ     B40                             ; GO TO OUTPUT STROBE
0047 E2 F7                      LOOP    B35                             ; LOOP IF NOT
0049 4B                         DEC     BX                              ; DECREMENT OUTER LOOP COUNT
004A 75 F2                      JNZ     B30                             ; MAKE ANOTHER PASS IF NOT ZERO

004C 5B                         POP     BX                              ; CLEAR (BX) FROM STACK
004D 80 CC 01                   OR      AH,1                            ; SET ERROR FLAG
0050 80 E4 F9                   AND     AH,0F9H                         ; TURN OFF THE UNUSED BITS
0053 EB 1C                      JMP     SHORT B70                       ; RETURN WITH ERROR FLAG SET
```

```
0055                    B40:                                    ;       SEND STROBE PULSE
0055 5B                         POP     BX                      ; RESTORE (BX) WITH TIMEOUT COUNT
0056 B0 0D                      MOV     AL,0DH                  ; SET THE STROBE LOW (BIT ON)
0058 42                         INC     DX                      ; OUTPUT STROBE TO CONTROL PORT
0059 FA                         CLI                             ; PREVENT INTERRUPT PULSE STRETCHING
005A EE                         OUT     DX,AL                   ; OUTPUT STROBE BIT   > 1us  < 5us
005B EB 00                      JMP     $+2                     ; I/O DELAY TO ALLOW FOR LINE LOADING
005D EB 00                      JMP     $+2                     ;  AND FOR CORRECT PULSE WIDTH
005F B0 0C                      MOV     AL,0CH                  ; SET THE -STROBE HIGH
0061 EE                         OUT     DX,AL
0062 FB                         STI                             ; INTERRUPTS BACK ON
0063 58                         POP     AX                      ; RECOVER THE OUTPUT CHAR

                        ;-----  PRINTER STATUS

0064                    B50:
0064 50                         PUSH    AX                      ; SAVE (AL) REGISTER
0065                    B60:
0065 8B 94 0008 R               MOV     DX,@PRINTER_BASE[SI]    ; GET PRINTER ATTACHMENT BASE ADDRESS
0069 42                         INC     DX                      ; POINT TO CONTROL PORT
006A EC                         IN      AL,DX                   ; PRE-CHARGE +BUSY LINE IF FLOATING
006B EC                         IN      AL,DX                   ; GET PRINTER STATUS HARDWARE BITS
006C 8A E0                      MOV     AH,AL                   ; SAVE
006E 80 E4 F8                   AND     AH,0F8H                 ; TURN OFF UNUSED BITS
0071                    B70:
0071 5A                         POP     DX                      ; RECOVER (AL) REGISTER
0072 8A C2                      MOV     AL,DL                   ; MOVE CHARACTER INTO (AL)
0074 80 F4 48                   XOR     AH,48H                  ; FLIP A COUPLE OF BITS
0077 EB AC                      JMP     B10                     ; RETURN FROM ROUTINE WITH STATUS IN AH

                        ;-----  INITIALIZE THE PRINTER PORT

0079                    B80:
0079 50                         PUSH    AX                      ; SAVE (AL)
007A 42                         INC     DX                      ; POINT TO OUTPUT PORT
007B 42                         INC     DX
007C B0 08                      MOV     AL,8                    ; SET INIT LINE LOW
007E EE                         OUT     DX,AL
007F B8 0FA0                    MOV     AX,1000*4               ; ADJUST FOR INITIALIZATION DELAY LOOP
0082                    B90:                                    ; INIT_LOOP
0082 48                         DEC     AX                      ; LOOP FOR RESET TO TAKE
0083 75 FD                      JNZ     B90                     ; INIT_LOOP
0085 B0 0C                      MOV     AL,0CH                  ; NO INTERRUPTS, NON AUTO LF, INIT HIGH
0087 EE                         OUT     DX,AL
0088 EB DB                      JMP     B60                     ; EXIT THROUGH STATUS ROUTINE

008A                    PRINTER_IO_1    ENDP

008A                            CODE    ENDS
                                END
```

```
                        PAGE 118,121
                        TITLE RS232 ---- 06/10/85  COMMUNICATIONS BIOS (RS232)
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  RS232_IO_1
                                EXTRN   A1:NEAR
                                EXTRN   DDS:NEAR

                        ;--- INT 14 H ----------------------------------------------------------------------
                        ;RS232_IO                                                                          :
                        ;       THIS ROUTINE PROVIDES BYTE STREAM I/O TO THE COMMUNICATIONS                 :
                        ;       PORT ACCORDING TO THE PARAMETERS:                                          :
                        ;                                                                                  :
                        ;       (AH)= 00H  INITIALIZE THE COMMUNICATIONS PORT                              :
                        ;                  (AL) HAS PARAMETERS FOR INITIALIZATION                          :
                        ;                                                                                  :
                        ;                  7       6       5       4       3       2       1       0       :
                        ;                  ----- BAUD RATE --      -PARITY--       STOPBIT   --WORD LENGTH--:
                        ;                                                                                  :
                        ;                  000 - 110               X0 - NONE       0 - 1     10 - 7 BITS   :
                        ;                  001 - 150               01 - ODD        1 - 2     11 - 8 BITS   :
                        ;                  010 - 300               11 - EVEN                               :
                        ;                  011 - 600                                                       :
                        ;                  100 - 1200                                                      :
                        ;                  101 - 2400                                                      :
                        ;                  110 - 4800                                                      :
                        ;                  111 - 9600                                                      :
                        ;                  ON RETURN, CONDITIONS SET AS IN CALL TO COMMO STATUS (AH=03H)    :
                        ;                                                                                  :
                        ;       (AH)= 01H  SEND THE CHARACTER IN (AL) OVER THE COMMO LINE                  :
                        ;                  (AL) REGISTER IS PRESERVED                                      :
                        ;                  ON EXIT, BIT 7 OF AH IS SET IF THE ROUTINE WAS UNABLE TO        :
                        ;                       TO TRANSMIT THE BYTE OF DATA OVER THE LINE.                :
                        ;                       IF BIT 7 OF AH IS NOT SET, THE                             :
                        ;                       REMAINDER OF (AH) IS SET AS IN A STATUS REQUEST,           :
                        ;                       REFLECTING THE CURRENT STATUS OF THE LINE.                 :
                        ;       (AH)= 02H  RECEIVE A CHARACTER IN (AL) FROM COMMO LINE BEFORE              :
                        ;                       RETURNING TO CALLER                                        :
                        ;                  ON EXIT, (AH) HAS THE CURRENT LINE STATUS, AS SET BY THE        :
                        ;                       THE STATUS ROUTINE, EXCEPT THAT THE ONLY BITS              :
                        ;                       LEFT ON ARE THE ERROR BITS (7,4,3,2,1)                     :
                        ;                       IF (AH) HAS BIT 7 ON (TIME OUT) THE REMAINING              :
                        ;                       BITS ARE NOT PREDICTABLE.                                  :
                        ;                       THUS, (AH) IS NON ZERO ONLY WHEN AN ERROR OCCURRED.        :
                        ;       (AH)= 03H  RETURN THE COMMO PORT STATUS IN (AX)                            :
                        ;                   (AH) CONTAINS THE LINE CONTROL STATUS                          :
                        ;                        BIT 7 = TIME OUT                                          :
                        ;                        BIT 6 = TRANSMIT SHIFT REGISTER EMPTY                     :
                        ;                        BIT 5 = TRANSMIT HOLDING REGISTER EMPTY                   :
                        ;                        BIT 4 = BREAK DETECT                                      :
                        ;                        BIT 3 = FRAMING ERROR                                     :
                        ;                        BIT 2 = PARITY ERROR                                      :
                        ;                        BIT 1 = OVERRUN ERROR                                     :
                        ;                        BIT 0 = DATA READY                                        :
                        ;                   (AL) CONTAINS THE MODEM STATUS                                 :
                        ;                        BIT 7 = RECEIVE LINE SIGNAL DETECT                        :
                        ;                        BIT 6 = RING INDICATOR                                    :
                        ;                        BIT 5 = DATA SET READY                                    :
                        ;                        BIT 4 = CLEAR TO SEND                                     :
                        ;                        BIT 3 = DELTA RECEIVE LINE SIGNAL DETECT                  :
                        ;                        BIT 2 = TRAILING EDGE RING DETECTOR                       :
                        ;                        BIT 1 = DELTA DATA SET READY                              :
                        ;                        BIT 0 = DELTA CLEAR TO SEND                               :
                        ;                                                                                  :
                        ;       (DX) = PARAMETER INDICATING WHICH RS232 CARD (0,1 ALLOWED)                 :
                        ;                                                                                  :
                        ; DATA AREA @RS232_BASE CONTAINS THE BASE ADDRESS OF THE 8250 ON THE CARD          :
                        ;       LOCATION 400H CONTAINS UP TO 4 RS232 ADDRESSES POSSIBLE                    :
                        ;       DATA AREA LABEL @RS232_TIM_OUT (BYTE) CONTAINS OUTER LOOP COUNT            :
                        ;       VALUE FOR TIMEOUT (DEFAULT=1)                                              :
                        ;OUTPUT                                                                            :
                        ;                  AX MODIFIED ACCORDING TO PARAMETERS OF CALL                     :
                        ;                  ALL OTHERS UNCHANGED                                            :
                        ;------------------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    RS232_IO_1      PROC    FAR

                        ;-----  VECTOR TO APPROPRIATE ROUTINE

0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS                      ; SAVE SEGMENT
0002 52                         PUSH    DX
0003 56                         PUSH    SI
0004 57                         PUSH    DI
0005 51                         PUSH    CX
0006 53                         PUSH    BX
0007 8B F2                      MOV     SI,DX                   ; RS232 VALUE TO (SI)
0009 8B FA                      MOV     DI,DX                   ; AND TO (DI) (FOR TIMEOUTS)
000B D1 E6                      SHL     SI,1                    ; WORD OFFSET
000D E8 0000 E                  CALL    DDS
0010 8B 94 0000 R               MOV     DX,@RS232_BASE[SI]      ; GET BASE ADDRESS
0014 0B D2                      OR      DX,DX                   ; TEST FOR 0 BASE ADDRESS
0016 74 13                      JZ      A3                      ; RETURN
0018 0A E4                      OR      AH,AH                   ; TEST FOR (AH)= 00H
001A 74 16                      JZ      A4                      ; COMMO INITIALIZATION
001C FE CC                      DEC     AH                      ; TEST FOR (AH)= 01H
001E 74 4B                      JZ      A5                      ; SEND (AL)
0020 FE CC                      DEC     AH                      ; TEST FOR (AH)= 02H
0022 74 70                      JZ      A12                     ; RECEIVE INTO (AL)
0024                    A2:
0024 FE CC                      DEC     AH                      ; TEST FOR (AH)= 03H
0026 75 03                      JNZ     A3
0028 E9 00B6 R                  JMP     A18                     ; COMMUNICATION STATUS
002B                    A3:                                     ; RETURN FROM RS232
002B 5B                         POP     BX
002C 59                         POP     CX
002D 5F                         POP     DI
002E 5E                         POP     SI
002F 5A                         POP     DX
0030 1F                         POP     DS
0031 CF                         IRET                            ; RETURN TO CALLER, NO ACTION
```

```
                        PAGE
                        ;-----  INITIALIZE THE COMMUNICATIONS PORT
                        A4:
                                MOV     AH,AL                   ; SAVE INITIALIZATION PARAMETERS IN (AH)
                                ADD     DX,3                    ; POINT TO 8250 CONTROL REGISTER
                                MOV     AL,80H
                                OUT     DX,AL                   ; SET DLAB=1

                        ;-----  DETERMINE BAUD RATE DIVISOR

                                MOV     DL,AH                   ; GET PARAMETERS TO (DL)
                                MOV     CL,4
                                ROL     DL,CL
                                AND     DX,0EH                  ; ISOLATE THEM
                                MOV     DI,OFFSET A1            ; BASE OF TABLE
                                ADD     DI,DX                   ; PUT INTO INDEX REGISTER
                                MOV     DX,@RS232_BASE[SI]      ; POINT TO HIGH ORDER OF DIVISOR
                                INC     DX
                                MOV     AL,CS:[DI]+1            ; GET HIGH ORDER OF DIVISOR
                                OUT     DX,AL                   ; SET ms OF DIVISOR TO 0
                                DEC     DX
                                JMP     $+2                     ; I/O DELAY
                                MOV     AL,CS:[DI]              ; GET LOW ORDER OF DIVISOR
                                OUT     DX,AL                   ; SET LOW OF DIVISOR
                                ADD     DX,3
                                MOV     AL,AH                   ; GET PARAMETERS BACK
                                AND     AL,01FH                 ; STRIP OFF THE BAUD BITS
                                OUT     DX,AL                   ; LINE CONTROL TO 8 BITS
                                DEC     DX
                                DEC     DX
                                JMP     $+2                     ; I/O DELAY
                                MOV     AL,0
                                OUT     DX,AL                   ; INTERRUPT ENABLES ALL OFF
                                JMP     SHORT A18               ; COM_STATUS

                        ;-----  SEND CHARACTER IN (AL) OVER COMMO LINE

                        A5:
                                PUSH    AX                      ; SAVE CHAR TO SEND
                                ADD     DX,4                    ; MODEM CONTROL REGISTER
                                MOV     AL,3                    ; DTR AND RTS
                                OUT     DX,AL                   ; DATA TERMINAL READY, REQUEST TO SEND
                                INC     DX                      ; MODEM STATUS REGISTER
                                INC     DX
                                MOV     BH,30H                  ; DATA SET READY & CLEAR TO SEND
                                CALL    WAIT_FOR_STATUS         ; ARE BOTH TRUE
                                JE      A9                      ; YES, READY TO TRANSMIT CHAR
                        A7:
                                POP     CX
                                MOV     AL,CL                   ; RELOAD DATA BYTE
                        A8:
                                OR      AH,80H                  ; INDICATE TIME OUT
                                JMP     A3                      ; RETURN

                        A9:                                     ; CLEAR_TO_SEND
                                DEC     DX                      ; LINE STATUS REGISTER
                        A10:                                    ; WAIT_SEND
                                MOV     BH,20H                  ; IS TRANSMITTER READY
                                CALL    WAIT_FOR_STATUS         ; TEST FOR TRANSMITTER READY
                                JNZ     A7                      ; RETURN WITH TIME OUT SET
                        A11:                                    ; OUT_CHAR
                                SUB     DX,5                    ; DATA PORT
                                POP     CX                      ; RECOVER IN CX TEMPORARILY
                                MOV     AL,CL                   ; MOVE CHAR TO AL FOR OUT, STATUS IN AH
                                OUT     DX,AL                   ; OUTPUT CHARACTER
                                JMP     A3                      ; RETURN

                        ;-----  RECEIVE CHARACTER FROM COMMO LINE

                        A12:
                                ADD     DX,4                    ; MODEM CONTROL REGISTER
                                MOV     AL,1                    ; DATA TERMINAL READY
                                OUT     DX,AL
                                INC     DX                      ; MODEM STATUS REGISTER
                                INC     DX
                        A13:                                    ; WAIT_DSR
                                MOV     BH,20H                  ; DATA SET READY
                                CALL    WAIT_FOR_STATUS         ; TEST FOR DSR
                                JNZ     A8                      ; RETURN WITH ERROR
                        A15:                                    ; WAIT_DSR_END
                                DEC     DX                      ; LINE STATUS REGISTER
                        A16:                                    ; WAIT_RECV
                                MOV     BH,1                    ; RECEIVE BUFFER FULL
                                CALL    WAIT_FOR_STATUS         ; TEST FOR RECEIVE BUFFER FULL
                                JNZ     A8                      ; SET TIME OUT ERROR
                        A17:                                    ; GET_CHAR
                                AND     AH,00011110B            ; TEST FOR ERROR CONDITIONS ON RECEIVE

                                MOV     DX,@RS232_BASE[SI]      ; DATA PORT
                                IN      AL,DX                   ; GET CHARACTER FROM LINE
                                JMP     A3                      ; RETURN

                        ;-----  COMMO PORT STATUS ROUTINE

                        A18:
                                MOV     DX,@RS232_BASE[SI]
                                ADD     DX,5                    ; CONTROL PORT
                                IN      AL,DX                   ; GET LINE CONTROL STATUS
                                MOV     AH,AL                   ; PUT IN (AH) FOR RETURN
                                INC     DX                      ; POINT TO MODEM STATUS REGISTER
                                IN      AL,DX                   ; GET MODEM CONTROL STATUS
                                JMP     A3                      ; RETURN
```

```
                        PAGE
                        ;--------------------------------------
                        ;       WAIT FOR STATUS ROUTINE        :
                        ;ENTRY: (BH)= STATUS BIT(S) TO LOOK FOR :
                        ;       (DX)= ADDRESS OF STATUS REG    :
                        ;EXIT:  ZERO FLAG ON = STATUS FOUND    :
                        ;       ZERO FLAG OFF = TIMEOUT.       :
                        ;       (AH)= LAST STATUS READ         :
                        ;--------------------------------------

00C5                    WAIT_FOR_STATUS PROC    NEAR
00C5 8A 9D 007C R               MOV     BL,@RS232_TIM_OUT[DI]   ; LOAD OUTER LOOP COUNT

                        ;-----  ADJUST OUTER LOOP COUNT

00C9 55                         PUSH    BP                      ; SAVE (BP)
00CA 53                         PUSH    BX                      ; SAVE (BX)
00CB 5D                         POP     BP                      ; USE BP FOR OUTER LOOP COUNT
00CC 81 E5 00FF                 AND     BP,00FFH                ; STRIP HIGH BITS
00D0 D1 D5                      RCL     BP,1                    ; MULTIPLY OUTER COUNT BY 4
00D2 D1 D5                      RCL     BP,1
00D4                    WFS0:
00D4 2B C9                      SUB     CX,CX
00D6                    WFS1:
00D6 EC                         IN      AL,DX                   ; GET STATUS
00D7 8A E0                      MOV     AH,AL                   ; MOVE TO (AH)
00D9 22 C7                      AND     AL,BH                   ; ISOLATE BITS TO TEST
00DB 3A C7                      CMP     AL,BH                   ; EXACTLY = TO MASK
00DD 74 07                      JE      WFS_END                 ; RETURN WITH ZERO FLAG ON

00DF E2 F5                      LOOP    WFS1                    ; TRY AGAIN

00E1 4D                         DEC     BP
00E2 75 F0                      JNZ     WFS0

00E4 0A FF                      OR      BH,BH                   ; SET ZERO FLAG OFF
00E6                    WFS_END:
00E6 5D                         POP     BP                      ; RESTORE (BP)
00E7 C3                         RET

00E8                    WAIT_FOR_STATUS ENDP

00E8                    RS232_IO_1      ENDP

00E8                    CODE    ENDS
                        END
```

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                        PAGE 118,121
                        TITLE VIDEO1 --- 06/10/85  VIDEO DISPLAY BIOS
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  ACT_DISP_PAGE
                                PUBLIC  READ_AC_CURRENT
                                PUBLIC  READ_CURSOR
                                PUBLIC  READ_DOT
                                PUBLIC  READ_LPEN
                                PUBLIC  SCROLL_DOWN
                                PUBLIC  SCROLL_UP
                                PUBLIC  SET_COLOR
                                PUBLIC  SET_CPOS
                                PUBLIC  SET_CTYPE
                                PUBLIC  SET_MODE
                                PUBLIC  WRITE_AC_CURRENT
                                PUBLIC  WRITE_C_CURRENT
                                PUBLIC  WRITE_DOT
                                PUBLIC  WRITE_TTY
                                PUBLIC  VIDEO_IO_1
                                PUBLIC  VIDEO_STATE

                                EXTRN   BEEP:NEAR               ; SPEEKER BEEP ROUTINE
                                EXTRN   CRT_CHAR_GEN:NEAR       ; CHARACTER GENERATOR GRAPHICS TABLE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   M5:WORD                 ; REGEN BUFFER LENGTH TABLE
                                EXTRN   M6:BYTE                 ; COLUMNS PER MODE TABLE
                                EXTRN   M7:BYTE                 ; MODE SET VALUE PER MODE TABLE

                        ;--- INT 10 H ----------------------------------------------------------------
                        ; VIDEO_IO                                                                    :
                        ;       THESE ROUTINES PROVIDE THE CRT DISPLAY INTERFACE                      :
                        ;       THE FOLLOWING FUNCTIONS ARE PROVIDED:                                :
                        ;                                                                            :
                        ;   (AH)= 00H  SET MODE (AL) CONTAINS MODE VALUE                             :
                        ;                (AL) = 00H  40X25 BW MODE (POWER ON DEFAULT)                :
                        ;                (AL) = 01H  40X25 COLOR                                     :
                        ;                (AL) = 02H  80X25 BW                                        :
                        ;                (AL) = 03H  80X25 COLOR                                     :
                        ;                            GRAPHICS MODES                                  :
                        ;                (AL) = 04H  320X200 COLOR                                   :
                        ;                (AL) = 05H  320X200 BW MODE                                 :
                        ;                (AL) = 06H  640X200 BW MODE                                 :
                        ;                (AL) = 07H    80X25 MONOCHROME (USED INTERNAL TO VIDEO ONLY) :
                        ;                *** NOTES -BW MODES OPERATE SAME AS COLOR MODES, BUT COLOR   :
                        ;                           BURST IS NOT ENABLED                             :
                        ;                          -CURSOR IS NOT DISPLAYED IN GRAPHICS MODE         :
                        ;   (AH)= 01H  SET CURSOR TYPE                                               :
                        ;                (CH) =  BITS 4-0 = START LINE FOR CURSOR                    :
                        ;                        ** HARDWARE WILL ALWAYS CAUSE BLINK                 :
                        ;                        ** SETTING BIT 5 OR 6 WILL CAUSE ERRATIC BLINKING   :
                        ;                           OR NO CURSOR AT ALL                              :
                        ;                (CL) =  BITS 4-0 = END LINE FOR CURSOR                      :
                        ;   (AH)= 02H  SET CURSOR POSITION                                           :
                        ;                (DH,DL) = ROW,COLUMN  (00H,00H) IS UPPER LEFT               :
                        ;                (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)         :
                        ;   (AH)= 03H  READ CURSOR POSITION                                          :
                        ;                (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)         :
                        ;                ON EXIT (DH,DL) = ROW,COLUMN OF CURRENT CURSOR              :
                        ;                        (CH,CL) = CURSOR MODE CURRENTLY SET                 :
                        ;   (AH)= 04H  READ LIGHT PEN POSITION                                       :
                        ;                ON EXIT:                                                    :
                        ;                (AH) = 00H -- LIGHT PEN SWITCH NOT DOWN/NOT TRIGGERED       :
                        ;                (AH) = 01H -- VALID LIGHT PEN VALUE IN REGISTERS            :
                        ;                        (DH,DL) = ROW,COLUMN OF CHARACTER LP POSITION       :
                        ;                        (CH) = RASTER LINE (0-199)                          :
                        ;                        (BX) = PIXEL COLUMN (0-319,639)                     :
                        ;   (AH)= 05H  SELECT ACTIVE DISPLAY PAGE (VALID ONLY FOR ALPHA MODES)       :
                        ;                (AL) = NEW PAGE VALUE (0-7 FOR MODES 0&1, 0-3 FOR MODES 2&3) :
                        ;   (AH)= 06H  SCROLL ACTIVE PAGE UP                                        :
                        ;                (AL) = NUMBER OF LINES, ( LINES BLANKED AT BOTTOM OF WINDOW ) :
                        ;                        (AL) = 00H MEANS BLANK ENTIRE WINDOW                :
                        ;                (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL         :
                        ;                (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL        :
                        ;                (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                   :
                        ;   (AH)= 07H  SCROLL ACTIVE PAGE DOWN                                       :
                        ;                (AL) = NUMBER OF LINES, INPUT LINES BLANKED AT TOP OF WINDOW :
                        ;                        (AL) = 00H MEANS BLANK ENTIRE WINDOW                :
                        ;                (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL         :
                        ;                (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL        :
                        ;                (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                   :
                        ;                                                                            :
                        ;   CHARACTER HANDLING ROUTINES                                              :
                        ;                                                                            :
                        ;   (AH)= 08H  READ ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION           :
                        ;                (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)            :
                        ;                ON EXIT:                                                    :
                        ;                (AL) = CHAR READ                                            :
                        ;                (AH) = ATTRIBUTE OF CHARACTER READ (ALPHA MODES ONLY)       :
                        ;   (AH)= 09H  WRITE ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION          :
                        ;                (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)            :
                        ;                (CX) = COUNT OF CHARACTERS TO WRITE                         :
                        ;                (AL) = CHAR TO WRITE                                        :
                        ;                (BL) = ATTRIBUTE OF CHARACTER (ALPHA)/COLOR OF CHAR (GRAPHICS):
                        ;                       SEE NOTE ON WRITE DOT FOR BIT 7 OF BL = 1.           :
                        ;   (AH)= 0AH  WRITE CHARACTER ONLY AT CURRENT CURSOR POSITION               :
                        ;                (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)            :
                        ;                (CX) = COUNT OF CHARACTERS TO WRITE                         :
                        ;                (AL) = CHAR TO WRITE                                        :
                        ;                       NOTE: USE FUNCTION (AH)= 09H IN GRAPHICS MODES       :
                        ;       FOR READ/WRITE CHARACTER INTERFACE WHILE IN GRAPHICS MODE, THE        :
                        ;               CHARACTERS ARE FORMED FROM A CHARACTER GENERATOR IMAGE        :
                        ;               MAINTAINED IN THE SYSTEM ROM.  ONLY THE 1ST 128 CHARS        :
                        ;               ARE CONTAINED THERE.  TO READ/WRITE THE SECOND 128 CHARS,    :
                        ;               THE USER MUST INITIALIZE THE POINTER AT INTERRUPT 1FH        :
                        ;               (LOCATION 0007CH) TO POINT TO THE 1K BYTE TABLE CONTAINING    :
                        ;               THE CODE POINTS FOR THE SECOND 128 CHARS (128-255).          :
                        ;       FOR WRITE CHARACTER INTERFACE IN GRAPHICS MODE, THE REPLICATION FACTOR :
                        ;               CONTAINED IN (CX) ON ENTRY WILL PRODUCE VALID RESULTS ONLY    :
                        ;               FOR CHARACTERS CONTAINED ON THE SAME ROW.  CONTINUATION TO    :
                        ;               SUCCEEDING LINES WILL NOT PRODUCE CORRECTLY.                  :
                        ;                                                                            :
```

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                        ;    GRAPHICS INTERFACE                                                      :
                        ;                                                                            :
                        ;    (AH)= 0BH  SET COLOR PALETTE                                            :
                        ;               (BH) = PALETTE COLOR ID BEING SET (0-127)                    :
                        ;               (BL) = COLOR VALUE TO BE USED WITH THAT COLOR ID             :
                        ;                      NOTE: FOR THE CURRENT COLOR CARD, THIS ENTRY POINT HAS :
                        ;                            MEANING ONLY FOR 320X200 GRAPHICS.              :
                        ;                      COLOR ID = 0 SELECTS THE BACKGROUND COLOR (0-15)       :
                        ;                      COLOR ID = 1 SELECTS THE PALETTE TO BE USED:           :
                        ;                               0 = GREEN(1)/RED(2)/YELLOW(3)                :
                        ;                               1 = CYAN(1)/MAGENTA(2)/WHITE(3)              :
                        ;                      IN 40X25 OR 80X25 ALPHA MODES, THE VALUE SET FOR      :
                        ;                            PALETTE COLOR 0 INDICATES THE BORDER COLOR      :
                        ;                            TO BE USED (VALUES 0-31, WHERE 16-31 SELECT     :
                        ;                            THE HIGH INTENSITY BACKGROUND SET.              :
                        ;    (AH)= 0CH  WRITE DOT                                                    :
                        ;               (DX) = ROW NUMBER                                            :
                        ;               (CX) = COLUMN NUMBER                                         :
                        ;               (AL) = COLOR VALUE                                           :
                        ;                      IF BIT 7 OF AL = 1, THEN THE COLOR VALUE IS EXCLUSIVE :
                        ;                      ORed WITH THE CURRENT CONTENTS OF THE DOT             :
                        ;    (AH)= 0DH  READ DOT                                                     :
                        ;               (DX) = ROW NUMBER                                            :
                        ;               (CX) = COLUMN NUMBER                                         :
                        ;               (AL) RETURNS THE DOT READ                                    :
                        ;                                                                            :
                        ;    ASCII TELETYPE ROUTINE FOR OUTPUT                                       :
                        ;                                                                            :
                        ;    (AH)= 0EH  WRITE TELETYPE TO ACTIVE PAGE                                :
                        ;               (AL) = CHAR TO WRITE                                         :
                        ;               (BL) = FOREGROUND COLOR IN GRAPHICS MODE                     :
                        ;               NOTE -- SCREEN WIDTH IS CONTROLLED BY PREVIOUS MODE SET      :
                        ;    (AH)= 0FH  CURRENT VIDEO STATE                                          :
                        ;               RETURNS THE CURRENT VIDEO STATE                              :
                        ;               (AL) = MODE CURRENTLY SET ( SEE (AH)= 00H FOR EXPLANATION)   :
                        ;               (AH) = NUMBER OF CHARACTER COLUMNS ON SCREEN                 :
                        ;               (BH) = CURRENT ACTIVE DISPLAY PAGE                           :
                        ;    (AH)= 10H  RESERVED                                                     :
                        ;    (AH)= 11H  RESERVED                                                     :
                        ;    (AH)= 12H  RESERVED                                                     :
                        ;    (AH)= 13H  WRITE STRING                                                 :
                        ;                       ES:BP  -  POINTER TO STRING TO BE WRITTEN             :
                        ;                       CX     -  LENGTH OF CHARACTER STRING TO WRITTEN       :
                        ;                       DX     -  CURSOR POSITION FOR STRING TO BE WRITTEN    :
                        ;                       BH     -  PAGE NUMBER                                 :
                        ;              (AL)= 00H  WRITE CHARACTER STRING                             :
                        ;                         BL     -  ATTRIBUTE                                :
                        ;                         STRING IS  <CHAR,CHAR, ... ,CHAR>                  :
                        ;                         CURSOR NOT MOVED                                   :
                        ;              (AL)= 01H  WRITE CHARACTER STRING AND MOVE CURSOR             :
                        ;                         BL     -  ATTRIBUTE                                :
                        ;                         STRING IS  <CHAR,CHAR, ... ,CHAR>                  :
                        ;                         CURSOR IS MOVED                                    :
                        ;              (AL)= 02H  WRITE CHARACTER AND ATTRIBUTE STRING               :
                        ;                                 (VALID FOR ALPHA MODES ONLY)               :
                        ;                         STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR>    :
                        ;                         CURSOR IS NOT MOVED                                :
                        ;              (AL)= 03H  WRITE CHARACTER AND ATTRIBUTE STRING AND MOVE CURSOR :
                        ;                                 (VALID FOR ALPHA MODES ONLY)               :
                        ;                         STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR>    :
                        ;                         CURSOR IS MOVED                                    :
                        ;                 NOTE:  CARRIAGE RETURN, LINE FEED, BACKSPACE, AND BELL ARE :
                        ;                        TREATED AS COMMANDS RATHER THAN PRINTABLE CHARACTERS. :
                        ;                                                                            :
                        ;       BX,CX,DX,SI,DI,BP,SP,DS,ES,SS PRESERVED DURING CALLS EXCEPT FOR      :
                        ;       BX,CX,DX RETURN VALUES ON FUNCTIONS 03H,04H,0DH AND 0DH. ON ALL CALLS :
                        ;       AX IS MODIFIED.                                                      :
                        ;--------------------------------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA,ES:NOTHING

0000 0067 R             M1      DW      OFFSET  SET_MODE         ;  TABLE OF ROUTINES WITHIN VIDEO I/O
0002 0137 R                     DW      OFFSET  SET_CTYPE
0004 015C R                     DW      OFFSET  SET_CPOS
0006 0184 R                     DW      OFFSET  READ_CURSOR
0008 0771 R                     DW      OFFSET  READ_LPEN
000A 019B R                     DW      OFFSET  ACT_DISP_PAGE
000C 0208 R                     DW      OFFSET  SCROLL_UP
000E 02A7 R                     DW      OFFSET  SCROLL_DOWN
0010 02F9 R                     DW      OFFSET  READ_AC_CURRENT
0012 0353 R                     DW      OFFSET  WRITE_AC_CURRENT
0014 0385 R                     DW      OFFSET  WRITE_C_CURRENT
0016 01BF R                     DW      OFFSET  SET_COLOR
0018 0446 R                     DW      OFFSET  WRITE_DOT
001A 0435 R                     DW      OFFSET  READ_DOT
001C 06EA R                     DW      OFFSET  WRITE_TTY
001E 01E5 R                     DW      OFFSET  VIDEO_STATE
0020 012E R                     DW      OFFSET  VIDEO_RETURN    ; RESERVED
0022 012E R                     DW      OFFSET  VIDEO_RETURN    ; RESERVED
0024 012E R                     DW      OFFSET  VIDEO_RETURN    ; RESERVED
0026 03B2 R                     DW      OFFSET  WRITE_STRING    ; CASE 19H, WRITE STRING
= 0028                  M1L     EQU     $-M1

0028                    VIDEO_IO_1      PROC    NEAR                    ;       ENTRY POINT FOR ORG 0F065H
0028 FB                         STI                                     ; INTERRUPTS BACK ON
0029 FC                         CLD                                     ; SET DIRECTION FORWARD
002A 06                         PUSH    ES
002B 1E                         PUSH    DS                              ; SAVE WORK AND PARAMETER REGISTERS
002C 52                         PUSH    DX
002D 51                         PUSH    CX
002E 53                         PUSH    BX
002F 56                         PUSH    SI
0030 57                         PUSH    DI
0031 55                         PUSH    BP
0032 E8 0000 E                  CALL    DDS                             ; POINT DS: TO DATA SEGMENT
0035 BE B800                    MOV     SI,0B800H                       ; GET SEGMENT FOR COLOR CARD
0038 8B 3E 0010 R               MOV     DI,@EQUIP_FLAG                  ; GET EQUIPMENT FLAGS SETTING
003C 81 E7 0030                 AND     DI,30H                          ; ISOLATE CRT SWITCHES
0040 83 FF 30                   CMP     DI,30H                          ; IS SETTING FOR BW CARD?
0043 75 03                      JNE     M2                              ; SKIP IF NOT BW CARD
0045 BE B000                    MOV     SI,0B000H                       ; ELSE GET SEGMENT FOR BW CARD
0048                    M2:
0048 80 FC 13                   CMP     AH,13H                          ; TEST FOR WRITE STRING OPERATION
004B 74 02                      JE      M3                              ; SKIP IF ES:BP VALID AS PASSED
```

```
004D 8E C6                      MOV     ES,SI                   ; SET UP TO POINT AT VIDEO MEMORY AREAS
004F                    M3:
004F 8B F0                      MOV     SI,AX                   ; MOVE COMMAND TO LOOK UP REGISTER
0051 C1 EE 08                   SHR     SI,8                    ; SHIFT COMMAND TO FORM BYTE OFFSET
0054 D1 E6                      SAL     SI,1                    ; TIMES 2 FOR WORD TABLE LOOKUP
0056 83 FE 28                   CMP     SI,MIL                  ; TEST FOR WITHIN TABLE RANGE
0059 73 09                      JNB     M4                      ; BRANCH TO EXIT IF NOT A VALID COMMAND

005B 8A 26 0049 R               MOV     AH,@CRT_MODE            ; MOVE CURRENT MODE INTO AH
005F 2E: FF A4 0000 R           JMP     WORD PTR CS:[SI+OFFSET M1]      ; GO TO SELECTED FUNCTION

0064                    M4:                                     ; COMMAND NOT VALID
0064 E9 012E R                  JMP     VIDEO_RETURN            ; DO NOTHING IF NOT IN VALID RANGE
0067                    VIDEO_IO_1      ENDP
                        ;--------------------------------------------------------
                        ; SET_MODE                                             :
                        ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO      :
                        ;       THE SELECTED MODE.  THE SCREEN IS BLANKED.      :
                        ; INPUT                                                 :
                        ;       (AL) = MODE SELECTED (RANGE 0-7)                :
                        ; OUTPUT                                                :
                        ;       NONE                                            :
                        ;--------------------------------------------------------
0067                    SET_MODE        PROC    NEAR
0067 BA 03D4                    MOV     DX,03D4H                ; ADDRESS OF COLOR CARD
006A 83 FF 30                   CMP     DI,30H                  ; IS BW CARD INSTALLED
006D 75 04                      JNE     M8                      ; OK WITH COLOR
006F B0 07                      MOV     AL,7                    ; INDICATE INTERNAL BW CARD MODE
0071 B2 B4                      MOV     DL,0B4H                 ; ADDRESS OF BW (MONOCHROME) CARD
0073                    M8:
0073 A2 0049 R                  MOV     @CRT_MODE,AL            ; SAVE MODE IN GLOBAL VARIABLE
0076 89 16 0063 R               MOV     @ADDR_6845,DX           ; SAVE ADDRESS OF BASE
007A C6 06 0084 R 18            MOV     @ROWS,25-1              ; INITIALIZE DEFAULT ROW COUNT OF 25
007F 1E                         PUSH    DS                      ; SAVE POINTER TO DATA SEGMENT
0080 50                         PUSH    AX                      ; SAVE MODE NUMBER (AL)
0081 98                         CBW                             ; CLEAR HIGH BYTE OF MODE
0082 8B F0                      MOV     SI,AX                   ; SET TABLE POINTER, INDEXED BY MODE
0084 2E: 8A 84 0000 E           MOV     AL,CS:[SI + OFFSET M7]  ; GET THE MODE SET VALUE FROM TABLE
0089 A2 0065 R                  MOV     @CRT_MODE_SET,AL        ; SAVE THE MODE SET VALUE
008C 24 37                      AND     AL,037H                 ; VIDEO OFF, SAVE HIGH RESOLUTION BIT
008E 52                         PUSH    DX                      ; SAVE OUTPUT PORT VALUE
008F 83 C2 04                   ADD     DX,4                    ; POINT TO CONTROL REGISTER
0092 EE                         OUT     DX,AL                   ; RESET VIDEO TO OFF TO SUPPRESS ROLLING
0093 5A                         POP     DX                      ; BACK TO BASE REGISTER
                                ASSUME  DS:ABS0
0094 2B DB                      SUB     BX,BX                   ; SET UP FOR ABS0 SEGMENT
0096 8E DB                      MOV     DS,BX                   ; ESTABLISH VECTOR TABLE ADDRESSING
0098 C5 1E 0074 R               LDS     BX,@PARM_PTR            ; GET POINTER TO VIDEO PARMS
                                ASSUME  DS:CODE
009C 58                         POP     AX                      ; RECOVER MODE NUMBER IN (AL)
009D B9 0010                    MOV     CX,16                   ; LENGTH OF EACH ROW OF TABLE
00A0 3C 02                      CMP     AL,2                    ; DETERMINE WHICH ONE TO USE
00A2 72 0E                      JC      M9                      ; MODE IS 0 OR 1
00A4 03 D9                      ADD     BX,CX                   ; NEXT ROW OF INITIALIZATION TABLE
00A6 3C 04                      CMP     AL,4
00A8 72 08                      JC      M9                      ; MODE IS 2 OR 3
00AA 03 D9                      ADD     BX,CX                   ; MOVE TO GRAPHICS ROW OF INIT_TABLE
00AC 3C 07                      CMP     AL,7
00AE 72 02                      JC      M9                      ; MODE IS 4,5, OR 6
00B0 03 D9                      ADD     BX,CX                   ; MOVE TO BW CARD ROW OF INIT_TABLE

                        ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

00B2                    M9:                                     ; OUT_INIT
00B2 50                         PUSH    AX                      ; SAVE MODE IN (AL)
00B3 8B 47 0A                   MOV     AX,[BX+10]              ; GET THE CURSOR MODE FROM THE TABLE
00B6 86 E0                      XCHG    AH,AL                   ; PUT CURSOR MODE IN CORRECT POSITION
00B8 1E                         PUSH    DS                      ; SAVE TABLE SEGMENT POINTER
                                ASSUME  DS:DATA
00B9 E8 0000 E                  CALL    DDS                     ; POINT DS TO DATA SEGMENT
00BC A3 0060 R                  MOV     @CURSOR_MODE,AX         ; PLACE INTO BIOS DATA SAVE AREA
                                ASSUME  DS:CODE
00BF 1F                         POP     DS                      ; RESTORE THE TABLE SEGMENT POINTER
00C0 32 E4                      XOR     AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                        ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE

00C2                    M10:                                    ;  INITIALIZATION LOOP
00C2 8A C4                      MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
00C4 EE                         OUT     DX,AL
00C5 42                         INC     DX                      ; POINT TO DATA PORT
00C6 FE C4                      INC     AH                      ; NEXT REGISTER VALUE
00C8 8A 07                      MOV     AL,[BX]                 ; GET TABLE VALUE
00CA EE                         OUT     DX,AL                   ; OUT TO CHIP
00CB 43                         INC     BX                      ; NEXT IN TABLE
00CC 4A                         DEC     DX                      ; BACK TO POINTER REGISTER
00CD E2 F3                      LOOP    M10                     ; DO THE WHOLE TABLE
00CF 58                         POP     AX                      ; GET MODE BACK INTO (AL)
00D0 1F                         POP     DS                      ; RECOVER SEGMENT VALUE
                                ASSUME  DS:DATA

                        ;-----  FILL REGEN AREA WITH BLANK

00D1 33 FF                      XOR     DI,DI                   ; SET UP POINTER FOR REGEN
00D3 89 3E 004E R               MOV     @CRT_START,DI           ; START ADDRESS SAVED IN GLOBAL
00D7 C6 06 0062 R 00            MOV     @ACTIVE_PAGE,0          ; SET PAGE VALUE
00DC B9 2000                    MOV     CX,8192                 ; NUMBER OF WORDS IN COLOR CARD
00DF 3C 04                      CMP     AL,4                    ; TEST FOR GRAPHICS
00E1 72 0A                      JC      M12                     ; NO_GRAPHICS_INIT
00E3 3C 07                      CMP     AL,7                    ; TEST FOR BW CARD
00E5 74 04                      JE      M11                     ; BW_CARD_INIT
00E7 33 C0                      XOR     AX,AX                   ; FILL FOR GRAPHICS MODE
00E9 EB 05                      JMP     SHORT M13               ; CLEAR_BUFFER
00EB                    M11:                                    ; BW_CARD_INIT
00EB B5 08                      MOV     CH,08H                  ; BUFFER SIZE ON BW CARD (2048)
00ED                    M12:                                    ; NO_GRAPHICS_INIT
00ED B8 0720                    MOV     AX,' '+7*H              ; FILL CHAR FOR ALPHA + ATTRIBUTE
00F0                    M13:                                    ; CLEAR_BUFFER
00F0 F3/ AB                     REP     STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS

                        ;-----  ENABLE VIDEO AND CORRECT PORT SETTING

00F2 8B 16 0063 R               MOV     DX,@ADDR_6845           ; PREPARE TO OUTPUT TO VIDEO ENABLE PORT
00F6 83 C2 04                   ADD     DX,4                    ; POINT TO THE MODE CONTROL REGISTER
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00F9 A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET THE MODE SET VALUE
00FC EE                         OUT     DX,AL                   ; SET VIDEO ENABLE PORT

                        ;-----  DETERMINE NUMBER OF COLUMNS, BOTH FOR ENTIRE DISPLAY
                        ;-----  AND THE NUMBER TO BE USED FOR TTY INTERFACE

00FD 2E: 8A 84 0000 E           MOV     AL,CS:[SI + OFFSET M6]  ; GET NUMBER OF COLUMNS ON THIS SCREEN
0102 98                         CBW                             ; CLEAR HIGH BYTE
0103 A3 004A R                  MOV     @CRT_COLS,AX            ; INITIALIZE NUMBER OF COLUMNS COUNT

                        ;-----  SET CURSOR POSITIONS

0106 81 E6 000E                 AND     SI,000EH                ; WORD OFFSET INTO CLEAR LENGTH TABLE
010A 2E: 8B 84 0000 E           MOV     AX,CS:[SI + OFFSET M5]  ; LENGTH TO CLEAR
010F A3 004C R                  MOV     @CRT_LEN,AX             ; SAVE LENGTH OF CRT -- NOT USED FOR BW
0112 B9 0008                    MOV     CX,8                    ; CLEAR ALL CURSOR POSITIONS
0115 BF 0050 R                  MOV     DI,OFFSET @CURSOR_POSN
0118 1E                         PUSH    DS                      ; ESTABLISH SEGMENT
0119 07                         POP     ES                      ;   ADDRESSING
011A 33 C0                      XOR     AX,AX
011C F3/ AB                     REP     STOSW                   ; FILL WITH ZEROES

                        ;-----  SET UP OVERSCAN REGISTER

011E 42                         INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
011F B0 30                      MOV     AL,30H                  ; 30H VALUE FOR ALL MODES EXCEPT 640X200
0121 80 3E 0049 R 06            CMP     @CRT_MODE,6             ; SEE IF THE MODE IS 640X200 BW
0126 75 02                      JNZ     M14                     ; IF NOT 640X200, THEN GO TO REGULAR
0128 B0 3F                      MOV     AL,3FH                  ; IF IT IS 640X200, THEN PUT IN 3FH
012A                    M14:
012A EE                         OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
012B A2 0066 R                  MOV     @CRT_PALETTE,AL         ; SAVE THE VALUE FOR FUTURE USE

                        ;-----  NORMAL RETURN FROM ALL VIDEO RETURNS

012E                    VIDEO_RETURN:
012E 5D                         POP     BP
012F 5F                         POP     DI
0130 5E                         POP     SI
0131 5B                         POP     BX
0132                    M15:                                    ; VIDEO_RETURN_C
0132 59                         POP     CX
0133 5A                         POP     DX
0134 1F                         POP     DS
0135 07                         POP     ES                      ; RECOVER SEGMENTS
0136 CF                         IRET                            ; ALL DONE
0137                    SET_MODE        ENDP
                        ;--------------------------------------------------------
                        ; SET_CTYPE
                        ;       THIS ROUTINE SETS THE CURSOR VALUE
                        ; INPUT
                        ;       (CX) HAS CURSOR VALUE CH-START LINE, CL-STOP LINE
                        ; OUTPUT
                        ;       NONE
                        ;--------------------------------------------------------
0137                    SET_CTYPE       PROC    NEAR
0137 B4 0A                      MOV     AH,10                   ; 6845 REGISTER FOR CURSOR SET
0139 89 0E 0060 R               MOV     @CURSOR_MODE,CX         ; SAVE IN DATA AREA
013D E8 0142 R                  CALL    M16                     ; OUTPUT CX REGISTER
0140 EB EC                      JMP     VIDEO_RETURN

                        ;-----  THIS ROUTINE OUTPUTS THE CX REGISTER TO THE 6845 REGISTERS NAMED IN (AH)


0142                    M16:
0142 8B 16 0063 R               MOV     DX,@ADDR_6845           ; ADDRESS REGISTER
0146 8A C4                      MOV     AL,AH                   ; GET VALUE
0148 EE                         OUT     DX,AL                   ; REGISTER SET
0149 42                         INC     DX                      ; DATA REGISTER
014A EB 00                      JMP     $+2                     ; I/O DELAY
014C 8A C5                      MOV     AL,CH                   ; DATA
014E EE                         OUT     DX,AL
014F 4A                         DEC     DX
0150 8A C4                      MOV     AL,AH
0152 FE C0                      INC     AL                      ; POINT TO OTHER DATA REGISTER
0154 EE                         OUT     DX,AL                   ; SET FOR SECOND REGISTER
0155 42                         INC     DX
0156 EB 00                      JMP     $+2                     ; I/O DELAY
0158 8A C1                      MOV     AL,CL                   ; SECOND DATA VALUE
015A EE                         OUT     DX,AL
015B C3                         RET                             ; ALL DONE
015C                    SET_CTYPE       ENDP


                        ;--------------------------------------------
                        ; SET_CPOS
                        ;       THIS ROUTINE SETS THE CURRENT CURSOR POSITION TO THE
                        ;       NEW X-Y VALUES PASSED
                        ;
                        ; INPUT
                        ;       DX - ROW,COLUMN OF NEW CURSOR
                        ;       BH - DISPLAY PAGE OF CURSOR
                        ; OUTPUT
                        ;       CURSOR IS SET AT 6845 IF DISPLAY PAGE IS CURRENT DISPLAY
                        ;--------------------------------------------
015C                    SET_CPOS        PROC    NEAR
015C 8A C7                      MOV     AL,BH                   ; MOVE PAGE NUMBER TO WORK REGISTER
015E 98                         CBW                             ; CONVERT PAGE TO WORD VALUE
015F D1 E0                      SAL     AX,1                    ; WORD OFFSET
0161 96                         XCHG    AX,SI                   ; USE INDEX REGISTER
0162 89 94 0050 R               MOV     [SI+OFFSET @CURSOR_POSN],DX     ; SAVE THE POINTER
0166 38 3E 0062 R               CMP     @ACTIVE_PAGE,BH
016A 75 05                      JNZ     M17                     ; SET_CPOS_RETURN
016C 8B C2                      MOV     AX,DX                   ; GET ROW/COLUMN TO AX
016E E8 0173 R                  CALL    M18                     ; CURSOR_SET
0171                    M17:                                    ; SET_CPOS_RETURN
0171 EB BB                      JMP     VIDEO_RETURN
0173                    SET_CPOS        ENDP

                        ;-----  SET CURSOR POSITION, AX HAS ROW/COLUMN FOR CURSOR

0173                    M18     PROC    NEAR
0173 E8 01F7 R                  CALL    POSITION                ; DETERMINE LOCATION IN REGEN BUFFER
0176 8B C8                      MOV     CX,AX
0178 03 0E 004E R               ADD     CX,@CRT_START           ; ADD IN THE START ADDRESS FOR THIS PAGE
017C D1 F9                      SAR     CX,1                    ; DIVIDE BY 2 FOR CHAR ONLY COUNT
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017E B4 0E                      MOV     AH,14                   ; REGISTER NUMBER FOR CURSOR
0180 E8 0142 R                  CALL    M16                     ; OUTPUT THE VALUE TO THE 6845
0183 C3                         RET
0184                    M18     ENDP
                        ;--------------------------------------------------
                        ; READ_CURSOR
                        ;       THIS ROUTINE READS THE CURRENT CURSOR VALUE FROM THE
                        ;       6845, FORMATS IT, AND SENDS IT BACK TO THE CALLER
                        ; INPUT
                        ;       BH - PAGE OF CURSOR
                        ; OUTPUT
                        ;       DX - ROW, COLUMN OF THE CURRENT CURSOR POSITION
                        ;       CX - CURRENT CURSOR MODE
                        ;--------------------------------------------
0184                    READ_CURSOR     PROC    NEAR
0184 8A DF                      MOV     BL,BH
0186 32 FF                      XOR     BH,BH
0188 D1 E3                      SAL     BX,1                    ; WORD OFFSET
018A 8B 97 0050 R               MOV     DX,[BX+OFFSET @CURSOR_POSN]
018E 8B 0E 0060 R               MOV     CX,@CURSOR_MODE
0192 5D                         POP     BP
0193 5F                         POP     DI
0194 5E                         POP     SI
0195 5B                         POP     BX
0196 58                         POP     AX                      ; DISCARD SAVED CX AND DX
0197 58                         POP     AX
0198 1F                         POP     DS
0199 07                         POP     ES
019A CF                         IRET
019B                    READ_CURSOR     ENDP
                        ;--------------------------------------------------
                        ; ACT_DISP_PAGE
                        ;       THIS ROUTINE SETS THE ACTIVE DISPLAY PAGE, ALLOWING
                        ;       THE FULL USE OF THE MEMORY SET ASIDE FOR THE VIDEO ATTACHMENT
                        ; INPUT
                        ;       AL HAS THE NEW ACTIVE DISPLAY PAGE
                        ; OUTPUT
                        ;       THE 6845 IS RESET TO DISPLAY THAT PAGE
                        ;--------------------------------------------------
019B                    ACT_DISP_PAGE   PROC    NEAR
019B A2 0062 R                  MOV     @ACTIVE_PAGE,AL         ; SAVE ACTIVE PAGE VALUE
019E 8B 0E 004C R               MOV     CX,@CRT_LEN             ; GET SAVED LENGTH OF REGEN BUFFER
01A2 98                         CBW                             ; CONVERT AL TO WORD
01A3 50                         PUSH    AX                      ; SAVE PAGE VALUE
01A4 F7 E1                      MUL     CX                      ; DISPLAY PAGE TIMES REGEN LENGTH
01A6 A3 004E R                  MOV     @CRT_START,AX           ; SAVE START ADDRESS FOR LATER
01A9 8B C8                      MOV     CX,AX                   ; START ADDRESS TO CX
01AB D1 F9                      SAR     CX,1                    ; DIVIDE BY 2 FOR 6845 HANDLING
01AD B4 0C                      MOV     AH,12                   ; 6845 REGISTER FOR START ADDRESS
01AF E8 0142 R                  CALL    M16
01B2 5B                         POP     BX                      ; RECOVER PAGE VALUE
01B3 D1 E3                      SAL     BX,1                    ; *2 FOR WORD OFFSET
01B5 8B 87 0050 R               MOV     AX,[BX + OFFSET @CURSOR_POSN]   ; GET CURSOR FOR THIS PAGE
01B9 E8 0173 R                  CALL    M18                     ; SET THE CURSOR POSITION
01BC E9 012E R                  JMP     VIDEO_RETURN
01BF                    ACT_DISP_PAGE   ENDP
                        ;--------------------------------------------
                        ; SET COLOR
                        ;       THIS ROUTINE WILL ESTABLISH THE BACKGROUND COLOR, THE OVERSCAN COLOR,
                        ;       AND THE FOREGROUND COLOR SET FOR MEDIUM RESOLUTION GRAPHICS
                        ; INPUT
                        ;       (BH) HAS COLOR ID
                        ;               IF BH=0, THE BACKGROUND COLOR VALUE IS SET
                        ;                       FROM THE LOW BITS OF BL (0-31)
                        ;               IF BH=1, THE PALETTE SELECTION IS MADE
                        ;                       BASED ON THE LOW BIT OF BL:
                        ;                               0 = GREEN, RED, YELLOW FOR COLORS 1,2,3
                        ;                               1 = BLUE, CYAN, MAGENTA FOR COLORS 1,2,3
                        ;       (BL) HAS THE COLOR VALUE TO BE USED
                        ; OUTPUT
                        ;       THE COLOR SELECTION IS UPDATED
                        ;--------------------------------------------
01BF                    SET_COLOR       PROC    NEAR
01BF 8B 16 0063 R               MOV     DX,@ADDR_6845           ; I/O PORT FOR PALETTE
01C3 83 C2 05                   ADD     DX,5                    ; OVERSCAN PORT
01C6 A0 0066 R                  MOV     AL,@CRT_PALETTE         ; GET THE CURRENT PALETTE VALUE
01C9 0A FF                      OR      BH,BH                   ; IS THIS COLOR 0?
01CB 75 0E                      JNZ     M20                     ; OUTPUT COLOR 1

                        ;-----  HANDLE COLOR 0 BY SETTING THE BACKGROUND COLOR

01CD 24 E0                      AND     AL,0E0H                 ; TURN OFF LOW 5 BITS OF CURRENT
01CF 80 E3 1F                   AND     BL,01FH                 ; TURN OFF HIGH 3 BITS OF INPUT VALUE
01D2 0A C3                      OR      AL,BL                   ; PUT VALUE INTO REGISTER
01D4                    M19:                                    ; OUTPUT THE PALETTE
01D4 EE                         OUT     DX,AL                   ; OUTPUT COLOR SELECTION TO 3D9 PORT
01D5 A2 0066 R                  MOV     @CRT_PALETTE,AL         ; SAVE THE COLOR VALUE
01D8 E9 012E R                  JMP     VIDEO_RETURN

                        ;-----  HANDLE COLOR 1 BY SELECTING THE PALETTE TO BE USED

01DB                    M20:
01DB 24 DF                      AND     AL,0DFH                 ; TURN OFF PALETTE SELECT BIT
01DD D0 EB                      SHR     BL,1                    ; TEST THE LOW ORDER BIT OF BL
01DF 73 F3                      JNC     M19                     ; ALREADY DONE
01E1 0C 20                      OR      AL,20H                  ; TURN ON PALETTE SELECT BIT
01E3 EB EF                      JMP     M19                     ; GO DO IT
01E5                    SET_COLOR       ENDP
                        ;--------------------------------------------------
                        ; VIDEO STATE
                        ;  RETURNS THE CURRENT VIDEO STATE IN AX
                        ;  AH = NUMBER OF COLUMNS ON THE SCREEN
                        ;  AL = CURRENT VIDEO MODE
                        ;  BH = CURRENT ACTIVE PAGE
                        ;--------------------------------------------------
01E5                    VIDEO_STATE     PROC    NEAR
01E5 8A 26 004A R               MOV     AH,BYTE PTR @CRT_COLS   ; GET NUMBER OF COLUMNS
01E9 A0 0049 R                  MOV     AL,@CRT_MODE            ; CURRENT MODE
01EC 8A 3E 0062 R               MOV     BH,@ACTIVE_PAGE         ; GET CURRENT ACTIVE PAGE
01F0 5D                         POP     BP                      ; RECOVER REGISTERS
01F1 5F                         POP     DI
01F2 5E                         POP     SI
01F3 59                         POP     CX                      ; DISCARD SAVED BX
01F4 E9 0132 R                  JMP     M15                     ; RETURN TO CALLER
```

SECTION 5

```
01F7                    VIDEO_STATE     ENDP
                        ;--------------------------------------
                        ; POSITION
                        ;       THIS SERVICE ROUTINE CALCULATES THE REGEN BUFFER ADDRESS
                        ;       OF A CHARACTER IN THE ALPHA MODE
                        ; INPUT
                        ;       AX = ROW, COLUMN POSITION
                        ; OUTPUT
                        ;       AX = OFFSET OF CHAR POSITION IN REGEN BUFFER
                        ;--------------------------------------
01F7                    POSITION        PROC    NEAR
01F7 53                         PUSH    BX                      ; SAVE REGISTER
01F8 8B D8                      MOV     BX,AX
01FA 8A C4                      MOV     AL,AH                   ; ROWS TO AL
01FC F6 26 004A R               MUL     BYTE PTR @CRT_COLS      ; DETERMINE BYTES TO ROW
0200 32 FF                      XOR     BH,BH
0202 03 C3                      ADD     AX,BX                   ; ADD IN COLUMN VALUE
0204 D1 E0                      SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
0206 5B                         POP     BX
0207 C3                         RET
0208                    POSITION        ENDP
                        ;--------------------------------------
                        ; SCROLL UP
                        ;       THIS ROUTINE MOVES A BLOCK OF CHARACTERS UP
                        ;       ON THE SCREEN
                        ; INPUT
                        ;       (AH) = CURRENT CRT MODE
                        ;       (AL) = NUMBER OF ROWS TO SCROLL
                        ;       (CX) = ROW/COLUMN OF UPPER LEFT CORNER
                        ;       (DX) = ROW/COLUMN OF LOWER RIGHT CORNER
                        ;       (BH) = ATTRIBUTE TO BE USED ON BLANKED LINE
                        ;       (DS) = DATA SEGMENT
                        ;       (ES) = REGEN BUFFER SEGMENT
                        ; OUTPUT
                        ;       NONE -- THE REGEN BUFFER IS MODIFIED
                        ;--------------------------------------
                                ASSUME  DS:DATA,ES:DATA
0208                    SCROLL_UP       PROC    NEAR

0208 E8 02E4 R                  CALL    TEST_LINE_COUNT
020B 80 FC 04                   CMP     AH,4                    ; TEST FOR GRAPHICS MODE
020E 72 08                      JC      N1                      ; HANDLE SEPARATELY
0210 80 FC 07                   CMP     AH,7                    ; TEST FOR BW CARD
0213 74 03                      JE      N1
0215 E9 04A3 R                  JMP     GRAPHICS_UP
0218                    N1:                                     ; UP_CONTINUE
0218 53                         PUSH    BX                      ; SAVE FILL ATTRIBUTE IN BH
0219 8B C1                      MOV     AX,CX                   ; UPPER LEFT POSITION
021B E8 0255 R                  CALL    SCROLL_POSITION         ; DO SETUP FOR SCROLL
021E 74 31                      JZ      N7                      ; BLANK_FIELD
0220 03 F0                      ADD     SI,AX                   ; FROM ADDRESS
0222 8A E6                      MOV     AH,DH                   ; # ROWS IN BLOCK
0224 2A E3                      SUB     AH,BL                   ; # ROWS TO BE MOVED
0226                    N2:                                     ; ROW_LOOP
0226 E8 0297 R                  CALL    N10                     ; MOVE ONE ROW
0229 03 F5                      ADD     SI,BP
022B 03 FD                      ADD     DI,BP                   ; POINT TO NEXT LINE IN BLOCK
022D FE CC                      DEC     AH                      ; COUNT OF LINES TO MOVE
022F 75 F5                      JNZ     N2                      ; ROW_LOOP
0231                    N3:                                     ; CLEAR_ENTRY
0231 58                         POP     AX                      ; RECOVER ATTRIBUTE IN AH
0232 B0 20                      MOV     AL,' '                  ; FILL WITH BLANKS
0234                    N4:                                     ; CLEAR_LOOP
0234 E8 02A0 R                  CALL    N11                     ; CLEAR THE ROW
0237 03 FD                      ADD     DI,BP                   ; POINT TO NEXT LINE
0239 FE CB                      DEC     BL                      ; COUNTER OF LINES TO SCROLL
023B 75 F7                      JNZ     N4                      ; CLEAR_LOOP
023D                    N5:                                     ; SCROLL_END
023D E8 0000 E                  CALL    DDS
0240 80 3E 0049 R 07            CMP     @CRT_MODE,7             ; IS THIS THE BLACK AND WHITE CARD
0245 74 07                      JE      N6                      ; IF SO, SKIP THE MODE RESET
0247 A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE MODE SET
024A BA 03D8                    MOV     DX,03D8H                ; ALWAYS SET COLOR CARD PORT
024D EE                         OUT     DX,AL
024E                    N6:                                     ; VIDEO_RET_HERE
024E E9 012E R                  JMP     VIDEO_RETURN
0251                    N7:                                     ; BLANK_FIELD
0251 8A DE                      MOV     BL,DH                   ; GET ROW COUNT
0253 EB DC                      JMP     N3                      ; GO CLEAR THAT AREA
0255                    SCROLL_UP       ENDP

                        ;-----  HANDLE COMMON SCROLL SET UP HERE

0255                    SCROLL_POSITION PROC    NEAR
0255 E8 01F7 R                  CALL    POSITION                ; CONVERT TO REGEN POINTER
0258 03 06 004E R               ADD     AX,@CRT_START           ; OFFSET OF ACTIVE PAGE
025C 8B F8                      MOV     DI,AX                   ; TO ADDRESS FOR SCROLL
025E 8B F0                      MOV     SI,AX                   ; FROM ADDRESS FOR SCROLL
0260 2B D1                      SUB     DX,CX                   ; DX = #ROWS, #COLS IN BLOCK
0262 FE C6                      INC     DH
0264 FE C2                      INC     DL                      ; INCREMENT FOR 0 ORIGIN
0266 32 ED                      XOR     CH,CH                   ; SET HIGH BYTE OF COUNT TO ZERO
0268 8B 2E 004A R               MOV     BP,@CRT_COLS            ; GET NUMBER OF COLUMNS IN DISPLAY
026C 03 ED                      ADD     BP,BP                   ; TIMES 2 FOR ATTRIBUTE BYTE
026E 8A C3                      MOV     AL,BL                   ; GET LINE COUNT
0270 F6 26 004A R               MUL     BYTE PTR @CRT_COLS      ; DETERMINE OFFSET TO FROM ADDRESS
0274 03 C0                      ADD     AX,AX                   ; *2 FOR ATTRIBUTE BYTE
0276 50                         PUSH    AX                      ; SAVE LINE COUNT
0277 A0 0049 R                  MOV     AL,@CRT_MODE            ; GET CURRENT MODE
027A 06                         PUSH    ES                      ; ESTABLISH ADDRESSING TO REGEN BUFFER
027B 1F                         POP     DS                      ;  FOR BOTH POINTERS
027C 3C 02                      CMP     AL,2                    ; TEST FOR COLOR CARD SPECIAL CASES HERE
027E 72 13                      JB      N9                      ; HAVE TO HANDLE 80X25 SEPARATELY
0280 3C 03                      CMP     AL,3
0282 77 0F                      JA      N9
                        ;-----
0284 52                         PUSH    DX                      ; 80X25 COLOR CARD SCROLL
0285 BA 03DA                    MOV     DX,3DAH                 ; GUARANTEED TO BE COLOR CARD HERE
0288                    N8:                                     ; WAIT_DISP_ENABLE
0288 EC                         IN      AL,DX                   ; GET PORT
0289 A8 08                      TEST    AL,RVRT                 ; WAIT FOR VERTICAL RETRACE
028B 74 FB                      JZ      N8                      ; WAIT_DISP_ENABLE
028D B0 25                      MOV     AL,25H
028F B2 D8                      MOV     DL,0D8H                 ; ADDRESS CONTROL PORT
```

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0291 EE                         OUT     DX,AL                   ; TURN OFF VIDEO DURING VERTICAL RETRACE
0292 5A                         POP     DX
0293                    N9:
0293 58                         POP     AX                      ; RESTORE LINE COUNT
0294 0A DB                      OR      BL,BL                   ; 0 SCROLL MEANS BLANK FIELD
0296 C3                         RET                             ; RETURN WITH FLAGS SET
0297                    SCROLL_POSITION ENDP

                        ;-----  MOVE_ROW
0297                    N10     PROC    NEAR
0297 8A CA                      MOV     CL,DL                   ; GET # OF COLS TO MOVE
0299 56                         PUSH    SI
029A 57                         PUSH    DI                      ; SAVE START ADDRESS
029B F3/ A5                     REP     MOVSW                   ; MOVE THAT LINE ON SCREEN
029D 5F                         POP     DI
029E 5E                         POP     SI                      ; RECOVER ADDRESSES
029F C3                         RET
02A0                    N10     ENDP

                        ;-----  CLEAR_ROW
02A0                    N11     PROC    NEAR
02A0 8A CA                      MOV     CL,DL                   ; GET # COLUMNS TO CLEAR
02A2 57                         PUSH    DI
02A3 F3/ AB                     REP     STOSW                   ; STORE THE FILL CHARACTER
02A5 5F                         POP     DI
02A6 C3                         RET
02A7                    N11     ENDP
                        ;--------------------------------------
                        ; SCROLL_DOWN
                        ;       THIS ROUTINE MOVES THE CHARACTERS WITHIN A DEFINED
                        ;       BLOCK DOWN ON THE SCREEN, FILLING THE TOP LINES
                        ;       WITH A DEFINED CHARACTER
                        ; INPUT
                        ;       (AH) = CURRENT CRT MODE
                        ;       (AL) = NUMBER OF LINES TO SCROLL
                        ;       (CX) = UPPER LEFT CORNER OF REGION
                        ;       (DX) = LOWER RIGHT CORNER OF REGION
                        ;       (BH) = FILL CHARACTER
                        ;       (DS) = DATA SEGMENT
                        ;       (ES) = REGEN SEGMENT
                        ; OUTPUT
                        ;       NONE -- SCREEN IS SCROLLED
                        ;--------------------------------------
02A7                    SCROLL_DOWN     PROC    NEAR
02A7 FD                         STD                             ; DIRECTION FOR SCROLL DOWN
02A8 E8 02E4 R                  CALL    TEST_LINE_COUNT         ;
02AB 80 FC 04                   CMP     AH,4                    ; TEST FOR GRAPHICS
02AE 72 08                      JC      N12
02B0 80 FC 07                   CMP     AH,7                    ; TEST FOR BW CARD
02B3 74 03                      JE      N12
02B5 E9 04FA R                  JMP     GRAPHICS_DOWN
02B8                    N12:                                    ; CONTINUE_DOWN
02B8 53                         PUSH    BX                      ; SAVE ATTRIBUTE IN BH
02B9 8B C2                      MOV     AX,DX                   ; LOWER RIGHT CORNER
02BB E8 0255 R                  CALL    SCROLL_POSITION         ; GET REGEN LOCATION
02BE 74 20                      JZ      N16
02C0 2B F0                      SUB     SI,AX                   ; SI IS FROM ADDRESS
02C2 8A E6                      MOV     AH,DH                   ; GET TOTAL # ROWS
02C4 2A E3                      SUB     AH,BL                   ; COUNT TO MOVE IN SCROLL
02C6                    N13:
02C6 E8 0297 R                  CALL    N10                     ; MOVE ONE ROW
02C9 2B F5                      SUB     SI,BP
02CB 2B FD                      SUB     DI,BP
02CD FE CC                      DEC     AH
02CF 75 F5                      JNZ     N13
02D1                    N14:
02D1 58                         POP     AX                      ; RECOVER ATTRIBUTE IN AH
02D2 B0 20                      MOV     AL,' '
02D4                    N15:
02D4 E8 02A0 R                  CALL    N11                     ; CLEAR ONE ROW
02D7 2B FD                      SUB     DI,BP                   ; GO TO NEXT ROW
02D9 FE CB                      DEC     BL
02DB 75 F7                      JNZ     N15
02DD E9 023D R                  JMP     N5                      ; SCROLL_END
02E0                    N16:
02E0 8A DE                      MOV     BL,DH
02E2 EB ED                      JMP     N14
02E4                    SCROLL_DOWN     ENDP

                        ;-----  IF  AMOUNT OF LINES TO BE SCROLLED = AMOUNT OF LINES IN WINDOW
                        ;-----   THEN  ADJUST AL; ELSE  RETURN;

02E4                    TEST_LINE_COUNT PROC    NEAR

02E4 8A D8                      MOV     BL,AL                   ; SAVE LINE COUNT IN BL
02E6 0A C0                      OR      AL,AL                   ; TEST IF AL IS ALREADY ZERO
02E8 74 0E                      JZ      BL_SET                  ; IF IT IS THEN RETURN...
02EA 50                         PUSH    AX                      ; SAVE AX
02EB 8A C6                      MOV     AL,DH                   ; SUBTRACT LOWER ROW FROM UPPER ROW
02ED 2A C5                      SUB     AL,CH
02EF FE C0                      INC     AL                      ; ADJUST DIFFERENCE BY 1
02F1 3A C3                      CMP     AL,BL                   ; LINE COUNT = AMOUNT OF ROWS IN WINDOW?
02F3 58                         POP     AX                      ; RESTORE AX
02F4 75 02                      JNE     BL_SET                  ; IF NOT THEN WE'RE ALL SET
02F6 2A DB                      SUB     BL,BL                   ; OTHERWISE SET BL TO ZERO
02F8                    BL_SET:
02F8 C3                         RET                             ; RETURN
02F9                    TEST_LINE_COUNT ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; READ_AC_CURRENT                                                               :
                        ;       THIS ROUTINE READS THE ATTRIBUTE AND CHARACTER AT THE CURRENT           :
                        ;       CURSOR POSITION AND RETURNS THEM TO THE CALLER                         :
                        ; INPUT                                                                        :
                        ;       (AH) = CURRENT CRT MODE                                                :
                        ;       (BH) = DISPLAY PAGE ( ALPHA MODES ONLY )                               :
                        ;       (DS) = DATA SEGMENT                                                    :
                        ;       (ES) = REGEN SEGMENT                                                   :
                        ; OUTPUT                                                                       :
                        ;       (AL) = CHARACTER READ                                                  :
                        ;       (AH) = ATTRIBUTE READ                                                  :
                        ;--------------------------------------------------------------------------------
                                ASSUME  DS:DATA,ES:DATA

02F9                    READ_AC_CURRENT PROC    NEAR
02F9 80 FC 04                   CMP     AH,4                    ; IS THIS GRAPHICS
02FC 72 08                      JC      P10

02FE 80 FC 07                   CMP     AH,7                    ; IS THIS BW CARD
0301 74 03                      JE      P10

0303 E9 062A R                  JMP     GRAPHICS_READ
0306                    P10:                                    ;  READ_AC_CONTINUE
0306 E8 0322 R                  CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
0309 8B F7                      MOV     SI,DI                   ; ESTABLISH ADDRESSING IN SI
030B 06                         PUSH    ES                      ; GET REGEN SEGMENT FOR QUICK ACCESS
030C 1F                         POP     DS

                        ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

030D 0A DB                      OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
030F 75 0D                      JNZ     P13                     ; ELSE SKIP RETRACE WAIT - DO FAST READ
0311                    P11:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
0311 FB                         STI                             ; ENABLE INTERRUPTS FIRST
0312 90                         NOP                             ; ALLOW FOR SMALL INTERRUPT WINDOW
0313 FA                         CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
0314 EC                         IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
0315 A8 01                      TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW
0317 75 F8                      JNZ     P11                     ; WAIT UNTIL IT IS
0319                    P12:                                    ;  NOW WAIT FOR EITHER RETRACE HIGH
0319 EC                         IN      AL,DX                   ; GET STATUS
031A A8 09                      TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
031C 74 FB                      JZ      P12                     ; WAIT UNTIL EITHER IS ACTIVE
031E                    P13:
031E AD                         LODSW                           ; GET THE CHARACTER AND ATTRIBUTE
031F E9 012E R                  JMP     VIDEO_RETURN            ;  EXIT WITH (AX)

0322                    READ_AC_CURRENT ENDP


0322                    FIND_POSITION   PROC    NEAR            ;       SETUP FOR BUFFER READ OR WRITE
0322 86 E3                      XCHG    AH,BL                   ; SWAP MODE TYPE WITH ATTRIBUTE
0324 8B E8                      MOV     BP,AX                   ; SAVE CHARACTER/ATTR IN (BP) REGISTER
0326 80 EB 02                   SUB     BL,2                    ; CONVERT DISPLAY MODE TYPE TO A
0329 D0 EB                      SHR     BL,1                    ;  ZERO VALUE FOR COLOR IN 80 COLUMN
032B 8B F3                      MOV     SI,BX                   ;  AND SAVE (2 OR 3 --> ZERO)
032D 8A DF                      MOV     BL,BH                   ; MOVE DISPLAY PAGE TO LOW BYTE
032F 32 FF                      XOR     BH,BH                   ; CLEAR HIGH BYTE OF COUNT/BYTE OFFSET
0331 8B FB                      MOV     DI,BX                   ; MOVE DISPLAY PAGE (COUNT) TO WORK REG
0333 D1 E7                      SAL     DI,1                    ; TIMES 2 FOR WORD OFFSET
0335 8B 85 0050 R               MOV     AX,[DI+OFFSET @CURSOR_POSN]     ; GET ROW/COLUMN OF THAT PAGE
0339 74 09                      JZ      P21                     ; SKIP BUFFER ADJUSTMENT IF PAGE ZERO

033B 33 FF                      XOR     DI,DI                   ; ELSE SET BUFFER START ADDRESS TO ZERO
033D                    P20:
033D 03 3E 004C R               ADD     DI,@CRT_LEN             ; ADD LENGTH OF BUFFER FOR ONE PAGE
0341 4B                         DEC     BX                      ; DECREMENT PAGE COUNT
0342 75 F9                      JNZ     P20                     ; LOOP TILL PAGE COUNT EXHAUSTED
0344                    P21:
0344 E8 01F7 R                  CALL    POSITION                ; DETERMINE LOCATION IN REGEN IN PAGE
0347 03 F8                      ADD     DI,AX                   ; ADD LOCATION TO START OF REGEN PAGE
0349 8B 16 0063 R               MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF ACTIVE DISPLAY
034D 83 C2 06                   ADD     DX,6                    ; POINT AT STATUS PORT
0350 8B DE                      MOV     BX,SI                   ; RECOVER CONVERTED MODE TYPE IN (BL)
0352 C3                         RET                             ;  BP= ATTRIBUTE/CHARACTER (FROM BL/AL)
                                                                ;  DI= POSITION (OFFSET IN REGEN BUFFER)
                                                                ;  DX= STATUS PORT ADDRESS OF ADAPTER
0353                    FIND_POSITION   ENDP                    ;  BL= MODE FLAG (ZERO FOR 80X25 COLOR)
```

```
                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; WRITE_AC_CURRENT                                                              :
                        ;       THIS ROUTINE WRITES THE ATTRIBUTE AND CHARACTER                         :
                        ;       AT THE CURRENT CURSOR POSITION                                         :
                        ; INPUT                                                                        :
                        ;       (AH) = CURRENT CRT MODE                                                :
                        ;       (BH) = DISPLAY PAGE                                                    :
                        ;       (CX) = COUNT OF CHARACTERS TO WRITE                                    :
                        ;       (AL) = CHAR TO WRITE                                                   :
                        ;       (BL) = ATTRIBUTE OF CHAR TO WRITE                                      :
                        ;       (DS) = DATA SEGMENT                                                    :
                        ;       (ES) = REGEN SEGMENT                                                   :
                        ; OUTPUT                                                                       :
                        ;       DISPLAY REGEN BUFFER UPDATED                                           :
                        ;--------------------------------------------------------------------------------

 0353                   WRITE_AC_CURRENT        PROC    NEAR
 0353 80 FC 04                  CMP     AH,4                    ; IS THIS GRAPHICS
 0356 72 08                     JC      P30
 0358 80 FC 07                  CMP     AH,7                    ; IS THIS BW CARD
 035B 74 03                     JE      P30
 035D E9 0582 R                 JMP     GRAPHICS_WRITE
 0360                   P30:                                    ;  WRITE_AC_CONTINUE
 0360 E8 0322 R                 CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                ; ADDRESS IN (DI) REGISTER
 0363 0A DB                     OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD AT 80
 0365 74 06                     JZ      P32                     ; SKIP TO RETRACE WAIT IF COLOR AT 80

 0367 95                        XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED FOR FAST WRITE
 0368 F3/ AB                    REP     STOSW                   ; STRING WRITE THE ATTRIBUTE & CHARACTER
 036A EB 16                     JMP     SHORT  P35              ; EXIT FAST WRITE ROUTINE

                        ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 036C                   P31:                                    ;  LOOP FOR EACH ATTR/CHAR WRITE
 036C 95                        XCHG    BP,AX                   ; PLACE ATTR/CHAR BACK IN SAVE REGISTER
 036D                   P32:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 036D FB                        STI                             ; ENABLE INTERRUPTS FIRST
 036E 90                        NOP                             ; ALLOW FOR INTERRUPT WINDOW
 036F FA                        CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 0370 EC                        IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 0371 A8 08                     TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 0373 75 09                     JNZ     P34                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 0375 A8 01                     TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 0377 75 F4                     JNZ     P32                     ; WAIT UNTIL IT IS
 0379                   P33:                                    ;  WAIT FOR EITHER RETRACE HIGH
 0379 EC                        IN      AL,DX                   ; GET STATUS AGAIN
 037A A8 09                     TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 037C 74 FB                     JZ      P33                     ; WAIT UNTIL EITHER IS ACTIVE
 037E                   P34:
 037E 95                        XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED IN (BP)
 037F AB                        STOSW                           ; WRITE THE ATTRIBUTE AND CHARACTER
 0380 E2 EA                     LOOP    P31                     ; AS MANY TIMES AS REQUESTED - TILL CX=0
 0382                   P35:
 0382 E9 012E R                 JMP     VIDEO_RETURN            ; EXIT

 0385                   WRITE_AC_CURRENT        ENDP

                        ;--------------------------------------------------------------------------------
                        ; WRITE_C_CURRENT                                                               :
                        ;       THIS ROUTINE WRITES THE CHARACTER AT                                   :
                        ;       THE CURRENT CURSOR POSITION, ATTRIBUTE UNCHANGED                       :
                        ; INPUT                                                                        :
                        ;       (AH) = CURRENT CRT MODE                                                :
                        ;       (BH) = DISPLAY PAGE                                                    :
                        ;       (CX) = COUNT OF CHARACTERS TO WRITE                                    :
                        ;       (AL) = CHAR TO WRITE                                                   :
                        ;       (DS) = DATA SEGMENT                                                    :
                        ;       (ES) = REGEN SEGMENT                                                   :
                        ; OUTPUT                                                                       :
                        ;       DISPLAY REGEN BUFFER UPDATED                                           :
                        ;--------------------------------------------------------------------------------

 0385                   WRITE_C_CURRENT PROC    NEAR
 0385 80 FC 04                  CMP     AH,4                    ; IS THIS GRAPHICS
 0388 72 08                     JC      P40
 038A 80 FC 07                  CMP     AH,7                    ; IS THIS BW CARD
 038D 74 03                     JE      P40
 038F E9 0582 R                 JMP     GRAPHICS_WRITE
 0392                   P40:
 0392 E8 0322 R                 CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                ; ADDRESS OF LOCATION IN (DI)

                        ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 0395                   P41:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 0395 FB                        STI                             ; ENABLE INTERRUPTS FIRST
 0396 0A DB                     OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
 0398 75 0F                     JNZ     P43                     ; ELSE SKIP RETRACE WAIT - DO FAST WRITE
 039A FA                        CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 039B EC                        IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 039C A8 08                     TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 039E 75 09                     JNZ     P43                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 03A0 A8 01                     TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 03A2 75 F1                     JNZ     P41                     ; WAIT UNTIL IT IS
 03A4                   P42:                                    ;  WAIT FOR EITHER RETRACE HIGH
 03A4 EC                        IN      AL,DX                   ; GET STATUS AGAIN
 03A5 A8 09                     TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 03A7 74 FB                     JZ      P42                     ; WAIT UNTIL EITHER RETRACE ACTIVE
 03A9                   P43:
 03A9 8B C5                     MOV     AX,BP                   ; GET THE CHARACTER SAVE IN (BP)
 03AB AA                        STOSB                           ; PUT THE CHARACTER INTO REGEN BUFFER
 03AC 47                        INC     DI                      ; BUMP POINTER PAST ATTRIBUTE
 03AD E2 E6                     LOOP    P41                     ;  AS MANY TIMES AS REQUESTED

 03AF E9 012E R                 JMP     VIDEO_RETURN

 03B2                   WRITE_C_CURRENT ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; WRITE_STRING                                                                  :
                        ;       THIS ROUTINE WRITES A STRING OF CHARACTERS TO THE CRT.                  :
                        ; INPUT                                                                        :
                        ;       (AL) = WRITE STRING COMMAND  0 - 3                                     :
                        ;       (BH) = DISPLAY PAGE                                                    :
                        ;       (CX) = COUNT OF CHARACTERS TO WRITE, IF (CX) = 0 THEN RETURN           :
                        ;       (DX) = CURSOR POSITION FOR START OF STRING WRITE                       :
                        ;       (BL) = ATTRIBUTE OF CHARACTER TO WRITE IF (AL) = 0  OR  (AL) = 1       :
                        ;       (ES) = SOURCE STRING SEGMENT                                           :
                        ;       (BP) = SOURCE STRING OFFSET                                            :
                        ; OUTPUT                                                                       :
                        ;       NONE                                                                   :
                        ;--------------------------------------------------------------------------------
03B2                    WRITE_STRING    PROC    NEAR
03B2 3C 04                      CMP     AL,04                   ; TEST FOR INVALID WRITE STRING OPTION
03B4 73 7C                      JNB     P59                     ; IF OPTION INVALID THEN RETURN
03B6 E3 7A                      JCXZ    P59                     ; IF ZERO LENGTH STRING THEN RETURN
                        
03B8 8B F3                      MOV     SI,BX                   ; GET CURRENT CURSOR PAGE
03BA C1 EE 08                   SHR     SI,8                    ; CLEAR HIGH BYTE
03BD D1 E6                      SAL     SI,1                    ; CONVERT TO PAGE OFFSET  (SI= PAGE)
03BF FF B4 0050 R               PUSH    [SI+OFFSET @CURSOR_POSN]; SAVE CURRENT CURSOR POSITION IN STACK
03C3 50                         PUSH    AX                      ; SAVE WRITE STRING OPTION
03C4 B8 0200                    MOV     AX,0200H                ; SET NEW CURSOR POSITION
03C7 CD 10                      INT     10H
03C9 58                         POP     AX                      ; RESTORE WRITE STRING OPTION
03CA                    P50:
03CA 51                         PUSH    CX
03CB 53                         PUSH    BX
03CC 50                         PUSH    AX
03CD 86 E0                      XCHG    AH,AL                   ; PUT THE WRITE STRING OPTION INTO (AH)
03CF 26: 8A 46 00               MOV     AL,ES:[BP]              ; GET CHARACTER FROM INPUT STRING
03D3 45                         INC     BP                      ; BUMP POINTER TO CHARACTER
                        
                        ;-----  TEST FOR SPECIAL CHARACTER'S
                        
03D4 3C 08                      CMP     AL,08H                  ; IS IT A BACKSPACE
03D6 74 0C                      JE      P51                     ; BACK_SPACE
03D8 3C 0D                      CMP     AL,CR                   ; IS IT CARRIAGE RETURN
03DA 74 08                      JE      P51                     ; CAR_RET
03DC 3C 0A                      CMP     AL,LF                   ; IS IT A LINE FEED
03DE 74 04                      JE      P51                     ; LINE_FEED
03E0 3C 07                      CMP     AL,07H                  ; IS IT A BELL
03E2 75 0D                      JNE     P52                     ; IF NOT THEN DO WRITE CHARACTER
03E4                    P51:
03E4 B4 0E                      MOV     AH,0EH                  ; TTY_CHARACTER WRITE
03E6 CD 10                      INT     10H                             ; WRITE TTY CHARACTER TO THE CRT
03E8 8B 94 0050 R               MOV     DX,[SI+OFFSET @CURSOR_POSN] ; GET CURRENT CURSOR POSITION
03EC 58                         POP     AX                              ; RESTORE REGISTERS
03ED 5B                         POP     BX
03EE 59                         POP     CX
03EF EB 2E                      JMP     SHORT P54               ; GO SET CURSOR POSITION AND CONTINUE
03F1                    P52:
03F1 B9 0001                    MOV     CX,1                    ; SET CHARACTER WRITE AMOUNT TO ONE
03F4 80 FC 02                   CMP     AH,2                    ; IS THE ATTRIBUTE IN THE STRING
03F7 72 05                      JB      P53                     ; IF NOT THEN SKIP
03F9 26: 8A 5E 00               MOV     BL,ES:[BP]              ; ELSE GET NEW ATTRIBUTE
03FD 45                         INC     BP                      ; BUMP STRING POINTER
03FE                    P53:
03FE B4 09                      MOV     AH,09H                  ;  GOT_CHARACTER
0400 CD 10                      INT     10H                     ; WRITE CHARACTER TO THE CRT
0402 58                         POP     AX                      ; RESTORE REGISTERS
0403 5B                         POP     BX
0404 59                         POP     CX
0405 FE C2                      INC     DL                      ; INCREMENT COLUMN COUNTER
0407 3A 16 004A R               CMP     DL,BYTE PTR @CRT_COLS   ; IF COLS ARE WITHIN RANGE FOR THIS MODE
040B 72 12                      JB      P54                     ;    THEN GO TO COLUMNS SET
040D FE C6                      INC     DH                      ; BUMP ROW COUNTER BY ONE
040F 2A D2                      SUB     DL,DL                   ; SET COLUMN COUNTER TO ZERO
0411 80 FE 19                   CMP     DH,25                   ; IF ROWS ARE LESS THAN 25 THEN
0414 72 09                      JB      P54                     ;    GO TO ROWS_COLUMNS_SET
                        
0416 50                         PUSH    AX                      ; ELSE SCROLL SCREEN
0417 B8 0E0A                    MOV     AX,0E0AH                ; DO SCROLL ONE LINE
041A CD 10                      INT     10H                     ; RESET ROW COUNTER TO 24
041C FE CE                      DEC     DH
041E 58                         POP     AX                      ; RESTORE REGISTERS
041F                    P54:                                    ;  ROW_COLUMNS_SET
041F 50                         PUSH    AX                      ; SAVE WRITE STRING OPTION
0420 B8 0200                    MOV     AX,0200H                ; SET NEW CURSOR POSITION COMMAND
0423 CD 10                      INT     10H                     ; ESTABLISH NEW CURSOR POSITION
0425 58                         POP     AX
0426 E2 A2                      LOOP    P50                     ; DO IT ONCE MORE UNTIL (CX) = ZERO
                        
0428 5A                         POP     DX                      ; RESTORE OLD CURSOR COORDINATES
0429 A8 01                      TEST    AL,01H                  ; IF CURSOR WAS NOT TO BE MOVED THEN
042B 75 05                      JNZ     P59                     ;  THEN EXIT WITHOUT RESETTING OLD VALUE
042D B8 0200                    MOV     AX,0200H                ; ELSE RESTORE OLD CURSOR POSITION
0430 CD 10                      INT     10H
0432                    P59:                                    ;  DONE - EXIT WRITE STRING
0432 E9 012E R                  JMP     VIDEO_RETURN            ; RETURN TO CALLER
                        
0435                    WRITE_STRING    ENDP
```

```
                        PAGE
                        ;--------------------------------------------
                        ; READ DOT  -- WRITE DOT
                        ; THESE ROUTINES WILL WRITE A DOT, OR READ THE
                        ;  DOT AT THE INDICATED LOCATION
                        ; ENTRY --
                        ;   DX = ROW (0-199)     (THE ACTUAL VALUE DEPENDS ON THE MODE)
                        ;   CX = COLUMN ( 0-639) ( THE VALUES ARE NOT RANGE CHECKED )
                        ;   AL = DOT VALUE TO WRITE (1,2 OR 4 BITS DEPENDING ON MODE,
                        ;        REQUIRED FOR WRITE DOT ONLY, RIGHT JUSTIFIED)
                        ;        BIT 7 OF AL = 1 INDICATES XOR THE VALUE INTO THE LOCATION
                        ;   DS = DATA SEGMENT
                        ;   ES = REGEN SEGMENT
                        ;
                        ; EXIT
                        ;        AL = DOT VALUE READ, RIGHT JUSTIFIED, READ ONLY
                        ;--------------------------------------------
                                ASSUME  DS:DATA,ES:DATA
0435                    READ_DOT        PROC    NEAR
0435 E8 0469 R                  CALL    R3                      ; DETERMINE BYTE POSITION OF DOT
0438 26: 8A 04                  MOV     AL,ES:[SI]              ; GET THE BYTE
043B 22 C4                      AND     AL,AH                   ; MASK OFF THE OTHER BITS IN THE BYTE
043D D2 E0                      SHL     AL,CL                   ; LEFT JUSTIFY THE VALUE
043F 8A CE                      MOV     CL,DH                   ; GET NUMBER OF BITS IN RESULT
0441 D2 C0                      ROL     AL,CL                   ; RIGHT JUSTIFY THE RESULT
0443 E9 012E R                  JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
0446                    READ_DOT        ENDP
                        ;
0446                    WRITE_DOT       PROC    NEAR
0446 50                         PUSH    AX                      ; SAVE DOT VALUE
0447 50                         PUSH    AX                      ;  TWICE
0448 E8 0469 R                  CALL    R3                      ; DETERMINE BYTE POSITION OF THE DOT
044B D2 E8                      SHR     AL,CL                   ; SHIFT TO SET UP THE BITS FOR OUTPUT
044D 22 C4                      AND     AL,AH                   ; STRIP OFF THE OTHER BITS
044F 26: 8A 0C                  MOV     CL,ES:[SI]              ; GET THE CURRENT BYTE
0452 5B                         POP     BX                      ; RECOVER XOR FLAG
0453 F6 C3 80                   TEST    BL,80H                  ; IS IT ON
0456 75 0D                      JNZ     R2                      ; YES, XOR THE DOT
0458 F6 D4                      NOT     AH                      ; SET MASK TO REMOVE THE INDICATED BITS
045A 22 CC                      AND     CL,AH
045C 0A C1                      OR      AL,CL                   ; OR IN THE NEW VALUE OF THOSE BITS
045E                    R1:                                     ; FINISH_DOT
045E 26: 88 04                  MOV     ES:[SI],AL              ; RESTORE THE BYTE IN MEMORY
0461 58                         POP     AX
0462 E9 012E R                  JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
0465                    R2:                                     ; XOR_DOT
0465 32 C1                      XOR     AL,CL                   ; EXCCUSIVE OR THE DOTS
0467 EB F5                      JMP     R1                      ; FINISH UP THE WRITING
0469                    WRITE_DOT       ENDP
                        ;--------------------------------------------
                        ; THIS SUBROUTINE DETERMINES THE REGEN BYTE LOCATION OF THE
                        ; INDICATED ROW COLUMN VALUE IN GRAPHICS MODE.
                        ; ENTRY --
                        ;  DX = ROW VALUE (0-199)
                        ;  CX = COLUMN VALUE (0-639)
                        ; EXIT --
                        ;  SI = OFFSET INTO REGEN BUFFER FOR BYTE OF INTEREST
                        ;  AH = MASK TO STRIP OFF THE BITS OF INTEREST
                        ;  CL = BITS TO SHIFT TO RIGHT JUSTIFY THE MASK IN AH
                        ;  DH = # BITS IN RESULT
                        ;  BX = MODIFIED
                        ;--------------------------------------------
0469                    R3      PROC    NEAR
                        ;
                        ;-----  DETERMINE 1ST BYTE IN INDICATED ROW BY MULTIPLYING ROW VALUE BY 40
                        ;-----    ( LOW BIT OF ROW DETERMINES EVEN/ODD, 80 BYTES/ROW )
                        ;
0469 93                         XCHG    AX,BX                   ; WILL SAVE AL AND AH DURING OPERATION
046A B0 28                      MOV     AL,40
046C F6 E2                      MUL     DL                      ; AX= ADDRESS OF START OF INDICATED ROW
046E A8 08                      TEST    AL,008H                 ; TEST FOR EVEN/ODD ROW CALCULATED
0470 74 03                      JZ      R4                      ; JUMP IF EVEN ROW
0472 05 1FD8                    ADD     AX,2000H-40             ; OFFSET TO LOCATION OF ODD ROWS ADJUST
0475                    R4:                                     ; EVEN_ROW
0475 96                         XCHG    SI,AX                   ; MOVE POINTER TO SI
0476 93                         XCHG    AX,BX                   ; RECOVER AL AND AH VALUES
0477 8B D1                      MOV     DX,CX                   ; COLUMN VALUE TO DX
                        ;
                        ;-----  DETERMINE GRAPHICS MODE CURRENTLY IN EFFECT
                        ;
                        ; SET UP THE REGISTERS ACCORDING TO THE MODE
                        ; CH = MASK FOR LOW OF COLUMN ADDRESS ( 7/3 FOR HIGH/MED RES )
                        ; CL = # OF ADDRESS BITS IN COLUMN VALUE ( 3/2 FOR H/M )
                        ; BL = MASK TO SELECT BITS FROM POINTED BYTE ( 80H/C0H FOR H/M )
                        ; BH = NUMBER OF VALID BITS IN POINTED BYTE ( 1/2 FOR H/M )
                        ;
0479 BB 02C0                    MOV     BX,2C0H
047C B9 0302                    MOV     CX,302H                 ; SET PARMS FOR MED RES
047F 80 3E 0049 R 06            CMP     @CRT_MODE,6
0484 72 06                      JC      R5                      ; HANDLE IF MED RES
0486 BB 0180                    MOV     BX,180H
0489 B9 0703                    MOV     CX,703H                 ; SET PARMS FOR HIGH RES
                        ;
                        ;-----  DETERMINE BIT OFFSET IN BYTE FROM COLUMN MASK
048C                    R5:
048C 22 EA                      AND     CH,DL                   ; ADDRESS OF PEL WITHIN BYTE TO CH
                        ;
                        ;-----  DETERMINE BYTE OFFSET FOR THIS LOCATION IN COLUMN
                        ;
048E D3 EA                      SHR     DX,CL                   ; SHIFT BY CORRECT AMOUNT
0490 03 F2                      ADD     SI,DX                   ; INCREMENT THE POINTER
0492 8A F7                      MOV     DH,BH                   ; GET THE # OF BITS IN RESULT TO DH
                        ;
                        ;-----  MULTIPLY BH (VALID BITS IN BYTE) BY CH (BIT OFFSET)
                        ;
0494 2A C9                      SUB     CL,CL                   ; ZERO INTO STORAGE LOCATION
0496                    R6:
0496 D0 C8                      ROR     AL,1                    ; LEFT JUSTIFY VALUE IN AL (FOR WRITE)
0498 02 CD                      ADD     CL,CH                   ; ADD IN THE BIT OFFSET VALUE
049A FE CF                      DEC     BH                      ; LOOP CONTROL
049C 75 F8                      JNZ     R6                      ; ON EXIT, CL HAS COUNT TO RESTORE BITS
049E 8A E3                      MOV     AH,BL                   ;  GET MASK TO AH
04A0 D2 EC                      SHR     AH,CL                   ;  MOVE THE MASK TO CORRECT LOCATION
04A2 C3                         RET                             ;  RETURN WITH EVERYTHING SET UP
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                        R3      ENDP
                        ;--------------------------------------------------------
                        ;  SCROLL UP
                        ;    THIS ROUTINE SCROLLS UP THE INFORMATION ON THE CRT
                        ; ENTRY --
                        ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                        ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                        ;    BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                        ;  BH = FILL VALUE FOR BLANKED LINES
                        ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                        ;  DS = DATA SEGMENT
                        ;  ES = REGEN SEGMENT
                        ; EXIT --
                        ;  NOTHING, THE SCREEN IS SCROLLED
                        ;--------------------------------------------------------
04A3                    GRAPHICS_UP     PROC    NEAR
04A3 8A D8                      MOV     BL,AL                   ; SAVE LINE COUNT IN BL
04A5 8B C1                      MOV     AX,CX                   ; GET UPPER LEFT POSITION INTO AX REG

                        ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
                        ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE

04A7 E8 06D8 R                  CALL    GRAPH_POSN
04AA 8B F8                      MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS

                        ;-----  DETERMINE SIZE OF WINDOW

04AC 2B D1                      SUB     DX,CX
04AE 81 C2 0101                 ADD     DX,101H                 ; ADJUST VALUES
04B2 C0 E6 02                   SAL     DH,2                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
                                                                ;  AND EVEN/ODD ROWS

                        ;-----  DETERMINE CRT MODE

04B5 80 3E 0049 R 06            CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
04BA 73 04                      JNC     R7                      ; FIND_SOURCE

                        ;-----  MEDIUM RES UP
04BC D0 E2                      SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
04BE D1 E7                      SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR

                        ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
04C0                    R7:                                     ; FIND_SOURCE
04C0 06                         PUSH    ES                      ; GET SEGMENTS BOTH POINTING TO REGEN
04C1 1F                         POP     DS
04C2 2A ED                      SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
04C4 C0 E3 02                   SAL     BL,2                    ; MULTIPLY NUMBER OF LINES BY 4
04C7 74 2D                      JZ      R11                     ; IF ZERO, THEN BLANK ENTIRE FIELD
04C9 8A C3                      MOV     AL,BL                   ; GET NUMBER OF LINES IN AL
04CB B4 50                      MOV     AH,80                   ; 80 BYTES/ROW
04CD F6 E4                      MUL     AH                      ; DETERMINE OFFSET TO SOURCE
04CF 8B F7                      MOV     SI,DI                   ; SET UP SOURCE
04D1 03 F0                      ADD     SI,AX                   ;  ADD IN OFFSET TO IT
04D3 8A E6                      MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
04D5 2A E3                      SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE

                        ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
04D7                    R8:                                     ; ROW LOOP
04D7 E8 0558 R                  CALL    R17                     ; MOVE ONE ROW
04DA 81 EE 1FB0                 SUB     SI,2000H-80             ; MOVE TO NEXT ROW
04DE 81 EF 1FB0                 SUB     DI,2000H-80
04E2 FE CC                      DEC     AH                      ; NUMBER OF ROWS TO MOVE
04E4 75 F1                      JNZ     R8                      ; CONTINUE TILL ALL MOVED

                        ;-----  FILL IN THE VACATED LINE(S)
04E6                    R9:                                     ; CLEAR_ENTRY
04E6 8A C7                      MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
04E8                    R10:
04E8 E8 0571 R                  CALL    R18                     ; CLEAR THAT ROW
04EB 81 EF 1FB0                 SUB     DI,2000H-80             ; POINT TO NEXT LINE
04EF FE CB                      DEC     BL                      ; NUMBER OF LINES TO FILL
04F1 75 F5                      JNZ     R10                     ; CLEAR_LOOP
04F3 E9 012E R                  JMP     VIDEO_RETURN            ; EVERYTHING DONE

04F6                    R11:                                    ; BLANK_FIELD
04F6 8A DE                      MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
04F8 EB EC                      JMP     R9                      ; CLEAR THE FIELD
04FA                    GRAPHICS_UP     ENDP
                        ;--------------------------------------------------------
                        ; SCROLL DOWN
                        ;  THIS ROUTINE SCROLLS DOWN THE INFORMATION ON THE CRT
                        ; ENTRY --
                        ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                        ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                        ;    BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                        ;  BH = FILL VALUE FOR BLANKED LINES
                        ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                        ;  DS = DATA SEGMENT
                        ;  ES = REGEN SEGMENT
                        ; EXIT --
                        ;  NOTHING, THE SCREEN IS SCROLLED
                        ;--------------------------------------------------------

04FA                    GRAPHICS_DOWN   PROC    NEAR
04FA FD                         STD                             ; SET DIRECTION
04FB 8A D8                      MOV     BL,AL                   ; SAVE LINE COUNT IN BL
04FD 8B C2                      MOV     AX,DX                   ; GET LOWER RIGHT POSITION INTO AX REG

                        ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
                        ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE

04FF E8 06D8 R                  CALL    GRAPH_POSN
0502 8B F8                      MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS

                        ;-----  DETERMINE SIZE OF WINDOW

0504 2B D1                      SUB     DX,CX
0506 81 C2 0101                 ADD     DX,101H                 ; ADJUST VALUES
050A C0 E6 02                   SAL     DH,2                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
                                                                ;  AND EVEN/ODD ROWS

                        ;-----  DETERMINE CRT MODE

050D 80 3E 0049 R 06            CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
0512 73 05                      JNC     R12                     ; FIND_SOURCE_DOWN
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                        ;-----  MEDIUM RES DOWN
0514 D0 E2                      SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
0516 D1 E7                      SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
0518 47                         INC     DI                      ; POINT TO LAST BYTE

                        ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
0519                    R12:                                    ; FIND_SOURCE_DOWN
0519 06                         PUSH    ES                      ; BOTH SEGMENTS TO REGEN
051A 1F                         POP     DS
051B 2A ED                      SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
051D 81 C7 00F0                 ADD     DI,240                  ; POINT TO LAST ROW OF PIXELS
0521 C0 E3 02                   SAL     BL,2                    ; MULTIPLY NUMBER OF LINES BY 4
0524 74 2E                      JZ      R16                     ; IF ZERO, THEN BLANK ENTIRE FIELD
0526 8A C3                      MOV     AL,BL                   ; GET NUMBER OF LINES IN AL
0528 B4 50                      MOV     AH,80                   ; 80 BYTES/ROW
052A F6 E4                      MUL     AH                      ; DETERMINE OFFSET TO SOURCE
052C 8B F7                      MOV     SI,DI                   ; SET UP SOURCE
052E 2B F0                      SUB     SI,AX                   ;  SUBTRACT THE OFFSET
0530 8A E6                      MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
0532 2A E3                      SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE

                        ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
0534                    R13:                                    ; ROW_LOOP_DOWN
0534 E8 0558 R                  CALL    R17                     ; MOVE ONE ROW
0537 81 EE 2050                 SUB     SI,2000H+80             ; MOVE TO NEXT ROW
053B 81 EF 2050                 SUB     DI,2000H+80
053F FE CC                      DEC     AH                      ; NUMBER OF ROWS TO MOVE
0541 75 F1                      JNZ     R13                     ; CONTINUE TILL ALL MOVED

                        ;-----  FILL IN THE VACATED LINE(S)
0543                    R14:                                    ; CLEAR_ENTRY_DOWN
0543 8A C7                      MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
0545                    R15:                                    ; CLEAR_LOOP_DOWN
0545 E8 0571 R                  CALL    R18                     ; CLEAR A ROW
0548 81 EF 2050                 SUB     DI,2000H+80             ; POINT TO NEXT LINE
054C FE CB                      DEC     BL                      ; NUMBER OF LINES TO FILL
054E 75 F5                      JNZ     R15                     ; CLEAR_LOOP_DOWN
0550 FC                         CLD                             ; RESET THE DIRECTION FLAG
0551 E9 012E R                  JMP     VIDEO_RETURN            ; EVERYTHING DONE

0554                    R16:                                    ; BLANK_FIELD_DOWN
0554 8A DE                      MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
0556 EB EB                      JMP     R14                     ; CLEAR THE FIELD
0558                    GRAPHICS_DOWN   ENDP


                        ;-----  ROUTINE TO MOVE ONE ROW OF INFORMATION

0558                    R17     PROC    NEAR
0558 8A CA                      MOV     CL,DL                   ; NUMBER OF BYTES IN THE ROW
055A 56                         PUSH    SI
055B 57                         PUSH    DI                      ; SAVE POINTERS
055C F3/ A4                     REP     MOVSB                   ; MOVE THE EVEN FIELD
055E 5F                         POP     DI
055F 5E                         POP     SI
0560 81 C6 2000                 ADD     SI,2000H
0564 81 C7 2000                 ADD     DI,2000H                ; POINT TO THE ODD FIELD
0568 56                         PUSH    SI
0569 57                         PUSH    DI                      ; SAVE THE POINTERS
056A 8A CA                      MOV     CL,DL                   ; COUNT BACK
056C F3/ A4                     REP     MOVSB                   ; MOVE THE ODD FIELD
056E 5F                         POP     DI
056F 5E                         POP     SI                      ; POINTERS BACK
0570 C3                         RET                             ; RETURN TO CALLER
0571                    R17     ENDP

                        ;-----  CLEAR A SINGLE ROW

0571                    R18     PROC    NEAR
0571 8A CA                      MOV     CL,DL                   ; NUMBER OF BYTES IN FIELD
0573 57                         PUSH    DI                      ; SAVE POINTER
0574 F3/ AA                     REP     STOSB                   ; STORE THE NEW VALUE
0576 5F                         POP     DI                      ; POINTER BACK
0577 81 C7 2000                 ADD     DI,2000H                ; POINT TO ODD FIELD
057B 57                         PUSH    DI
057C 8A CA                      MOV     CL,DL
057E F3/ AA                     REP     STOSB                   ; FILL THE ODD FIELD
0580 5F                         POP     DI
0581 C3                         RET                             ; RETURN TO CALLER
0582                    R18     ENDP
                        ;--------------------------------------------------
                        ; GRAPHICS WRITE
                        ;  THIS ROUTINE WRITES THE ASCII CHARACTER TO THE CURRENT
                        ;  POSITION ON THE SCREEN.
                        ; ENTRY --
                        ;  AL = CHARACTER TO WRITE
                        ;  BL = COLOR ATTRIBUTE TO BE USED FOR FOREGROUND COLOR
                        ;       IF BIT 7 IS SET, THE CHAR IS XOR'D INTO THE REGEN BUFFER
                        ;       (0 IS USED FOR THE BACKGROUND COLOR)
                        ;  CX = NUMBER OF CHARS TO WRITE
                        ;  DS = DATA SEGMENT
                        ;  ES = REGEN SEGMENT
                        ; EXIT --
                        ;  NOTHING IS RETURNED
                        ;
                        ; GRAPHICS READ
                        ;   THIS ROUTINE READS THE ASCII CHARACTER AT THE CURRENT CURSOR
                        ;   POSITION ON THE SCREEN BY MATCHING THE DOTS ON THE SCREEN TO THE
                        ;   CHARACTER GENERATOR CODE POINTS
                        ; ENTRY --
                        ;  NONE  (0 IS ASSUMED AS THE BACKGROUND COLOR)
                        ; EXIT --
                        ;  AL = CHARACTER READ AT THAT POSITION (0 RETURNED IF NONE FOUND)
                        ;
                        ; FOR BOTH ROUTINES, THE IMAGES USED TO FORM CHARS ARE CONTAINED IN ROM
                        ;  FOR THE 1ST 128 CHARS.  TO ACCESS CHARS IN THE SECOND HALF, THE USER
                        ;  MUST INITIALIZE THE VECTOR AT INTERRUPT 1FH (LOCATION 0007CH) TO
                        ;  POINT TO THE USER SUPPLIED TABLE OF GRAPHIC IMAGES (8X8 BOXES).
                        ;  FAILURE TO DO SO WILL CAUSE IN STRANGE RESULTS
                        ;--------------------------------------------------
                                ASSUME  DS:DATA,ES:DATA
0582                    GRAPHICS_WRITE  PROC    NEAR
0582 B4 00                      MOV     AH,0                    ; ZERO TO HIGH OF CODE POINT
0584 50                         PUSH    AX                      ; SAVE CODE POINT VALUE
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                        ;-----  DETERMINE POSITION IN REGEN BUFFER TO PUT CODE POINTS
0585 E8 06D5 R                  CALL    S26                     ; FIND LOCATION IN REGEN BUFFER
0588 8B F8                      MOV     DI,AX                   ; REGEN POINTER IN DI
                        ;-----  DETERMINE REGION TO GET CODE POINTS FROM
058A 58                         POP     AX                      ; RECOVER CODE POINT
058B 3C 80                      CMP     AL,80H                  ; IS IT IN SECOND HALF
058D 73 06                      JAE     S1                      ; YES
                        ;-----  IMAGE IS IN FIRST HALF, CONTAINED IN ROM
058F BE 0000 E                  MOV     SI,OFFSET CRT_CHAR_GEN  ; OFFSET OF IMAGES
0592 0E                         PUSH    CS                      ; SAVE SEGMENT ON STACK
0593 EB 0F                      JMP     SHORT S2                ; DETERMINE_MODE
                        ;-----  IMAGE IS IN SECOND HALF, IN USER MEMORY
0595                    S1:                                     ; EXTEND_CHAR
0595 2C 80                      SUB     AL,80H                  ; ZERO ORIGIN FOR SECOND HALF
0597 1E                         PUSH    DS                      ; SAVE DATA POINTER
0598 2B F6                      SUB     SI,SI
059A 8E DE                      MOV     DS,SI                   ; ESTABLISH VECTOR ADDRESSING
                                ASSUME  DS:ABS0
059C C5 36 007C R               LDS     SI,@EXT_PTR             ; GET THE OFFSET OF THE TABLE
05A0 8C DA                      MOV     DX,DS                   ; GET THE SEGMENT OF THE TABLE
                                ASSUME  DS:DATA
05A2 1F                         POP     DS                      ; RECOVER DATA SEGMENT
05A3 52                         PUSH    DX                      ; SAVE TABLE SEGMENT ON STACK
                        ;-----  DETERMINE GRAPHICS MODE IN OPERATION
05A4                    S2:                                     ;       DETERMINE_MODE
05A4 C1 E0 03                   SAL     AX,3                    ; MULTIPLY CODE POINT VALUE BY 8
05A7 03 F0                      ADD     SI,AX                   ; SI HAS OFFSET OF DESIRED CODES
05A9 80 3E 0049 R 06            CMP     @CRT_MODE,6
05AE 1F                         POP     DS                      ; RECOVER TABLE POINTER SEGMENT
05AF 72 2C                      JC      S7                      ; TEST FOR MEDIUM RESOLUTION MODE
                        ;-----  HIGH RESOLUTION MODE
05B1                    S3:                                     ; HIGH_CHAR
05B1 57                         PUSH    DI                      ; SAVE REGEN POINTER
05B2 56                         PUSH    SI                      ; SAVE CODE POINTER
05B3 B6 04                      MOV     DH,4                    ; NUMBER OF TIMES THROUGH LOOP
05B5                    S4:
05B5 AC                         LODSB                           ; GET BYTE FROM CODE POINTS
05B6 F6 C3 80                   TEST    BL,80H                  ; SHOULD WE USE THE FUNCTION
05B9 75 16                      JNZ     S6                      ;  TO PUT CHAR IN
05BB AA                         STOSB                           ; STORE IN REGEN BUFFER
05BC AC                         LODSB
05BD                    S5:
05BD 26: 88 85 1FFF             MOV     ES:[DI+2000H-1],AL      ; STORE IN SECOND HALF
05C2 83 C7 4F                   ADD     DI,79                   ; MOVE TO NEXT ROW IN REGEN
05C5 FE CE                      DEC     DH                      ; DONE WITH LOOP
05C7 75 EC                      JNZ     S4
05C9 5E                         POP     SI
05CA 5F                         POP     DI                      ; RECOVER REGEN POINTER
05CB 47                         INC     DI                      ; POINT TO NEXT CHAR POSITION
05CC E2 E3                      LOOP    S3                      ; MORE CHARS TO WRITE
05CE E9 012E R                  JMP     VIDEO_RETURN
05D1                    S6:
05D1 26: 32 05                  XOR     AL,ES:[DI]              ; EXCLUSIVE OR WITH CURRENT
05D4 AA                         STOSB                           ; STORE THE CODE POINT
05D5 AC                         LODSB                           ; AGAIN FOR ODD FIELD
05D6 26: 32 85 1FFF             XOR     AL,ES:[DI+2000H-1]
05DB EB E0                      JMP     S5                      ; BACK TO MAINSTREAM
                        ;-----  MEDIUM RESOLUTION WRITE
05DD                    S7:                                     ;  MED_RES_WRITE
05DD 8A D3                      MOV     DL,BL                   ; SAVE HIGH COLOR BIT
05DF D1 E7                      SAL     DI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
                                                                ; EXPAND BL TO FULL WORD OF COLOR
05E1 80 E3 03                   AND     BL,3                    ; ISOLATE THE COLOR BITS ( LOW 2 BITS )
05E4 B0 55                      MOV     AL,055H                 ; GET BIT CONVERSION MULTIPLIER
05E6 F6 E3                      MUL     BL                      ; EXPAND 2 COLOR BITS TO 4 REPLICATIONS
05E8 8A D8                      MOV     BL,AL                   ; PLACE BACK IN WORK REGISTER
05EA 8A F8                      MOV     BH,AL                   ; EXPAND TO 8 REPLICATIONS OF COLOR BITS
05EC                    S8:                                     ;  MED_CHAR
05EC 57                         PUSH    DI                      ; SAVE REGEN POINTER
05ED 56                         PUSH    SI                      ; SAVE THE CODE POINTER
05EE B6 04                      MOV     DH,4                    ; NUMBER OF LOOPS
05F0                    S9:
05F0 AC                         LODSB                           ; GET CODE POINT
05F1 E8 06AD R                  CALL    S21                     ; DOUBLE UP ALL THE BITS
05F4 23 C3                      AND     AX,BX                   ; CONVERT TO FOREGROUND COLOR ( 0 BACK )
05F6 86 E0                      XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
05F8 F6 C2 80                   TEST    DL,80H                  ; IS THIS XOR FUNCTION
05FB 74 03                      JZ      S10                     ; NO, STORE IT IN AS IT IS
05FD 26: 33 05                  XOR     AX,ES:[DI]              ; DO FUNCTION WITH LOW/HIGH
0600                    S10:                                    ;
0600 26: 89 05                  MOV     ES:[DI],AX              ; STORE FIRST BYTE HIGH, SECOND LOW
0603 AC                         LODSB                           ; GET CODE POINT
0604 E8 06AD R                  CALL    S21
0607 23 C3                      AND     AX,BX                   ; CONVERT TO COLOR
0609 86 E0                      XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
060B F6 C2 80                   TEST    DL,80H                  ; AGAIN, IS THIS XOR FUNCTION
060E 74 05                      JZ      S11                     ; NO, JUST STORE THE VALUES
0610 26: 33 85 2000             XOR     AX,ES:[DI+2000H]        ; FUNCTION WITH FIRST HALF LOW
0615                    S11:
0615 26: 89 85 2000             MOV     ES:[DI+2000H],AX        ; STORE SECOND PORTION HIGH
061A 83 C7 50                   ADD     DI,80                   ; POINT TO NEXT LOCATION
061D FE CE                      DEC     DH
061F 75 CF                      JNZ     S9                      ; KEEP GOING
0621 5E                         POP     SI                      ; RECOVER CODE POINTER
0622 5F                         POP     DI                      ; RECOVER REGEN POINTER
0623 47                         INC     DI                      ; POINT TO NEXT CHAR POSITION
0624 47                         INC     DI
0625 E2 C5                      LOOP    S8                      ; MORE TO WRITE
0627 E9 012E R                  JMP     VIDEO_RETURN
062A                    GRAPHICS_WRITE  ENDP
                        ;--------------------------------------
                        ; GRAPHICS READ
```

```
                        ;--------------------------------------------
06A0                    GRAPHICS_READ   PROC    NEAR
06A0 E8 06D5 R                  CALL    S26                     ; CONVERTED TO OFFSET IN REGEN
06A3 8B F0                      MOV     SI,AX                   ; SAVE IN SI
06A5 83 EC 08                   SUB     SP,8                    ; ALLOCATE SPACE FOR THE READ CODE POINT
06A8 8B EC                      MOV     BP,SP                   ; POINTER TO SAVE AREA
                        ;
                        ;-----  DETERMINE GRAPHICS MODES
                        ;
06AA 80 3E 0049 R 06            CMP     @CRT_MODE,6
06AF 06                         PUSH    ES
06B0 1F                         POP     DS                      ; POINT TO REGEN SEGMENT
06B1 72 19                      JC      S13                     ; MEDIUM RESOLUTION
                        ;
                        ;-----  HIGH RESOLUTION READ
                        ;
                        ;-----  GET VALUES FROM REGEN BUFFER AND CONVERT TO CODE POINT
06B3 B6 04                      MOV     DH,4                    ; NUMBER OF PASSES
06B5                    S12:
06B5 8A 04                      MOV     AL,[SI]                 ; GET FIRST BYTE
06B7 88 46 00                   MOV     [BP],AL                 ; SAVE IN STORAGE AREA
06BA 45                         INC     BP                      ; NEXT LOCATION
06BB 8A 84 2000                 MOV     AL,[SI+2000H]           ; GET LOWER REGION BYTE
06BF 88 46 00                   MOV     [BP],AL                 ; ADJUST AND STORE
06C2 45                         INC     BP
06C3 83 C6 50                   ADD     SI,80                   ; POINTER INTO REGEN
06C6 FE CE                      DEC     DH                      ; LOOP CONTROL
06C8 75 EB                      JNZ     S12                     ; DO IT SOME MORE
06CA EB 16                      JMP     SHORT S15               ; GO MATCH THE SAVED CODE POINTS
                        ;
                        ;-----  MEDIUM RESOLUTION READ
06CC                    S13:                                    ; MED_RES_READ
06CC D1 E6                      SAL     SI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
06CE B6 04                      MOV     DH,4                    ; NUMBER OF PASSES
06D0                    S14:
06D0 E8 06BC R                  CALL    S23                     ; GET BYTES FROM REGEN INTO SINGLE SAVE
06D3 81 C6 1FFE                 ADD     SI,2000H-2              ; GO TO LOWER REGION
06D7 E8 06BC R                  CALL    S23                     ; GET THIS PAIR INTO SAVE
06DA 81 EE 1FB2                 SUB     SI,2000H-80+2           ; ADJUST POINTER BACK INTO UPPER
06DE FE CE                      DEC     DH
06E0 75 EE                      JNZ     S14                     ; KEEP GOING UNTIL ALL 8 DONE
                        ;
                        ;-----  SAVE AREA HAS CHARACTER IN IT, MATCH IT
06E2                    S15:                                    ; FIND_CHAR
06E2 BF 0000 E                  MOV     DI,OFFSET CRT_CHAR_GEN  ; ESTABLISH ADDRESSING
06E5 0E                         PUSH    CS
06E6 07                         POP     ES                      ; CODE POINTS IN CS
06E7 83 ED 08                   SUB     BP,8                    ; ADJUST POINTER TO START OF SAVE AREA
06EA 8B F5                      MOV     SI,BP
06EC FC                         CLD                             ; ENSURE DIRECTION
06ED B0 00                      MOV     AL,0                    ; CURRENT CODE POINT BEING MATCHED
06EF                    S16:
06EF 16                         PUSH    SS                      ; ESTABLISH ADDRESSING TO STACK
06F0 1F                         POP     DS                      ; FOR THE STRING COMPARE
06F1 BA 0080                    MOV     DX,128                  ; NUMBER TO TEST AGAINST
06F4                    S17:
06F4 56                         PUSH    SI                      ; SAVE SAVE AREA POINTER
06F5 57                         PUSH    DI                      ; SAVE CODE POINTER
06F6 B9 0004                    MOV     CX,4                    ; NUMBER OF WORDS TO MATCH
06F9 F3/ A7                     REPE    CMPSW                   ; COMPARE THE 8 BYTES AS WORDS
06FB 5F                         POP     DI                      ; RECOVER THE POINTERS
06FC 5E                         POP     SI
06FD 74 1E                      JZ      S18                     ; IF ZERO FLAG SET, THEN MATCH OCCURRED
06FF FE C0                      INC     AL                      ; NO MATCH, MOVE ON TO NEXT
0701 83 C7 08                   ADD     DI,8                    ; NEXT CODE POINT
0704 4A                         DEC     DX                      ; LOOP CONTROL
0705 75 ED                      JNZ     S17                     ; DO ALL OF THEM
                        ;
                        ;-----  CHAR NOT MATCHED, MIGHT BE IN USER SUPPLIED SECOND HALF
                        ;
0707 3C 00                      CMP     AL,0                    ;  AL<> 0 IF ONLY 1ST HALF SCANNED
0709 74 12                      JE      S18                     ;  IF = 0, THEN ALL HAS BEEN SCANNED
070B 2B C0                      SUB     AX,AX
070D 8E D8                      MOV     DS,AX                   ;  ESTABLISH ADDRESSING TO VECTOR
                                ASSUME  DS:ABS0
070F C4 3E 007C R               LES     DI,@EXT_PTR             ;  GET POINTER
0713 8C C0                      MOV     AX,ES                   ;  SEE IF THE POINTER REALLY EXISTS
0715 0B C7                      OR      AX,DI                   ;  IF ALL 0, THEN DOESN'T EXIST
0717 74 04                      JZ      S18                     ;  NO SENSE LOOKING
0719 B0 80                      MOV     AL,128                  ; ORIGIN FOR SECOND HALF
071B EB D2                      JMP     S16                     ; GO BACK AND TRY FOR IT
                                ASSUME  DS:DATA
                        ;
                        ;-----  CHARACTER IS FOUND ( AL=0 IF NOT FOUND )
071D                    S18:
071D 83 C4 08                   ADD     SP,8                    ; READJUST THE STACK, THROW AWAY SAVE
0720 E9 012E R                  JMP     VIDEO_RETURN            ; ALL DONE
0723                    GRAPHICS_READ   ENDP
                        ;--------------------------------------------
                        ; EXPAND_BYTE
                        ;  THIS ROUTINE TAKES THE BYTE IN AL AND DOUBLES ALL
                        ;  OF THE BITS, TURNING THE 8 BITS INTO 16 BITS.
                        ;  THE RESULT IS LEFT IN AX
                        ;--------------------------------------------
0723                    S21     PROC    NEAR
0723 51                         PUSH    CX                      ; SAVE REGISTER
0724 B9 0008                    MOV     CX,8                    ; SHIFT COUNT REGISTER FOR ONE BYTE
0727                    S22:
0727 D0 C8                      ROR     AL,1                    ; SHIFT BITS, LOW BIT INTO CARRY FLAG
0729 D1 DD                      RCR     BP,1                    ; MOVE CARRY FLAG (LOW BIT) INTO RESULTS
072B D1 FD                      SAR     BP,1                    ; SIGN EXTEND HIGH BIT (DOUBLE IT)
072D E2 F8                      LOOP    S22                     ; REPEAT FOR ALL 8 BITS
                        ;
072F 95                         XCHG    AX,BP                   ; MOVE RESULTS TO PARAMETER REGISTER
0730 59                         POP     CX                      ; RECOVER REGISTER
0731 C3                         RET                             ; ALL DONE
0732                    S21     ENDP
                        ;--------------------------------------------
                        ; MED_READ_BYTE
                        ; THIS ROUTINE WILL TAKE 2 BYTES FROM THE REGEN BUFFER,
                        ;  COMPARE AGAINST THE CURRENT FOREGROUND COLOR, AND PLACE
                        ;  THE CORRESPONDING ON/OFF BIT PATTERN INTO THE CURRENT
                        ;  POSITION IN THE SAVE AREA
                        ; ENTRY --
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                        ;  SI,DS = POINTER TO REGEN AREA OF INTEREST
                        ;  BX = EXPANDED FOREGROUND COLOR
                        ;  BP = POINTER TO SAVE AREA
                        ; EXIT --
                        ;  SI AND BP ARE INCREMENTED
                        ;--------------------------------------------------
06BC                    S23     PROC    NEAR
06BC AD                         LODSW                   ; GET FIRST BYTE AND SECOND BYTES
06BD 86 C4                      XCHG    AL,AH           ; SWAP FOR COMPARE
06BF B9 C000                    MOV     CX,0C000H       ; 2 BIT MASK TO TEST THE ENTRIES
06C2 B2 00                      MOV     DL,0            ; RESULT REGISTER
06C4                    S24:
06C4 85 C1                      TEST    AX,CX           ; IS THIS SECTION BACKGROUND?
06C6 74 01                      JZ      S25             ; IF ZERO, IT IS BACKGROUND (CARRY=0)
06C8 F9                         STC                     ; WASN'T, SO SET CARRY
06C9                    S25:
06C9 D0 D2                      RCL     DL,1            ; MOVE THAT BIT INTO THE RESULT
06CB C1 E9 02                   SHR     CX,2            ; MOVE THE MASK TO THE RIGHT BY 2 BITS
06CE 73 F4                      JNC     S24             ; DO IT AGAIN IF MASK DIDN'T FALL OUT
06D0 88 56 00                   MOV     [BP],DL         ; STORE RESULT IN SAVE AREA
06D3 45                         INC     BP              ; ADJUST POINTER
06D4 C3                         RET                     ; ALL DONE
06D5                    S23     ENDP
                        ;--------------------------------------------
                        ; V4_POSITION
                        ;  THIS ROUTINE TAKES THE CURSOR POSITION CONTAINED IN
                        ;  THE MEMORY LOCATION, AND CONVERTS IT INTO AN OFFSET
                        ;  INTO THE REGEN BUFFER, ASSUMING ONE BYTE/CHAR.
                        ;  FOR MEDIUM RESOLUTION GRAPHICS, THE NUMBER MUST
                        ;  BE DOUBLED.
                        ; ENTRY -- NO REGISTERS,MEMORY LOCATION @CURSOR_POSN IS USED
                        ; EXIT--
                        ;  AX CONTAINS OFFSET INTO REGEN BUFFER
                        ;--------------------------------------------
06D5                    S26     PROC    NEAR
06D5 A1 0050 R                  MOV     AX,@CURSOR_POSN         ; GET CURRENT CURSOR
06D8                    GRAPH_POSN      LABEL   NEAR
06D8 53                         PUSH    BX                      ; SAVE REGISTER
06D9 8B D8                      MOV     BX,AX                   ; SAVE A COPY OF CURRENT CURSOR
06DB 8A C4                      MOV     AL,AH                   ; GET ROWS TO AL
06DD F6 26 004A R               MUL     BYTE PTR @CRT_COLS      ; MULTIPLY BY BYTES/COLUMN
06E1 C1 E0 02                   SHL     AX,2                    ; MULTIPLY * 4 SINCE 4 ROWS/BYTE
06E4 2A FF                      SUB     BH,BH                   ; ISOLATE COLUMN VALUE
06E6 03 C3                      ADD     AX,BX                   ; DETERMINE OFFSET
06E8 5B                         POP     BX                      ; RECOVER POINTER
06E9 C3                         RET                             ; ALL DONE
06EA                    S26     ENDP
                        ;--- WRITE_TTY ------------------------------------------------------------------------
                        ;                                                                                     :
                        ;   THIS INTERFACE PROVIDES A TELETYPE LIKE INTERFACE TO THE                          :
                        ;     VIDEO CARDS.  THE INPUT CHARACTER IS WRITTEN TO THE CURRENT                     :
                        ;     CURSOR POSITION, AND THE CURSOR IS MOVED TO THE NEXT POSITION.                  :
                        ;     IF THE CURSOR LEAVES THE LAST COLUMN OF THE FIELD, THE COLUMN                   :
                        ;     IS SET TO ZERO, AND THE ROW VALUE IS INCREMENTED.  IF THE ROW                   :
                        ;     ROW VALUE LEAVES THE FIELD, THE CURSOR IS PLACED ON THE LAST ROW,               :
                        ;     FIRST COLUMN, AND THE ENTIRE SCREEN IS SCROLLED UP ONE LINE.                    :
                        ;     WHEN THE SCREEN IS SCROLLED UP, THE ATTRIBUTE FOR FILLING THE                   :
                        ;     NEWLY BLANKED LINE IS READ FROM THE CURSOR POSITION ON THE PREVIOUS             :
                        ;     LINE BEFORE THE SCROLL, IN CHARACTER MODE.  IN GRAPHICS MODE,                   :
                        ;     THE 0 COLOR IS USED.                                                            :
                        ;   ENTRY --                                                                          :
                        ;     (AH) = CURRENT CRT MODE                                                         :
                        ;     (AL) = CHARACTER TO BE WRITTEN                                                  :
                        ;            NOTE THAT BACK SPACE, CARRIAGE RETURN, BELL AND LINE FEED ARE            :
                        ;            HANDLED AS COMMANDS RATHER THAN AS DISPLAY GRAPHICS CHARACTERS           :
                        ;     (BL) = FOREGROUND COLOR FOR CHAR WRITE IF CURRENTLY IN A GRAPHICS MODE          :
                        ;   EXIT --                                                                           :
                        ;     ALL REGISTERS SAVED                                                             :
                        ;-------------------------------------------------------------------------------------
                                ASSUME  DS:DATA
06EA                    WRITE_TTY       PROC    NEAR
06EA 50                         PUSH    AX                      ; SAVE REGISTERS
06EB 53                         PUSH    BX                      ; SAVE CHARACTER TO WRITE
06EC B4 03                      MOV     AH,03H
06EE 8A 3E 0062 R               MOV     BH,@ACTIVE_PAGE         ; GET CURRENT PAGE SETTING
06F2 CD 10                      INT     10H                     ; READ THE CURRENT CURSOR POSITION
06F4 58                         POP     AX                      ; RECOVER CHARACTER
                        ;-----  DX NOW HAS THE CURRENT CURSOR POSITION
06F5 3C 0D                      CMP     AL,CR                   ; IS IT CARRIAGE RETURN OR CONTROL
06F7 76 46                      JBE     U8                      ; GO TO CONTROL CHECKS IF IT IS
                        ;-----  WRITE THE CHAR TO THE SCREEN
06F9                    U0:
06F9 B4 0A                      MOV     AH,0AH                  ; WRITE CHARACTER ONLY COMMAND
06FB B9 0001                    MOV     CX,1                    ; ONLY ONE CHARACTER
06FE CD 10                      INT     10H                     ; WRITE THE CHARACTER
                        ;-----  POSITION THE CURSOR FOR NEXT CHAR
0700 FE C2                      INC     DL
0702 3A 16 004A R               CMP     DL,BYTE PTR @CRT_COLS   ; TEST FOR COLUMN OVERFLOW
0706 75 33                      JNZ     U7                      ;  SET_CURSOR
0708 B2 00                      MOV     DL,0                    ; COLUMN FOR CURSOR
070A 80 FE 18                   CMP     DH,25-1                 ; CHECK FOR LAST ROW
070D 75 2A                      JNZ     U6                      ;  SET_CURSOR_INC
                        ;-----  SCROLL REQUIRED
070F                    U1:
070F B4 02                      MOV     AH,02H
0711 CD 10                      INT     10H                     ; SET THE CURSOR
                        ;-----  DETERMINE VALUE TO FILL WITH DURING SCROLL
0713 A0 0049 R                  MOV     AL,@CRT_MODE            ; GET THE CURRENT MODE
0716 3C 04                      CMP     AL,4
0718 72 06                      JC      U2                      ; READ-CURSOR
071A 3C 07                      CMP     AL,7
071C B7 00                      MOV     BH,0                    ; FILL WITH BACKGROUND
071E 75 06                      JNE     U3                      ; SCROLL-UP
0720                    U2:                                     ; READ-CURSOR
0720 B4 08                      MOV     AH,08H                  ; GET READ CURSOR COMMAND
0722 CD 10                      INT     10H                     ; READ CHAR/ATTR AT CURRENT CURSOR
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                        MOV     BH,AH                   ; STORE IN BH
                U3:                                     ; SCROLL-UP
                        MOV     AX,0601H                ; SCROLL ONE LINE
                        SUB     CX,CX                   ; UPPER LEFT CORNER
                        MOV     DH,25-1                 ; LOWER RIGHT ROW
                        MOV     DL,BYTE PTR @CRT_COLS   ; LOWER RIGHT COLUMN
                        DEC     DL
                U4:                                     ; VIDEO-CALL-RETURN
                        INT     10H                     ; SCROLL UP THE SCREEN
                U5:                                     ; TTY-RETURN
                        POP     AX                      ; RESTORE THE CHARACTER
                        JMP     VIDEO_RETURN            ; RETURN TO CALLER

                U6:                                     ; SET-CURSOR-INC
                        INC     DH                      ; NEXT ROW
                U7:                                     ; SET-CURSOR
                        MOV     AH,02H
                        JMP     U4                      ; ESTABLISH THE NEW CURSOR

                ;-----  CHECK FOR CONTROL CHARACTERS
                U8:
                        JE      U9                      ; WAS IT A CARRIAGE RETURN
                        CMP     AL,LF                   ; IS IT A LINE FEED
                        JE      U10                     ; GO TO LINE FEED
                        CMP     AL,07H                  ; IS IT A BELL
                        JE      U11                     ; GO TO BELL
                        CMP     AL,08H                  ; IS IT A BACKSPACE
                        JNE     U0                      ; IF NOT A CONTROL, DISPLAY IT

                ;-----  BACK SPACE FOUND

                        OR      DL,DL                   ; IS IT ALREADY AT START OF LINE
                        JE      U7                      ; SET_CURSOR
                        DEC     DX                      ; NO -- JUST MOVE IT BACK
                        JMP     U7                      ; SET_CURSOR

                ;-----  CARRIAGE RETURN FOUND

                U9:
                        MOV     DL,0                    ; MOVE TO FIRST COLUMN
                        JMP     U7                      ; SET_CURSOR

                ;-----  LINE FEED FOUND

                U10:
                        CMP     DH,25-1                 ; BOTTOM OF SCREEN
                        JNE     U6                      ; YES, SCROLL THE SCREEN
                        JMP     U1                      ; NO, JUST SET THE CURSOR

                ;-----  BELL FOUND

                U11:
                        MOV     CX,1331                 ; DIVISOR FOR 896 HZ TONE
                        MOV     BL,31                   ; SET COUNT FOR 31/64 SECOND FOR BEEP
                        CALL    BEEP                    ; SOUND THE POD BELL
                        JMP     U5                      ; TTY_RETURN
                WRITE_TTY       ENDP
                ;--------------------------------------------------------------------------
                ; LIGHT PEN                                                               :
                ;       THIS ROUTINE TESTS THE LIGHT PEN SWITCH AND THE LIGHT           :
                ;       PEN TRIGGER. IF BOTH ARE SET, THE LOCATION OF THE LIGHT         :
                ;       PEN IS DETERMINED. OTHERWISE, A RETURN WITH NO INFORMATION      :
                ;       IS MADE.                                                        :
                ; ON EXIT:                                                              :
                ;       (AH) = 0 IF NO LIGHT PEN INFORMATION IS AVAILABLE               :
                ;            BX,CX,DX ARE DESTROYED                                     :
                ;       (AH) = 1 IF LIGHT PEN IS AVAILABLE                              :
                ;            (DH,DL) = ROW,COLUMN OF CURRENT LIGHT PEN POSITION         :
                ;            (CH) = RASTER POSITION                                     :
                ;            (BX) = BEST GUESS AT PIXEL HORIZONTAL POSITION             :
                ;--------------------------------------------------------------------------
                        ASSUME  DS:DATA
                V1      DB      3,3,5,5,3,3,3,4         ; SUBTRACT_TABLE
                ;-----  WAIT FOR LIGHT PEN TO BE DEPRESSED

                READ_LPEN       PROC    NEAR
                        MOV     AH,0                    ; SET NO LIGHT PEN RETURN CODE
                        MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF 6845
                        ADD     DX,6                    ; POINT TO STATUS REGISTER
                        IN      AL,DX                   ; GET STATUS REGISTER
                        TEST    AL,004H                 ; TEST LIGHT PEN SWITCH
                        JZ      V6_A                    ; GO IF YES
                        JMP     V6                      ; NOT SET, RETURN

                ;-----  NOW TEST FOR LIGHT PEN TRIGGER

                V6_A:   TEST    AL,2                    ; TEST LIGHT PEN TRIGGER
                        JNZ     V7A                     ; RETURN WITHOUT RESETTING TRIGGER
                        JMP     V7

                ;-----  TRIGGER HAS BEEN SET, READ THE VALUE IN

                V7A:
                        MOV     AH,16                   ; LIGHT PEN REGISTERS ON 6845

                ;-----  INPUT REGISTERS POINTED TO BY AH, AND CONVERT TO ROW COLUMN IN (DX)

                        MOV     DX,@ADDR_6845           ; ADDRESS REGISTER FOR 6845
                        MOV     AL,AH                   ; REGISTER TO READ
                        OUT     DX,AL                   ; SET IT UP
                        JMP     $+2                     ; I/O DELAY
                        INC     DX                      ; DATA REGISTER
                        IN      AL,DX                   ; GET THE VALUE
                        MOV     CH,AL                   ; SAVE IN CX
                        DEC     DX                      ; ADDRESS REGISTER
                        INC     AH
                        MOV     AL,AH                   ; SECOND DATA REGISTER
                        OUT     DX,AL
                        INC     DX                      ; POINT TO DATA REGISTER
                        JMP     $+2                     ; I/O DELAY
                        IN      AL,DX                   ; GET SECOND DATA VALUE
                        MOV     AH,CH                   ; AX HAS INPUT VALUE
```

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                        ;-----  AX HAS THE VALUE READ IN FROM THE 6845
                        
07A4 8A 1E 0049 R               MOV     BL,@CRT_MODE
07A8 2A FF                      SUB     BH,BH                   ; MODE_VALUE TO BX
07AA 2E: 8A 9F 0769 R           MOV     BL,CS:VI[BX]            ; DETERMINE AMOUNT TO SUBTRACT
07AF 2B C3                      SUB     AX,BX                   ; TAKE IT AWAY
07B1 8B 1E 004E R               MOV     BX,@CRT_START
07B5 D1 EB                      SHR     BX,1
07B7 2B C3                      SUB     AX,BX                   ; CONVERT TO CORRECT PAGE ORIGIN
07B9 79 02                      JNS     V2                      ; IF POSITIVE, DETERMINE MODE
07BB 2B C0                      SUB     AX,AX                   ; <0 PLAYS AS 0
                        
                        ;-----  DETERMINE MODE OF OPERATION
                        
07BD                    V2:                                     ; DETERMINE_MODE
07BD B1 03                      MOV     CL,3                    ; SET #8 SHIFT COUNT
07BF 80 3E 0049 R 04            CMP     @CRT_MODE,4             ; DETERMINE IF GRAPHICS OR ALPHA
07C4 72 29                      JB      V4                      ; ALPHA_PEN
07C6 80 3E 0049 R 07            CMP     @CRT_MODE,7
07CB 74 22                      JE      V4                      ; ALPHA_PEN
                        
                        ;-----  GRAPHICS MODE
                        
07CD B2 28                      MOV     DL,40                   ; DIVISOR FOR GRAPHICS
07CF F6 F2                      DIV     DL                      ; DETERMINE ROW(AL) AND COLUMN(AH)
                                                                ;  AL RANGE 0-99, AH RANGE 0-39
                        ;-----  DETERMINE GRAPHIC ROW POSITION
                        
07D1 8A E8                      MOV     CH,AL                   ; SAVE ROW VALUE IN CH
07D3 02 ED                      ADD     CH,CH                   ; *2 FOR EVEN/ODD FIELD
07D5 8A DC                      MOV     BL,AH                   ; COLUMN VALUE TO BX
07D7 2A FF                      SUB     BH,BH                   ; MULTIPLY BY 8 FOR MEDIUM RES
07D9 80 3E 0049 R 06            CMP     @CRT_MODE,6             ; DETERMINE MEDIUM OR HIGH RES
07DE 75 04                      JNE     V3                      ; NOT_HIGH_RES
07E0 B1 04                      MOV     CL,4                    ; SHIFT VALUE FOR HIGH RES
07E2 D0 E4                      SAL     AH,1                    ; COLUMN VALUE TIMES 2 FOR HIGH RES
07E4                    V3:                                     ; NOT_HIGH_RES
07E4 D3 E3                      SHL     BX,CL                   ; MULTIPLY *16 FOR HIGH RES
                        
                        ;-----  DETERMINE ALPHA CHAR POSITION
                        
07E6 8A D4                      MOV     DL,AH                   ; COLUMN VALUE FOR RETURN
07E8 8A F0                      MOV     DH,AL                   ; ROW VALUE
07EA C0 EE 02                   SHR     DH,2                    ; DIVIDE BY 4 FOR VALUE IN 0-24 RANGE
07ED EB 12                      JMP     SHORT V5                ; LIGHT_PEN_RETURN_SET
                        
                        ;-----  ALPHA MODE ON LIGHT PEN
                        
07EF                    V4:                                     ; ALPHA_PEN
07EF F6 36 004A R               DIV     BYTE PTR @CRT_COLS      ; DETERMINE ROW,COLUMN VALUE
07F3 8A F0                      MOV     DH,AL                   ; ROWS TO DH
07F5 8A D4                      MOV     DL,AH                   ; COLS TO DL
07F7 D2 E0                      SAL     AL,CL                   ; MULTIPLY ROWS * 8
07F9 8A E8                      MOV     CH,AL                   ; GET RASTER VALUE TO RETURN REGISTER
07FB 8A DC                      MOV     BL,AH                   ; COLUMN VALUE
07FD 32 FF                      XOR     BH,BH                   ;  TO BX
07FF D3 E3                      SAL     BX,CL
0801                    V5:                                     ; LIGHT_PEN_RETURN_SET
0801 B4 01                      MOV     AH,1                    ; INDICATE EVERY THING SET
0803                    V6:                                     ; LIGHT_PEN_RETURN
0803 52                         PUSH    DX                      ; SAVE RETURN VALUE (IN CASE)
0804 8B 16 0063 R               MOV     DX,@ADDR_6845           ; GET BASE ADDRESS
0808 83 C2 07                   ADD     DX,7                    ; POINT TO RESET PARM
080B EE                         OUT     DX,AL                   ; ADDRESS, NOT DATA, IS IMPORTANT
080C 5A                         POP     DX                      ; RECOVER VALUE
080D                    V7:                                     ; RETURN_NO_RESET
080D 5D                         POP     BP
080E 5F                         POP     DI
080F 5E                         POP     SI
0810 1F                         POP     DS                      ; DISCARD SAVED BX,CX,DX
0811 1F                         POP     DS
0812 1F                         POP     DS
0813 1F                         POP     DS
0814 07                         POP     ES
0815 CF                         IRET
0816                    READ_LPEN       ENDP
0816                    CODE    ENDS
                                END
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                        PAGE 118,121
                        TITLE BIOS ----- 06/10/85  BIOS ROUTINES
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  EQUIPMENT_1
                                PUBLIC  MEMORY_SIZE_DET_1
                                PUBLIC  NMI_INT_1

                                EXTRN   C8042:NEAR              ; POST SEND 8042 COMMAND ROUTINE
                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   D1:NEAR                 ; "PARITY CHECK 1" MESSAGE
                                EXTRN   D2:NEAR                 ; "PARITY CHECK 2" MESSAGE
                                EXTRN   D2A:NEAR                ; "????" UNKNOWN ADDRESS MESSAGE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   DBF_42:NEAR             ; POST WAIT 8042 RESPONSE ROUTINE
                                EXTRN   PRT_HEX:NEAR            ; DISPLAY CHARACTER ROUTINE
                                EXTRN   PRT_SEG:NEAR            ; DISPLAY FIVE CHARACTER ADDRESS ROUTINE
                                EXTRN   P_MSG:NEAR              ; DISPLAY MESSAGE STRING ROUTINE

                        ;--- INT  12 H ----------------------------------------------------------------------
                        ; MEMORY_SIZE_DETERMINE                                                            :
                        ;       THIS ROUTINE RETURNS THE AMOUNT OF MEMORY IN THE SYSTEM AS                 :
                        ;       DETERMINED BY THE POST ROUTINES.  (UP TO 640K)                             :
                        ;       NOTE THAT THE SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS              :
                        ;       THERE IS A FULL COMPLEMENT OF 512K BYTES ON THE PLANAR.                    :
                        ; INPUT                                                                            :
                        ;       NO REGISTERS                                                               :
                        ;       THE @MEMORY_SIZE VARIABLE IS SET DURING POWER ON DIAGNOSTICS               :
                        ;       ACCORDING TO THE FOLLOWING ASSUMPTIONS:                                    :
                        ;                                                                                  :
                        ;       1. CONFIGURATION RECORD IN NON-VOLATILE MEMORY EQUALS THE ACTUAL            :
                        ;          MEMORY SIZE INSTALLED.                                                  :
                        ;                                                                                  :
                        ;       2. ALL INSTALLED MEMORY IS FUNCTIONAL.  IF THE MEMORY TEST DURING          :
                        ;          POST INDICATES LESS, THEN THIS VALUE BECOMES THE DEFAULT.               :
                        ;          IF NON-VOLATILE MEMORY IS NOT VALID (NOT INITIALIZED OR BATTERY         :
                        ;          FAILURE) THEN ACTUAL MEMORY DETERMINED BECOMES THE DEFAULT.             :
                        ;                                                                                  :
                        ;       3. ALL MEMORY FROM 0 TO 640K MUST BE CONTIGUOUS.                           :
                        ;                                                                                  :
                        ; OUTPUT                                                                           :
                        ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY                            :
                        ;----------------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    MEMORY_SIZE_DET_1  PROC FAR
0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS                      ; SAVE SEGMENT
0002 E8 0000 E                  CALL    DDS                     ; ESTABLISH ADDRESSING
0005 A1 0013 R                  MOV     AX,@MEMORY_SIZE         ; GET VALUE
0008 1F                         POP     DS                      ; RECOVER SEGMENT
0009 CF                         IRET                            ; RETURN TO CALLER
000A                    MEMORY_SIZE_DET_1 ENDP

                        ;--- INT  11 H ----------------------------------------------------------------------
                        ; EQUIPMENT DETERMINATION                                                          :
                        ;       THIS ROUTINE ATTEMPTS TO DETERMINE WHAT OPTIONAL                           :
                        ;       DEVICES ARE ATTACHED TO THE SYSTEM.                                        :
                        ; INPUT                                                                            :
                        ;       NO REGISTERS                                                               :
                        ;       THE @EQUIP_FLAG VARIABLE IS SET DURING THE POWER ON                        :
                        ;       DIAGNOSTICS USING THE FOLLOWING HARDWARE ASSUMPTIONS:                      :
                        ;       PORT 03FA = INTERRUPT ID REGISTER OF 8250 (PRIMARY)                        :
                        ;            02FA = INTERRUPT ID REGISTER OF 8250 (SECONDARY)                      :
                        ;              BITS 7-3 ARE ALWAYS 0                                               :
                        ;       PORT 0378 = OUTPUT PORT OF PRINTER (PRIMARY)                               :
                        ;            0278 = OUTPUT PORT OF PRINTER (SECONDARY)                             :
                        ;            03BC = OUTPUT PORT OF PRINTER (MONOCHROME-PRINTER)                    :
                        ;  OUTPUT                                                                          :
                        ;       (AX) IS SET, BIT SIGNIFICANT, TO INDICATE ATTACHED I/O                     :
                        ;       BIT 15,14 = NUMBER OF PRINTERS ATTACHED                                    :
                        ;       BIT 13 = INTERNAL MODEM INSTALLED                                          :
                        ;       BIT 12 NOT USED                                                            :
                        ;       BIT 11,10,9 = NUMBER OF RS232 CARDS ATTACHED                               :
                        ;       BIT 8 = NOT USED                                                           :
                        ;       BIT 7,6 = NUMBER OF DISKETTE DRIVES                                        :
                        ;                 00=1, 01=2 ONLY IF BIT 0 = 1                                     :
                        ;       BIT 5,4 = INITIAL VIDEO MODE                                               :
                        ;                         00 - UNUSED                                              :
                        ;                         01 - 40X25 BW USING COLOR CARD                           :
                        ;                         10 - 80X25 BW USING COLOR CARD                           :
                        ;                         11 - 80X25 BW USING BW CARD                              :
                        ;                                                                                  :
                        ;       BIT 3 = NOT USED                                                           :
                        ;       BIT 2 = NOT USED                                                           :
                        ;       BIT 1 = MATH COPROCESSOR                                                   :
                        ;       BIT 0 = 1 (IPL DISKETTE INSTALLED)                                         :
                        ;       NO OTHER REGISTERS AFFECTED                                                :
                        ;----------------------------------------------------------------------------------

000A                    EQUIPMENT_1  PROC  FAR                  ; ENTRY POINT FOR ORG 0F84DH
000A FB                         STI                             ; INTERRUPTS BACK ON
000B 1E                         PUSH    DS                      ; SAVE SEGMENT REGISTER
000C E8 0000 E                  CALL    DDS                     ; ESTABLISH ADDRESSING
000F A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; GET THE CURRENT SETTINGS
0012 1F                         POP     DS                      ; RECOVER SEGMENT
0013 CF                         IRET                            ; RETURN TO CALLER
0014                    EQUIPMENT_1     ENDP
```

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                        PAGE
                        ;-- HARDWARE INT  02 H -- ( NMI LEVEL ) ------------------------------------------
                        ; NON-MASKABLE INTERRUPT ROUTINE (REAL MODE)                                      :
                        ;       THIS ROUTINE WILL PRINT A "PARITY CHECK 1 OR 2" MESSAGE AND ATTEMPT       :
                        ;       TO FIND THE STORAGE LOCATION IN BASE 640K CONTAINING THE BAD PARITY.      :
                        ;       IF FOUND, THE SEGMENT ADDRESS WILL BE PRINTED.  IF NO PARITY ERROR        :
                        ;       CAN BE FOUND (INTERMITTENT READ PROBLEM)  ?????  WILL BE DISPLAYED        :
                        ;       WHERE THE ADDRESS WOULD NORMALLY GO.                                      :
                        ;                                                                                 :
                        ;       PARITY CHECK 1 = PLANAR BOARD MEMORY FAILURE.                             :
                        ;       PARITY CHECK 2 = OFF PLANAR BOARD MEMORY FAILURE.                         :
                        ;-------------------------------------------------------------------------------

 0014                   NMI_INT_1 PROC    NEAR
 0014 50                        PUSH    AX                              ; SAVE ORIGINAL CONTENTS OF (AX)

 0015 E4 61                     IN      AL,PORT_B
 0017 A8 C0                     TEST    AL,PARITY_ERR                   ; PARITY CHECK OR I/O CHECK ?
 0019 75 07                     JNZ     NMI_1                           ; GO TO ERROR HALTS IF HARDWARE ERROR

 001B B0 0D                     MOV     AL,CMOS_REG_D                   ; ELSE ?? - LEAVE NMI ON
 001D E8 0000 E                 CALL    CMOS_READ                       ; TOGGLE NMI USING COMMON READ ROUTINE
 0020 58                        POP     AX                              ; RESTORE ORIGINAL CONTENTS OF (AX)
 0021 CF                        IRET                                    ; EXIT NMI HANDLER BACK TO PROGRAM


 0022                   NMI_1:                                          ;       HARDWARE ERROR
 0022 50                        PUSH    AX                              ; SAVE INITIAL CHECK MASK IN (AL)
 0023 B0 8D                     MOV     AL,CMOS_REG_D+NMI               ; MASK TRAP (NMI) INTERRUPTS OFF
 0025 E6 70                     OUT     CMOS_PORT,AL
 0027 B0 AD                     MOV     AL,DIS_KBD                      ; DISABLE THE KEYBOARD
 0029 E8 0000 E                 CALL    C8042                           ; SEND COMMAND TO ADAPTER
 002C E8 0000 E                 CALL    DDS                             ; ADDRESS DATA SEGMENT
 002F B4 00                     MOV     AH,0                            ; INITIALIZE AND SET MODE FOR VIDEO
 0031 A0 0049 R                 MOV     AL,@CRT_MODE                    ; GET CURRENT MODE
 0034 CD 10                     INT     10H                             ; CALL VIDEO_IO TO CLEAR SCREEN

                        ;-----  DISPLAY "PARITY CHECK ?" ERROR MESSAGES

 0036 58                        POP     AX                              ; RECOVER INITIAL CHECK STATUS
 0037 BE 0000 E                 MOV     SI,OFFSET D1                    ; PLANAR ERROR, ADDRESS "PARITY CHECK 1"
 003A A8 80                     TEST    AL,PARITY_CHECK                 ; CHECK FOR PLANAR ERROR
 003C 74 05                     JZ      NMI_2                           ; SKIP IF NOT

 003E 50                        PUSH    AX                              ; SAVE STATUS
 003F E8 0000 E                 CALL    P_MSG                           ; DISPLAY "PARITY CHECK 1" MESSAGE
 0042 58                        POP     AX                              ; AND RECOVER STATUS
 0043                   NMI_2:
 0043 BE 0000 E                 MOV     SI,OFFSET D2                    ; ADDRESS OF "PARITY CHECK 2" MESSAGE
 0046 A8 40                     TEST    AL,IO_CHECK                     ; I/O PARITY CHECK ?
 0048 74 03                     JZ      NMI_3                           ; SKIP IF CORRECT ERROR DISPLAYED
 004A E8 0000 E                 CALL    P_MSG                           ; DISPLAY "PARITY CHECK 2" ERROR

                        ;-----  TEST FOR HOT NMI ON PLANAR PARITY LINE

 004D                   NMI_3:
 004D E4 61                     IN      AL,PORT_B
 004F 0C 0C                     OR      AL,RAM_PAR_OFF                  ; TOGGLE PARITY CHECK ENABLES
 0051 E6 61                     OUT     PORT_B,AL
 0053 24 F3                     AND     AL,RAM_PAR_ON                   ; TO CLEAR THE PENDING CHECK
 0055 E6 61                     OUT     PORT_B,AL

 0057 FC                        CLD                                     ; SET DIRECTION FLAG TO INCREMENT
 0058 2B D2                     SUB     DX,DX                           ; POINT (DX) AT START OF REAL MEMORY
 005A 2B F6                     SUB     SI,SI                           ; SET (SI) TO START OF (DS:)
 005C E4 61                     IN      AL,PORT_B                       ; READ CURRENT PARITY CHECK LATCH
 005E A8 C0                     TEST    AL,PARITY_ERR                   ; CHECK FOR HOT NMI SOURCE
 0060 75 19                     JNZ     NMI_5                           ; SKIP IF ERROR NOT RESET (DISPLAY ???)

                        ;-----  SEE IF LOCATION THAT CAUSED PARITY CHECK CAN BE FOUND IN BASE MEMORY

 0062 8B 1E 0013 R              MOV     BX,@MEMORY_SIZE                 ; GET BASE MEMORY SIZE WORD
 0066                   NMI_4:
 0066 8E DA                     MOV     DS,DX                           ; POINT TO 64K SEGMENT
 0068 B9 8000                   MOV     CX,4000H*2                      ; SET WORD COUNT FOR 64 KB SCAN
 006B F3/ AD                    REP     LODSW                           ; READ 64 KB OF MEMORY
 006D E4 61                     IN      AL,PORT_B                       ; READ PARITY CHECK LATCHES
 006F A8 C0                     TEST    AL,PARITY_ERR                   ; CHECK FOR ANY PARITY ERROR PENDING
 0071 75 10                     JNZ     NMI_6                           ; GO PRINT SEGMENT ADDRESS IF ERROR

 0073 80 C6 10                  ADD     DH,010H                         ; POINT TO NEXT 64K BLOCK
 0076 83 EB 40                  SUB     BX,16D*4                        ; DECREMENT COUNT OF 1024 BYTE SEGMENTS
 0079 77 EB                     JA      NMI_4                           ; LOOP TILL ALL 64K SEGMENTS DONE
 007B                   NMI_5:
 007B BE 0000 E                 MOV     SI,OFFSET D2A                   ; PRINT ROW OF ????? IF PARITY
 007E E8 0000 E                 CALL    P_MSG                           ; CHECK COULD NOT BE RE-CREATED
 0081 FA                        CLI
 0082 F4                        HLT                                     ; HALT SYSTEM

 0083                   NMI_6:
 0083 E8 0000 E                 CALL    PRT_SEG                         ; PRINT SEGMENT VALUE (IN DX)
 0086 B0 28                     MOV     AL,'('                          ; PRINT (S)
 0088 E8 0000 E                 CALL    PRT_HEX
 008B B0 53                     MOV     AL,'S'
 008D E8 0000 E                 CALL    PRT_HEX
 0090 B0 29                     MOV     AL,')'
 0092 E8 0000 E                 CALL    PRT_HEX
 0095 FA                        CLI                                     ; HALT SYSTEM
 0096 F4                        HLT

 0097                   NMI_INT_1 ENDP

 0097                   CODE    ENDS
                        END
```

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                        PAGE 118,121
                        TITLE BIOS1 ---- 06/10/85  INTERRUPT 15H BIOS ROUTINES
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  CASSETTE_IO_1
                                PUBLIC  GATE_A20
                                PUBLIC  SHUT9

                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   CMOS_WRITE:NEAR         ; WRITE CMOS LOCATION ROUTINE
                                EXTRN   CONF_TBL:NEAR           ; SYSTEM/BIOS CONFIGURATION TABLE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   PROC_SHUTDOWN:NEAR      ; 80286 HARDWARE RESET ROUTINE

                        ;--- INT 15 H ----------------------------------------------------------------
                        ;       INPUT - CASSETTE I/O FUNCTIONS                                      :
                        ;                                                                           :
                        ;               (AH) = 00H                                                  :
                        ;               (AH) = 01H                                                  :
                        ;               (AH) = 02H                                                  :
                        ;               (AH) = 03H                                                  :
                        ;           RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)          :
                        ;           IF CASSETTE PORT NOT PRESENT                                    :
                        ;-------------------------------------------------------------------------- :
                        ;       INPUT - UNUSED FUNCTIONS                                            :
                        ;               (AH) = 04H THROUGH 7FH                                      :
                        ;           RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)          :
                        ;                   (UNLESS INTERCEPTED BY SYSTEM HANDLERS)                 :
                        ;                   NOTE: THE KEYBOARD INTERRUPT HANDLER INTERRUPTS WITH AH=4FH :
                        ;-------------------------------------------------------------------------- :
                        ; EXTENSIONS                                                                 :
                        ;               (AH) = 80H    DEVICE OPEN                                   :
                        ;                               (BX) = DEVICE ID                            :
                        ;                               (CX) = PROCESS ID                           :
                        ;                                                                           :
                        ;               (AH) = 81H    DEVICE CLOSE                                  :
                        ;                               (BX) = DEVICE ID                            :
                        ;                               (CX) = PROCESS ID                           :
                        ;                                                                           :
                        ;               (AH) = 82H    PROGRAM TERMINATION                           :
                        ;                               (BX) = DEVICE ID                            :
                        ;                                                                           :
                        ;               (AH) = 83H    EVENT WAIT                                    :
                        ;                                                                           :
                        ;                               (AL) = 00H SET INTERVAL                     :
                        ;                               (ES:BX) POINTER TO A BYTE IN CALLERS MEMORY :
                        ;                                       THAT WILL HAVE THE HIGH ORDER BIT SET :
                        ;                                       AS SOON AS POSSIBLE AFTER THE INTERVAL :
                        ;                                       EXPIRES.                            :
                        ;                               (CX,DX) NUMBER OF MICROSECONDS TO ELAPSE BEFORE :
                        ;                                       POSTING.                            :
                        ;                               (AL) = 01H CANCEL                           :
                        ;                                                                           :
                        ;                         RETURNS: CARRY IF AL NOT = 00H OR 01H             :
                        ;                                  OR IF FUNCTION AL=0 ALREADY BUSY         :
                        ;                                                                           :
                        ;               (AH) = 84H    JOYSTICK SUPPORT                              :
                        ;                               (DX) = 00H - READ THE CURRENT SWITCH SETTINGS :
                        ;                                       RETURNS AL = SWITCH SETTINGS (BITS 7-4) :
                        ;                               (DX) = 01H - READ THE RESISTIVE INPUTS      :
                        ;                                       RETURNS AX = A(x) VALUE             :
                        ;                                               BX = A(y) VALUE             :
                        ;                                               CX = B(x) VALUE             :
                        ;                                               DX = B(y) VALUE             :
                        ;                                                                           :
                        ;               (AH) = 85H    SYSTEM REQUEST KEY PRESSED                    :
                        ;                               (AL) = 00H MAKE OF KEY                      :
                        ;                               (AL) = 01H BREAK OF KEY                     :
                        ;                                                                           :
                        ;               (AH) = 86H    WAIT                                          :
                        ;                               (CX,DX) NUMBER OF MICROSECONDS TO ELAPSE BEFORE :
                        ;                                       RETURN TO CALLER                    :
                        ;                                                                           :
                        ;               (AH) = 87H    MOVE BLOCK                                    :
                        ;                               (CX)    NUMBER OF WORDS TO MOVE             :
                        ;                               (ES:SI)  POINTER TO DESCRIPTOR TABLE        :
                        ;                                                                           :
                        ;               (AH) = 88H    EXTENDED MEMORY SIZE DETERMINE                :
                        ;                                                                           :
                        ;               (AH) = 89H    PROCESSOR TO VIRTUAL MODE                     :
                        ;                                                                           :
                        ;               (AH) = 90H     DEVICE BUSY LOOP                             :
                        ;                               (AL)    SEE TYPE CODE                       :
                        ;                                                                           :
                        ;               (AH) = 91H    INTERRUPT COMPLETE FLAG SET                   :
                        ;                               (AL)    TYPE CODE                           :
                        ;                               00H -> 7FH                                  :
                        ;                                       SERIALLY REUSABLE DEVICES           :
                        ;                                       OPERATING SYSTEM MUST SERIALIZE ACCESS :
                        ;                               80H -> BFH                                  :
                        ;                                       REENTRANT DEVICES; ES:BX IS USED TO :
                        ;                                       DISTINGUISH DIFFERENT CALLS (MULTIPLE I/O :
                        ;                                       CALLS ARE ALLOWED SIMULTANEOUSLY)   :
                        ;                               C0H -> FFH                                  :
                        ;                                       WAIT ONLY CALLS --  THERE IS NO     :
                        ;                                       COMPLEMENTARY 'POST' FOR THESE WAITS. :
                        ;                                       THESE ARE TIMEOUT ONLY.  TIMES ARE  :
                        ;                                       FUNCTION NUMBER DEPENDENT.          :
                        ;                                                                           :
                        ;                               TYPE  DESCRIPTION           TIMEOUT         :
                        ;                                                                           :
                        ;                               00H = DISK                  YES             :
                        ;                               01H = DISKETTE              YES             :
                        ;                               02H = KEYBOARD              NO              :
                        ;                               80H = NETWORK               NO              :
                        ;                                     ES:BX --> NCB                         :
                        ;                               FDH = DISKETTE MOTOR START  YES             :
                        ;                               FEH = PRINTER               YES             :
                        ;                                                                           :
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                        PAGE
                        ;       (AH) = C0H    RETURN CONFIGURATION PARAMETERS POINTER                   :
                        ;                       RETURNS                                                 :
                        ;                         (AH) = 00H AND CY= 0 (IF PRESENT ELSE 86 AND CY= 1)   :
                        ;                         (ES:BX) = PARAMETER TABLE ADDRESS POINTER              :
                        ;                                   WHERE:                                      :
                        ;                                                                               :
                        ;                   DW    8             LENGTH OF FOLLOWING TABLE               :
                        ;                   DB    MODEL_BYTE    SYSTEM MODEL BYTE                       :
                        ;                   DB    TYPE_BYTE     SYSTEM MODEL TYPE BYTE                  :
                        ;                   DB    BIOS_LEVEL    BIOS REVISION LEVEL                     :
                        ;                   DB    ?             10000000 = DMA CHANNEL 3 USE BY BIOS    :
                        ;                                       01000000 = CASCADED INTERRUPT LEVEL 2   :
                        ;                                       00100000 = REAL TIME CLOCK AVAILABLE    :
                        ;                                       00010000 = KEYBOARD SCAN CODE HOOK INT  :
                        ;                   DB    0             RESERVED                                :
                        ;                   DB    0             RESERVED                                :
                        ;                   DB    0             RESERVED                                :
                        ;                   DB    0             RESERVED                                :
                        ;                                                                               :
                        ;-------------------------------------------------------------------------------

                                ASSUME  CS:CODE

0000                    CASSETTE_IO_1   PROC    FAR
0000 FB                         STI                             ; ENABLE INTERRUPTS
0001 80 FC 80                   CMP     AH,080H                 ; CHECK FOR RANGE
0004 72 4E                      JB      C1                      ; RETURN IF 00-7FH
0006 80 FC C0                   CMP     AH,0C0H                 ; CHECK FOR CONFIGURATION PARAMETERS
0009 74 51                      JE      CONF_PARMS
000B 80 EC 80                   SUB     AH,080H                 ; BASE ON 0
000E 0A E4                      OR      AH,AH
0010 74 48                      JZ      DEV_OPEN                ; DEVICE OPEN
0012 FE CC                      DEC     AH
0014 74 44                      JZ      DEV_CLOSE               ; DEVICE CLOSE
0016 FE CC                      DEC     AH
0018 74 40                      JZ      PROG_TERM               ; PROGRAM TERMINATION
001A FE CC                      DEC     AH
001C 74 47                      JZ      EVENT_WAIT              ; EVENT WAIT
001E FE CC                      DEC     AH
0020 75 03                      JNZ     NOT_JOYSTICK
0022 E9 00D0 R                  JMP     JOY_STICK               ; JOYSTICK BIOS
0025                    NOT_JOYSTICK:
0025 FE CC                      DEC     AH
0027 74 31                      JZ      SYS_REQ                 ; SYSTEM REQUEST KEY
0029 FE CC                      DEC     AH
002B 74 07                      JZ      C1_A                    ; WAIT
002D FE CC                      DEC     AH
002F 75 06                      JNZ     C1_B
0031 E9 01CA R                  JMP     BLOCKMOVE               ; MOVE BLOCK

0034 E9 016A R          C1_A:   JMP     WAIT                    ; WAIT

0037 FE CC              C1_B:   DEC     AH

0039 75 03                      JNZ     C1_C
003B E9 03EE R                  JMP     EXT_MEMORY              ; GO GET THE EXTENDED MEMORY

003E FE CC              C1_C:   DEC     AH
0040 75 03                      JNZ     C1_D                    ; CHECK FOR FUNCTION 89H
0042 E9 03FA R                  JMP     SET_VMODE               ; SWAP TO VIRTUAL MODE

0045 80 EC 07           C1_D:   SUB     AH,7                    ; CHECK FOR FUNCTION 90H
0048 75 03                      JNZ     C1_E                    ; GO IF NOT
004A E9 0483 R                  JMP     DEVICE_BUSY

004D FE CC              C1_E:   DEC     AH                      ; CHECK FOR FUNCTION 8BH
004F 75 03                      JNZ     C1                      ; GO IF NOT
0051 E9 0487 R                  JMP     INT_COMPLETE

0054 B4 86              C1:     MOV     AH,86H                  ; SET BAD COMMAND
0056 F9                         STC                             ; SET CARRY FLAG ON
0057                    C1_F:
0057 CA 0002                    RET     2                       ; FAR RETURN EXIT FROM ROUTINES


005A                    DEV_OPEN:                               ; NULL HANDLERS

005A                    DEV_CLOSE:

005A                    PROG_TERM:

005A                    SYS_REQ:
005A EB FB                      JMP     C1_F                    ; RETURN
005C                    CASSETTE_IO_1   ENDP

005C                    CONF_PARMS      PROC    NEAR
005C 0E                         PUSH    CS                      ; GET CODE SEGMENT
005D 07                         POP     ES                      ; PLACE IN SELECTOR POINTER
005E BB 0000 E                  MOV     BX,OFFSET CONF_TBL      ; GET OFFSET OF PARAMETER TABLE
0061 32 E4                      XOR     AH,AH                   ; CLEAR AH AND SET CARRY OFF
0063 EB F2                      JMP     C1_F                    ; EXIT THROUGH COMMON RETURN
0065                    CONF_PARMS      ENDP

0065                    EVENT_WAIT      PROC    NEAR
                                ASSUME  DS:DATA
0065 1E                         PUSH    DS                      ; SAVE
0066 E8 0000 E                  CALL    DDS
0069 0A C0                      OR      AL,AL
006B 74 08                      JZ      EVENT_WAIT_2            ; GO IF ZERO
006D FE C8                      DEC     AL                      ; CHECK IF 1
006F 74 45                      JZ      EVENT_WAIT_3
0071 1F                         POP     DS                      ; RESTORE DATA SEGMENT
0072 F9                         STC                             ; SET CARRY
0073 EB E2                      JMP     C1_F                    ; EXIT

0075                    EVENT_WAIT_2:
0075 FA                         CLI                             ; NO INTERRUPTS ALLOWED
0076 F6 06 00A0 R 01            TEST    @RTC_WAIT_FLAG,01       ; CHECK FOR FUNCTION ACTIVE
007B 74 05                      JZ      EVENT_WAIT_1
007D FB                         STI                             ; ENABLE INTERRUPTS
007E 1F                         POP     DS
007F F9                         STC                             ; SET ERROR
0080 EB D5                      JMP     C1_F                    ; RETURN
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                        EVENT_WAIT_1:
0082 E4 A1                      IN      AL,INTB01               ; ENSURE INTERRUPT UNMASKED
0084 EB 00                      JMP     $+2
0086 24 FE                      AND     AL,0FEH
0088 E6 A1                      OUT     INTB01,AL
008A 8C 06 009A R               MOV     @USER_FLAG_SEG,ES       ; SET UP TRANSFER TABLE
008E 89 1E 0098 R               MOV     @USER_FLAG,BX
0092 89 0E 009E R               MOV     @RTC_HIGH,CX
0096 89 16 009C R               MOV     @RTC_LOW,DX
009A C6 06 00A0 R 01            MOV     @RTC_WAIT_FLAG,01       ; SET ON FUNCTION ACTIVE SWITCH
009F B0 0B                      MOV     AL,CMOS_REG_B           ; ENABLE PIE
00A1 E8 0000 E                  CALL    CMOS_READ               ; READ CMOS LOCATION
00A4 24 7F                      AND     AL,07FH                 ; CLEAR SET
00A6 0C 40                      OR      AL,040H                 ; ENABLE PIE
00A8 50                         PUSH    AX                      ; SAVE AH
00A9 8A E0                      MOV     AH,AL                   ; PLACE DATA INTO DATA REGISTER
00AB B0 0B                      MOV     AL,CMOS_REG_B           ; ADDRESS ALARM REGISTER
00AD E8 0000 E                  CALL    CMOS_WRITE              ; PLACE DATA IN AH INTO ALARM REGISTER
00B0 58                         POP     AX                      ; RESTORE AH
00B1 1F                         POP     DS
00B2 FB                         STI                             ; ENABLE INTERRUPTS
00B3 F8                         CLC                             ; CLEAR CARRY
00B4 EB A1                      JMP     C1_F

                        ;-----  CANCEL

                        EVENT_WAIT_3:
00B6 50                         PUSH    AX                      ; SAVE
00B7 FA                         CLI                             ; DISABLE INTERRUPTS
00B8 B0 0B                      MOV     AX,X*CMOS_REG_B         ; TURN OFF PIE
00BB E8 0000 E                  CALL    CMOS_READ               ; GET ALARM REGISTER
00BE 24 BF                      AND     AL,0BFH                 ; CLEAR PIE
00C0 86 E0                      XCHG    AH,AL                   ; PLACE INTO WRITE REGISTER
00C2 E8 0000 E                  CALL    CMOS_WRITE              ; WRITE BACK TO ALARM REGISTER
00C5 58                         POP     AX                      ; RESTORE AH
00C6 C6 06 00A0 R 00            MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION ACTIVE FLAG OFF
00CB FB                         STI                             ; ENABLE INTERRUPTS
00CC 1F                         POP     DS                      ; RESTORE DATA SEGMENT
00CD F8                         CLC                             ; SET CARRY OFF
00CE EB 87                      JMP     C1_F                    ; RETURN

00D0                    EVENT_WAIT      ENDP
                        ;--- JOY_STICK ------------------------------------------------------
                        ;       THIS ROUTINE WILL READ THE JOYSTICK PORT                     :
                        ;                                                                   :
                        ;       INPUT                                                       :
                        ;       (DX)=0 READ THE CURRENT SWITCHES                            :
                        ;              RETURNS (AL)= SWITCH SETTINGS IN BITS 7-4            :
                        ;                                                                   :
                        ;       (DX)=1  READ THE RESISTIVE INPUTS                           :
                        ;               RETURNS (AX)=A(x) VALUE                             :
                        ;                       (BX)=A(y) VALUE                             :
                        ;                       (CX)=B(x) VALUE                             :
                        ;                       (DX)=B(y) VALUE                             :
                        ;                                                                   :
                        ;       CY FLAG ON IF NO ADAPTER CARD OR INVALID CALL               :
                        ;-------------------------------------------------------------------

00D0                    JOY_STICK       PROC    NEAR
00D0 FB                         STI                             ; INTERRUPTS BACK ON
00D1 8B C2                      MOV     AX,DX                   ; GET SUB FUNCTION CODE
00D3 BA 0201                    MOV     DX,201H                 ; ADDRESS OF PORT
00D6 0A C0                      OR      AL,AL
00D8 74 0B                      JZ      JOY_2                   ; READ SWITCHES
00DA FE C8                      DEC     AL
00DC 74 0C                      JZ      JOY_3                   ; READ RESISTIVE INPUTS
00DE E9 0054 R                  JMP     C1                      ; GO TO ERROR RETURN
00E1                    JOY_1:
00E1 FB                         STI
00E2 E9 0057 R                  JMP     C1_F                    ; GO TO COMMON RETURN

00E5                    JOY_2:
00E5 EC                         IN      AL,DX
00E6 24 F0                      AND     AL,0F0H                 ; STRIP UNWANTED BITS OFF
00E8 EB F7                      JMP     JOY_1                   ; FINISHED

00EA                    JOY_3:
00EA B3 01                      MOV     BL,1
00EC E8 0108 R                  CALL    TEST_CORD
00EF 51                         PUSH    CX                      ; SAVE A(X) VALUE
00F0 B3 02                      MOV     BL,2
00F2 E8 0108 R                  CALL    TEST_CORD
00F5 51                         PUSH    CX                      ; SAVE A(Y) VALUE
00F6 B3 04                      MOV     BL,4
00F8 E8 0108 R                  CALL    TEST_CORD
00FB 51                         PUSH    CX                      ; SAVE B(X) VALUE
00FC B3 08                      MOV     BL,8
00FE E8 0108 R                  CALL    TEST_CORD
0101 8B D1                      MOV     DX,CX                   ; SAVE B(Y) VALUE
0103 59                         POP     CX                      ; GET B(X) VALUE
0104 5B                         POP     BX                      ; GET A(Y) VALUE
0105 58                         POP     AX                      ; GET A(X) VALUE
0106 EB D9                      JMP     JOY_1                   ; FINISHED - RETURN

0108                    TEST_CORD       PROC  NEAR
0108 52                         PUSH    DX                      ; SAVE
0109 FA                         CLI                             ; BLOCK INTERRUPTS WHILE READING
010A B0 00                      MOV     AL,0                    ; SET UP TO LATCH TIMER 0
010C E6 43                      OUT     TIMER+3,AL
010E EB 00                      JMP     $+2
0110 E4 40                      IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
0112 EB 00                      JMP     $+2
0114 8A E0                      MOV     AH,AL
0116 E4 40                      IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
0118 86 E0                      XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW
011A 50                         PUSH    AX                      ; SAVE
011B B9 04FF                    MOV     CX,4FFH                 ; SET COUNT
011E EE                         OUT     DX,AL                   ; FIRE TIMER
011F EB 00                      JMP     $+2
0121                    TEST_CORD_1:
0121 EC                         IN      AL,DX                   ; READ VALUES
0122 84 C3                      TEST    AL,BL                   ; HAS PULSE ENDED?
0124 E0 FB                      LOOPNZ  TEST_CORD_1
```

```
0126 83 F9 00                   CMP     CX,0
0129 59                         POP     CX                      ; ORIGINAL COUNT
012A 75 04                      JNZ     SHORT TEST_CORD_2
012C 2B C9                      SUB     CX,CX                   ; SET 0 COUNT FOR RETURN
012E EB 28                      JMP     SHORT TEST_CORD_3       ; EXIT WITH COUNT = 0
0130                    TEST_CORD_2:
0130 B0 00                      MOV     AL,0                    ; SET UP TO LATCH TIMER 0
0132 E6 43                      OUT     TIMER+3,AL
0134 EB 00                      JMP     $+2
0136 E4 40                      IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
0138 8A E0                      MOV     AH,AL
013A EB 00                      JMP     $+2
013C E4 40                      IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
013E 86 E0                      XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW

0140 3B C8                      CMP     CX,AX                   ; CHECK FOR COUNTER WRAP
0142 73 0B                      JAE     TEST_CORD_4             ; GO IF NO
0144 52                         PUSH    DX
0145 BA FFFF                    MOV     DX,-1

0148 2B D0                      SUB     DX,AX                   ; ADJUST FOR WRAP
014A 03 CA                      ADD     CX,DX
014C 5A                         POP     DX
014D EB 02                      JMP     SHORT TEST_CORD_5

014F                    TEST_CORD_4:
014F 2B C8                      SUB     CX,AX
0151                    TEST_CORD_5:
0151 81 E1 1FF0                 AND     CX,1FF0H                ; ADJUST
0155 C1 E9 04                   SHR     CX,4

0158                    TEST_CORD_3:
0158 FB                         STI                             ; INTERRUPTS BACK ON
0159 BA 0201                    MOV     DX,201H                 ; FLUSH OTHER INPUTS
015C 51                         PUSH    CX
015D 50                         PUSH    AX
015E B9 04FF                    MOV     CX,4FFH                 ; COUNT
0161                    TEST_CORD_6:
0161 EC                         IN      AL,DX
0162 A8 0F                      TEST    AL,0FH
0164 E0 FB                      LOOPNZ  TEST_CORD_6

0166 58                         POP     AX
0167 59                         POP     CX
0168 5A                         POP     DX                      ; SET COUNT

0169 C3                         RET                             ; RETURN

016A                    TEST_CORD       ENDP
016A                    JOY_STICK       ENDP

016A                    WAIT    PROC    NEAR
016A 1E                         PUSH    DS                      ; SAVE
016B E8 0000 E                  CALL    DDS
016E F6 06 00A0 R 01            TEST    @RTC_WAIT_FLAG,01       ; TEST FOR FUNCTION ACTIVE
0173 74 05                      JZ      WAIT_1
0175 1F                         POP     DS
0176 F9                         STC                             ; SET ERROR
0177 E9 0057 R                  JMP     C1_F                    ; RETURN
017A                    WAIT_1:
017A FA                         CLI                             ; NO INTERRUPTS ALLOWED
017B E4 A1                      IN      AL,INTB01               ; ENSURE INTERRUPT UNMASKED
017D EB 00                      JMP     $+2
017F 24 FE                      AND     AL,0FEH
0181 E6 A1                      OUT     INTB01,AL
0183 8C 1E 009A R               MOV     @USER_FLAG_SEG,DS       ; SET UP TRANSFER TABLE
0187 C7 06 0098 R 00A0 R        MOV     @USER_FLAG_OFFSET @RTC_WAIT_FLAG
018D 89 0E 009E R               MOV     @RTC_HIGH,CX
0191 89 16 009C R               MOV     @RTC_LOW,DX
0195 C6 06 00A0 R 01            MOV     @RTC_WAIT_FLAG,01       ; SET ON FUNCTION ACTIVE SWITCH
019A 50                         PUSH    AX                      ; SAVE (AH)
019B B8 0B0B                    MOV     AX,X*CMOS_REG_B         ; ENABLE PIE
019E E8 0000 E                  CALL    CMOS_READ               ; READ ALARM BYTE
01A1 24 7F                      AND     AL,07FH                 ; CLEAR SIT BIT
01A3 0C 40                      OR      AL,040H                 ; ENABLE PIE BIT
01A5 86 E0                      XCHG    AH,AL                   ; DATA TO WORK REGISTER
01A7 E8 0000 E                  CALL    CMOS_WRITE              ; WRITE NEW ALARM BYTE
01AA 58                         POP     AX                      ; RESTORE (AH)

                        ;-----  WAIT TILL RTC TIMEOUT POSTED   (WITH ERROR TIMEOUT)

01AB FB                         STI                             ; ENABLE INTERRUPTS
01AC 51                         PUSH    CX
01AD 52                         PUSH    DX                      ; SAVE CALLERS PARAMETERS
01AE 87 D1                      XCHG    DX,CX                   ; SWAP COUNT WORK REGISTERS
01B0                    WAIT_2:
01B0 F6 06 00A0 R 80            TEST    @RTC_WAIT_FLAG,080H     ; CHECK FOR END OF WAIT - CLEAR CARRY
01B5 E1 F9                      LOOPZ   WAIT_2                  ; DECREMENT TIMEOUT DELAY TILL WAIT END
01B7 75 05                      JNZ     WAIT_9                  ; EXIT IF RTC TIMER WAIT ENDED FLAG SET
01B9 83 EA 01                   SUB     DX,1                    ; DECREMENT ERROR TIMEOUT COUNTER
01BC 73 F2                      JNC     WAIT_2                  ; LOOP TILL COUNTERS TIMEOUT
01BE                    WAIT_9:
01BE C6 06 00A0 R 00            MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION INACTIVE
01C3 5A                         POP     DX
01C4 59                         POP     CX                      ; RESTORE CALLERS PARAMETERS
01C5 1F                         POP     DS
01C6 F8                         CLC                             ; CLEAR CARRY FLAG
01C7 E9 0057 R                  JMP     C1_F

01CA                    WAIT    ENDP
```

```
                        PAGE
                        ;--- INT  15 H -- ( FUNCTION 87 H - BLOCK MOVE ) ------------------------------
                        ;                                                                             :
                        ;       THIS BIOS FUNCTION PROVIDES A MEANS FOR A REAL MODE PROGRAM OR SYSTEM  :
                        ;       TO TRANSFER A BLOCK OF STORAGE TO AND FROM STORAGE ABOVE THE 1 MEG     :
                        ;       ADDRESS RANGE IN PROTECTED MODE SPACE BY SWITCHING TO PROTECTED MODE.  :
                        ;                                                                             :
                        ; ENTRY:                                                                       :
                        ;       (AH) =  87H (FUNCTION CALL) - BLOCK MOVE.                             :
                        ;       (CX) =  WORD COUNT OF STORAGE BLOCK TO BE MOVED.                       :
                        ;               NOTE: MAX COUNT = 8000H FOR 32K WORDS (65K BYTES)             :
                        ;       ES:SI = LOCATION OF A GDT TABLE BUILT BY ROUTINE USING THIS FUNCTION. :
                        ;                                                                             :
                        ;       (ES:SI) POINTS TO A DESCRIPTOR TABLE (GDT) BUILT BEFORE INTERRUPTING  :
                        ;       TO THIS FUNCTION.  THE DESCRIPTORS ARE USE TO PERFORM THE BLOCK        :
                        ;       MOVE IN THE PROTECTED MODE.  THE SOURCE AND TARGET DESCRIPTORS        :
                        ;       BUILT BY THE USER MUST HAVE A SEGMENT LENGTH = 2 * CX-1 OR GREATER.   :
                        ;       THE DATA ACCESS RIGHTS BYTE MUST BE SET TO CPL0-R/W (93H).  THE       :
                        ;       24 BIT ADDRESS (BYTE HI, WORD LOW) MUST BE SET TO THE TARGET/SOURCE.  :
                        ;                                                                             :
                        ;       ***  NO INTERRUPTS ARE ALLOWED DURING TRANSFER.  LARGE BLOCK MOVES    :
                        ;            MAY CAUSE LOST INTERRUPTS.                                       :
                        ;                                                                             :
                        ; EXIT:                                                                        :
                        ;       (AH) = 00H  IF SUCCESSFUL                                             :
                        ;       (AH) = 01H  IF MEMORY PARITY (PARITY ERROR REGISTERS ARE CLEARED)     :
                        ;       (AH) = 02H  IF ANY OTHER EXCEPTION INTERRUPT ERROR OCCURRED           :
                        ;       (AH) = 03H  IF GATE ADDRESS LINE 20 FAILED                            :
                        ;                   ALL REGISTERS ARE RESTORED EXCEPT (AH).                   :
                        ;                                                                             :
                        ;       IF SUCCESSFUL - CARRY FLAG = 0                                        :
                        ;       IF ERROR ------ CARRY FLAG = 1                                        :
                        ;                                                                             :
                        ; DESCRIPTION:                                                                 :
                        ;                                                                             :
                        ;       1.  SAVE ENTRY REGISTERS AND SETUP FOR SHUTDOWN EXIT.                 :
                        ;       2.  THE REQUIRED ENTRIES ARE BUILT IN THE GDT AT (ES:SI).             :
                        ;       3.  GATE ADDRESS LINE 20 ACTIVE, CLI AND SET SHUTDOWN CODES.          :
                        ;       4.  THE IDTR IS LOADED AND POINTS TO A ROM RESIDENT TABLE.            :
                        ;       5.  THE GDTR IS LOADED FROM THE OFFSET POINTER (ES:SI).               :
                        ;       6.  THE PROCESSOR IS PUT INTO PROTECTED MODE.                         :
                        ;       7.  LOAD (DS) AND (ES) WITH SELECTORS FOR THE SOURCE AND TARGET.      :
                        ;       8.  DS:SI (SOURCE) (ES:DI) (TARGET) REP MOVSW IS EXECUTED.            :
                        ;       9.  CHECK MADE FOR PARITY ERRORS.                                     :
                        ;      10.  REAL MODE RESTORED WHEN SHUTDOWN 09H IS EXECUTED.                 :
                        ;      11.  ERRORS ARE CHECKED FOR AND RETURN CODES ARE SET FOR (AH).         :
                        ;      12.  ADDRESS LINE 20 GATE IS DISABLED.                                 :
                        ;      13.  RETURN WITH REGISTERS RESTORED AND STATUS RETURN CODE.            :
                        ;             (FOR PC-AT COMPATIBILITY ZF=1 IF SUCCESSFUL, ZF=0 IF ERROR.)    :
                        ;-----------------------------------------------------------------------------
                        ;
                        ;       THE FOLLOWING DIAGRAM DEPICTS THE ORGANIZATION OF A BLOCK MOVE GDT.
                        ;-----------------------------------------------------------------------------
                        ;                       G D T                                                 :
                        ;  (ES:SI)                                                                    :
                        ;     |                .------------.                                        :
                        ;     |                v            |                                        :
                        ;    +00 .---------------.          |                                        :
                        ;        |     DUMMY     |          |    1. THE FIRST DESCRIPTOR IS THE REQUIRED DUMMY.  :
                        ;        |               |          |       (USER INITIALIZED TO 0)              :
                        ;    +08 |---------------|          |                                        :
                        ;        |    GDT LOC    |  --*     |    2. THE SECOND DESCRIPTOR POINTS TO THE GDT  :
                        ;        |               |          |       TABLE AS A DATA SEGMENT.             :
                        ;    +10 |---------------|          |       (USER INITIALIZED TO 0 - MODIFIED BY BIOS)  :
                        ;        |    SOURCE     |          |    3. THE THIRD DESCRIPTOR POINTS TO THE SOURCE  :
                        ;        |     GDT       |          |       TO BE MOVED. (FROM)                  :
                        ;    +18 |---------------|          |       (USER INITIALIZED)                   :
                        ;        |    TARGET     |          |    4. THE FOURTH DESCRIPTOR POINTS TO THE  :
                        ;        |     GDT       |          |       DESTINATION SEGMENT. (TO)            :
                        ;    +20 |---------------|          |       (USER INITIALIZED)                   :
                        ;        |     BIOS      |          |    5. THE FIFTH IS A DESCRIPTOR THAT BIOS USES  :
                        ;        |     (CS)      |          |       TO CREATE THE PROTECTED MODE CODE SEGMENT.  :
                        ;    +28 |---------------|          |       (USER INITIALIZED TO 0 - MODIFIED BY BIOS)  :
                        ;        |     (SS)      |          |    6. THE SIXTH DESCRIPTOR IS USED BY BIOS TO  :
                        ;        |               |          |       CREATE A PROTECTED MODE STACK SEGMENT.  :
                        ;        *---------------*          |       (USER INITIALIZED TO 0 - MODIFIED BY BIOS)  :
                        ;                                   |       (POINTS TO USERS STACK)              :
                        ;                                   |                                            :
                        ;                                   |                                            :
                        ;                                   |                                            :
                        ;            SAMPLE  OF  SOURCE  OR  TARGET  DESCRIPTOR                         :
                        ;                                   |                                            :
                        ;          SOURCE_TARGET_DEF      STRUC                                         :
                        ;                                   |                                            :
                        ;            SEG_LIMIT          DW      ?   ; SEGMENT LIMIT (1-65536 BYTES)     :
                        ;            LO_WORD            DW      ?   ; 24 BIT SEGMENT PHYSICAL           :
                        ;            HI_BYTE            DB      ?   ;    ADDRESS (0 TO (16M-1))         :
                        ;            DATA_ACC_RIGHTS    DB     93H  ; ACCESS RIGHTS BYTE (CPL0-R/W)    :
                        ;            RESERVED           DW      0   ; RESERVED WORD (MUST BE ZERO)      :
                        ;                                                                               :
                        ;          SOURCE_TARGET_DEF      ENDS                                          :
                        ;                                                                               :
                        ;-----------------------------------------------------------------------------
                        ;
                        ;       THE GLOBAL DESCRIPTOR TABLE (ACTUAL LOCATION POINTED TO BY ES:SI)
                        ;
                        BLOCKMOVE_GDT_DEF       STRUC
0000 ????????????????   CGDT_LOC                DQ      ?               ; FIRST DESCRIPTOR NOT ACCESSIBLE
0008 ????????????????   SOURCE                  DQ      ?               ; LOCATION OF CALLING ROUTINE GDT
0010 ????????????????   TARGET                  DQ      ?               ; SOURCE DESCRIPTOR
0018 ????????????????   BIOS_CS                 DQ      ?               ; TARGET DESCRIPTOR
0020 ????????????????   TEMP_SS                 DQ      ?               ; BIOS CODE DESCRIPTOR
0028 ????????????????   BLOCKMOVE_GDT_DEF       DQ      ?               ; STACK DESCRIPTOR
0030                    BLOCKMOVE_GDT_DEF       ENDS

01CA                    BLOCKMOVE       PROC    NEAR

01CA FC                         CLD                             ; SET DIRECTION FORWARD
01CB 60                         PUSHA                           ; SAVE GENERAL PURPOSE REGISTERS
01CC 06                         PUSH    ES                      ; SAVE USERS EXTRA SEGMENT
01CD 1E                         PUSH    DS                      ; SAVE USERS DATA SEGMENT

                        ;-----  SAVE THE CALLING ROUTINE"S STACK

01CE E8 0000 E                  CALL    DDS                     ; SET DS TO DATA AREA
```

SECTION 5

```
01D1 8C 16 0069 R               MOV     @IO_ROM_SEG,SS          ; SAVE USERS STACK SEGMENT
01D5 89 26 0067 R               MOV     @IO_ROM_INIT,SP         ; SAVE USERS STACK POINTER

                        ;=====  SET UP THE PROTECTED MODE DEFINITIONS  =====

                        ;-----  MAKE A 24 BIT ADDRESS OUT OF THE ES:SI FOR THE GDT POINTER

                                ASSUME  DS:NOTHING              ; POINT (DS) TO USERS CONTROL BLOCK
01D9 8C C0                      MOV     AX,ES                   ; GET THE GDT DATA SEGMENT
01DB 8E D8                      MOV     DS,AX                   ; MOVE THE GDT SEGMENT POINTER TO (DS)
01DD 8A F4                      MOV     DH,AH                   ; BUILD HIGH BYTE OF THE 24 BIT ADDRESS
01DF C0 EE 04                   SHR     DH,4                    ; USE ONLY HIGH NIBBLE SHIFT - RIGHT 4
01E2 C1 E0 04                   SHL     AX,4                    ; STRIP HIGH NIBBLE FROM (AX)
01E5 03 C6                      ADD     AX,SI                   ; ADD THE GDT OFFSET TO DEVELOP LOW WORD
01E7 80 D6 00                   ADC     DH,0                    ; ADJUST HIGH BYTE IF CARRY FROM LOW

                        ;-----  SET THE GDT_LOC

01EA C7 44 08 FFFF              MOV     [SI].CGDT_LOC.SEG_LIMIT,MAX_SEG_LEN
01EF 89 44 0A                   MOV     [SI].CGDT_LOC.BASE_LO_WORD,AX   ; SET THE LOW WORD
01F2 88 74 0C                   MOV     [SI].CGDT_LOC.BASE_HI_BYTE,DH   ; SET THE HIGH BYTE
01F5 C7 44 0E 0000              MOV     [SI].CGDT_LOC.DATA_RESERVED,0   ; RESERVED

                        ;-----  SET UP THE CODE SEGMENT DESCRIPTOR

01FA C7 44 20 FFFF              MOV     [SI].BIOS_CS.SEG_LIMIT,MAX_SEG_LEN
01FF C7 44 22 0000              MOV     [SI].BIOS_CS.BASE_LO_WORD,CSEG@_LO      ; LOW WORD OF (CS)= 0
0204 C6 44 24 0F                MOV     [SI].BIOS_CS.BASE_HI_BYTE,CSEG@_HI      ; HIGH BYTE OF (CS)= 0FH
0208 C6 44 25 9B                MOV     [SI].BIOS_CS.DATA_ACC_RIGHTS,CPL0_CODE_ACCESS
020C C7 44 26 0000              MOV     [SI].BIOS_CS.DATA_RESERVED,0            ; RESERVED

                        ;-----  MAKE A 24 BIT ADDRESS OUT OF THE (SS) - ( (SP) REMAINS USER (SP) )

0211 8C D0                      MOV     AX,SS                   ; GET THE CURRENT STACK SEGMENT
0213 8A F4                      MOV     DH,AH                   ; FORM HIGH BYTE OF 24 BIT ADDRESS
0215 C0 EE 04                   SHR     DH,4                    ; FORM HIGH BYTE - SHIFT RIGHT 4
0218 C1 E0 04                   SHL     AX,4                    ; STRIP HIGH NIBBLE FROM (AX)

                        ;-----  SS IS NOW IN POSITION FOR A 24 BIT ADDRESS --> SETUP THE (SS) DESCRIPTOR

021B C7 44 28 FFFF              MOV     [SI].TEMP_SS.SEG_LIMIT,MAX_SEG_LEN  ; SET THE SS SEGMENT LIMIT
0220 89 44 2A                   MOV     [SI].TEMP_SS.BASE_LO_WORD,AX        ; SET THE LOW WORD
0223 88 74 2C                   MOV     [SI].TEMP_SS.BASE_HI_BYTE,DH        ; SET THE HIGH BYTE
0226 C6 44 2D 93                MOV     [SI].TEMP_SS.DATA_ACC_RIGHTS,CPL0_DATA_ACCESS  ; SET CPL 0

                        ;-----  GATE ADDRESS BIT 20 ON  (DISABLE INTERRUPTS)

022A B4 DF                      MOV     AH,ENABLE_BIT20         ; GET ENABLE MASK
022C E8 03CC R                  CALL    GATE_A20                ; ENABLE A20 AND CLEAR INTERRUPTS
022F 3C 00                      CMP     AL,0                    ; WAS THE COMMAND ACCEPTED?
0231 74 06                      JZ      BL4                     ; GO IF YES

0233 B0 03                      MOV     AL,03H                  ; SET THE ERROR FLAG IF NOT
0235 E6 80                      OUT     MFG_PORT,AL
0237 EB 51                      JMP     SHORT SHUT9             ; EARLY ERROR EXIT

                        ;-----  SET SHUTDOWN RETURN ADDRESS AND DISABLE NMI
0239                    BL4:
0239 B8 098F                    MOV     AX,9*H+CMOS_SHUT_DOWN+NMI       ; SET THE SHUTDOWN BYTE LOCATION
023C E8 0000 E                  CALL    CMOS_WRITE                      ; TO SHUT DOWN 9 AND DISABLE NMI

                        ;-----  CLEAR EXCEPTION ERROR FLAG

023F 2A C0                      SUB     AL,AL
0241 E6 80                      OUT     MFG_PORT,AL             ; SET ERROR FLAG LOCATION TO 0

                        ;-----  LOAD THE IDT AND GDT

0243 BD 02C6 R                  MOV     BP,OFFSET ROM_IDT_LOC
                                SEGOV   CS                      ; LOAD THE IDT
0246 2E                 +       DB      02EH
                                LIDT    [BP]                    ;   REGISTER FROM THIS AREA
0247 0F                 +       DB      00FH
0248                    + ??0001 LABEL  BYTE
0248 8B 5E 00           +       MOV     BX,WORD PTR [BP]
024B                    + ??0002 LABEL  BYTE
0248                    +       ORG     OFFSET CS:??0001
0248 01                 +       DB      001H
024B                    +       ORG     OFFSET CS:??0002

                                LGDT    [SI].CGDT_LOC           ; LOAD GLOBAL DESCRIPTOR TABLE REGISTER
024B 0F                 +       DB      00FH
024C                    + ??0003 LABEL  BYTE
024C 8B 54 08           +       MOV     DX,WORD PTR [SI].CGDT_LOC
024F                    + ??0004 LABEL  BYTE
024C                    +       ORG     OFFSET CS:??0003
024C 01                 +       DB      001H
024F                    +       ORG     OFFSET CS:??0004


                        ;-----  SWITCH TO VIRTUAL MODE

024F B8 0001                    MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
0252 0F 01 F0           +       DB      0FH,001H,0F0H
0255 EA                          DB      0EAH                   ; PURGE PRE-FETCH QUEUE WITH FAR JUMP
0256 025A R                      DW      OFFSET VIRT            ;  - TO OFFSET
0258 0020                        DW      BIOS_CS                ;  - IN SEGMENT -PROTECTED MODE SELECTOR
025A                    VIRT:

                        ;-----  IN PROTECTED MODE - SETUP STACK SELECTOR AND SOURCE/TARGET SELECTORS

025A B8 0028                    MOV     AX,TEMP_SS              ; USER'S SS+SP IS NOT A DESCRIPTOR
025D 8E D0                      MOV     SS,AX                   ; LOAD STACK SELECTOR
025F B8 0010                    MOV     AX,SOURCE               ; GET THE SOURCE ENTRY
0262 8E D8                      MOV     DS,AX                   ; LOAD SOURCE SELECTOR
0264 B8 0018                    MOV     AX,TARGET               ; GET THE TARGET ENTRY
0267 8E C0                      MOV     ES,AX                   ; LOAD TARGET SELECTOR
0269 2B F6                      SUB     SI,SI                   ; SET SOURCE INDEX REGISTER TO ZERO
026B 2B FF                      SUB     DI,DI                   ; SET TARGET INDEX REGISTER TO ZERO

026D F3/ A5                     REP     MOVSW                   ; MOVE THE BLOCK COUNT PASSED IN (CX)

                        ;-----  CHECK FOR MEMORY PARITY BEFORE SHUTDOWN
```

```
                        IN      AL,PORT_B               ; GET THE PARITY LATCHES
                        AND     AL,PARITY_ERR           ; STRIP UNWANTED BITS
                        JZ      DONE1                   ; GO IF NO PARITY ERROR

                ;-----  CLEAR PARITY BEFORE SHUTDOWN

                        MOV     AX,DS:[DI]              ; FETCH CURRENT SOURCE DATA
                        MOV     DS:[DI],AX              ; WRITE IT BACK
                        MOV     AL,01                   ; SET PARITY CHECK ERROR = 01
                        OUT     MFG_PORT,AL
                        IN      AL,PORT_B
                        OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK LATCHES
                        OUT     PORT_B,AL               ;  TO CLEAR THE PENDING ERROR
                        AND     AL,RAM_PAR_ON           ;  AND ENABLE CHECKING
                        OUT     PORT_B,AL

                ;-----  CAUSE A SHUTDOWN

                DONE1:
                        JMP     PROC_SHUTDOWN           ; GO RESET PROCESSOR AND SHUTDOWN

                        ;======================
                ;------  RETURN FROM SHUTDOWN
                        ;======================
                SHUT9:                                  ;       RESTORE USERS STACK
                        ASSUME  DS:DATA
                        MOV     AX,DATA                 ; SET DS TO DATA AREA
                        MOV     DS,AX
                        MOV     SS,@IO_ROM_SEG          ; GET USER STACK SEGMENT
                        MOV     SP,@IO_ROM_INIT         ; GET USER STACK POINTER

                ;-----  GATE ADDRESS BIT 20 OFF

                        MOV     AH,DISABLE_BIT20        ; DISABLE MASK
                        CALL    GATE_A20                ; GATE ADDRESS 20 LINE OFF
                        CMP     AL,0                    ; COMMAND ACCEPTED?
                        JZ      DONE3                   ; GO IF YES

                        IN      AL,MFG_PORT             ; CHECK FOR ANY OTHER ERROR FIRST
                        CMP     AL,0                    ; WAS THERE AN ERROR?
                        JNZ     DONE3                   ; REPORT FIRST ERROR IF YES
                        MOV     AL,03H                  ; ELSE SET GATE A20 ERROR FLAG
                        OUT     MFG_PORT,AL

                ;-----  RESTORE THE USERS REGISTERS AND SET RETURN CODES

                DONE3:
                        MOV     AX,CMOS_REG_D           ; CLEAR (AH) TO ZERO AND (AL) TO DEFAULT
                        OUT     CMOS_PORT,AL            ; ENABLE NMI INTERRUPTS

                        POP     DS                      ; RESTORE USER DATA SEGMENT
                        POP     ES                      ; RESTORE USER EXTRA SEGMENT
                        IN      AL,MFG_PORT             ; GET THE ENDING STATUS RETURN CODE
                        MOV     BP,SP                   ; POINT TO REGISTERS IN THE STACK
                        MOV     [BP+15],AL              ; PLACE ERROR CODE INTO STACK AT (AH)
                        CMP     AH,AL                   ; SET THE ZF & CY FLAGS WITH RETURN CODE
                        POPA                            ; RESTORE THE GENERAL PURPOSE REGISTERS
                        STI                             ; TURN INTERRUPTS ON
                DONE4   PROC    FAR
                        RET     2                       ; RETURN WITH FLAGS SET --  (AH)= CODE
                DONE4   ENDP                            ;  (CY=0,ZF=1)= OK   (CY=1,ZF=0)= ERROR

                ;-----  BLOCK MOVE EXCEPTION INTERRUPT HANDLER

                EX_INT:
                        MOV     AL,02H                  ; GET EXCEPTION ERROR CODE
                        OUT     MFG_PORT,AL             ; SET EXCEPTION INTERRUPT OCCURRED FLAG
                        JMP     PROC_SHUTDOWN           ; CAUSE A EARLY SHUTDOWN

                ;-----  ROM IDT LOCATION

                ROM_IDT_LOC:
                        DW      ROM_IDT_END-ROM_IDT     ; LENGTH OF ROM IDT TABLE
                        DW      ROM_IDT                 ; LOW WORD OF BASE ADDRESS
                        DB      CSEG@_HI                ; HIGH BYTE OF BASE ADDRESS
                        DB      0                       ; RESERVED

                ;-----  THE ROM EXCEPTION INTERRUPT VECTOR GATES FOR BLOCK MOVE

                ROM_IDT:                                ;       EXCEPTION 00
                        DW      EX_INT                  ; DESTINATION OFFSET
                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
                        DB      0                       ; WORD COPY COUNT
                        DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
                        DW      0                       ; RESERVED
                                                        ;       EXCEPTION 01
                        DW      EX_INT                  ; DESTINATION OFFSET
                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
                        DB      0                       ; WORD COPY COUNT
                        DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
                        DW      0                       ; RESERVED
                                                        ;       EXCEPTION 02
                        DW      EX_INT                  ; DESTINATION OFFSET
                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
                        DB      0                       ; WORD COPY COUNT
                        DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
                        DW      0                       ; RESERVED
                                                        ;       EXCEPTION 03
                        DW      EX_INT                  ; DESTINATION OFFSET
                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
                        DB      0                       ; WORD COPY COUNT
                        DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
                        DW      0                       ; RESERVED
                                                        ;       EXCEPTION 04
                        DW      EX_INT                  ; DESTINATION OFFSET
                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
                        DB      0                       ; WORD COPY COUNT
                        DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
                        DW      0                       ; RESERVED
                                                        ;       EXCEPTION 05
                        DW      EX_INT                  ; DESTINATION OFFSET
                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
                        DB      0                       ; WORD COPY COUNT
```

```
02F9 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
02FA 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 06
02FC 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
02FE 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0300 00                 DB      0                       ; WORD COPY COUNT
0301 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0302 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 07
0304 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0306 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0308 00                 DB      0                       ; WORD COPY COUNT
0309 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
030A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 08
030C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
030E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0310 00                 DB      0                       ; WORD COPY COUNT
0311 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0312 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 09
0314 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0316 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0318 00                 DB      0                       ; WORD COPY COUNT
0319 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
031A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 10
031C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
031E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0320 00                 DB      0                       ; WORD COPY COUNT
0321 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0322 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 11
0324 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0326 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0328 00                 DB      0                       ; WORD COPY COUNT
0329 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
032A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 12
032C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
032E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0330 00                 DB      0                       ; WORD COPY COUNT
0331 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0332 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 13
0334 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0336 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0338 00                 DB      0                       ; WORD COPY COUNT
0339 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
033A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 14
033C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
033E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0340 00                 DB      0                       ; WORD COPY COUNT
0341 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0342 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 15
0344 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0346 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0348 00                 DB      0                       ; WORD COPY COUNT
0349 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
034A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 16
034C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
034E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0350 00                 DB      0                       ; WORD COPY COUNT
0351 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0352 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 17
0354 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0356 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0358 00                 DB      0                       ; WORD COPY COUNT
0359 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
035A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 18
035C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
035E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0360 00                 DB      0                       ; WORD COPY COUNT
0361 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0362 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 19
0364 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0366 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0368 00                 DB      0                       ; WORD COPY COUNT
0369 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
036A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 20
036C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
036E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0370 00                 DB      0                       ; WORD COPY COUNT
0371 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0372 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 21
0374 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0376 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0378 00                 DB      0                       ; WORD COPY COUNT
0379 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
037A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 22
037C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
037E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0380 00                 DB      0                       ; WORD COPY COUNT
0381 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0382 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 23
0384 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
0386 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0388 00                 DB      0                       ; WORD COPY COUNT
0389 87                 DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
038A 0000               DW      0                       ; RESERVED
                                                        ;       EXCEPTION 24
038C 02BF R             DW      EX_INT                  ; DESTINATION OFFSET
038E 0020               DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0390 00                 DB      0                       ; WORD COPY COUNT
```

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0391 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
0392 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 25
0394 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
0396 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
0398 00                         DB      0                       ; WORD COPY COUNT
0399 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
039A 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 26
039C 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
039E 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
03A0 00                         DB      0                       ; WORD COPY COUNT
03A1 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
03A2 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 27
03A4 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
03A6 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
03A8 00                         DB      0                       ; WORD COPY COUNT
03A9 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
03AA 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 28
03AC 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
03AE 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
03B0 00                         DB      0                       ; WORD COPY COUNT
03B1 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
03B2 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 29
03B4 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
03B6 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
03B8 00                         DB      0                       ; WORD COPY COUNT
03B9 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
03BA 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 30
03BC 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
03BE 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
03C0 00                         DB      0                       ; WORD COPY COUNT
03C1 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
03C2 0000                       DW      0                       ; RESERVED
                                                                ;       EXCEPTION 31
03C4 02BF R                     DW      EX_INT                  ; DESTINATION OFFSET
03C6 0020                       DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
03C8 00                         DB      0                       ; WORD COPY COUNT
03C9 87                         DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
03CA 0000                       DW      0                       ; RESERVED
03CC                    ROM_IDT_END:
03CC                    BLOCKMOVE       ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; GATE_A20                                                                      :
                        ;       THIS ROUTINE CONTROLS A SIGNAL WHICH GATES ADDRESS BIT 20.              :
                        ;       THE GATE A20 SIGNAL IS AN OUTPUT OF THE 8042 SLAVE PROCESSOR.          :
                        ;       ADDRESS BIT 20 SHOULD BE GATED ON BEFORE ENTERING PROTECTED MODE.      :
                        ;       IT SHOULD BE GATED OFF AFTER ENTERING REAL MODE FROM PROTECTED         :
                        ;       MODE.   INTERRUPTS ARE LEFT DISABLED ON EXIT.                          :
                        ; INPUT                                                                        :
                        ;       (AH)= DDH  ADDRESS BIT 20 GATE OFF. (A20 ALWAYS ZERO)                  :
                        ;       (AH)= DFH  ADDRESS BIT 20 GATE ON. (A20 CONTROLLED BY 80286)           :
                        ; OUTPUT                                                                       :
                        ;       (AL)= 00H  OPERATION SUCCESSFUL. 8042 HAS ACCEPTED COMMAND.            :
                        ;       (AL)= 02H  FAILURE--8042 UNABLE TO ACCEPT COMMAND.                     :
                        ;--------------------------------------------------------------------------------
03CC                    GATE_A20        PROC
03CC 51                         PUSH    CX                      ; SAVE USERS (CX)
03CD FA                         CLI                             ; DISABLE INTERRUPTS WHILE USING 8042
03CE E8 03E5 R                  CALL    EMPTY_8042              ; INSURE 8042 INPUT BUFFER EMPTY
03D1 75 10                      JNZ     GATE_A20_RETURN         ; EXIT IF 8042 UNABLE TO ACCEPT COMMAND
03D3 B0 D1                      MOV     AL,0D1H                 ; 8042 COMMAND TO WRITE OUTPUT PORT
03D5 E6 64                      OUT     STATUS_PORT,AL          ; OUTPUT COMMAND TO 8042
03D7 E8 03E5 R                  CALL    EMPTY_8042              ; WAIT FOR 8042 TO ACCEPT COMMAND
03DA 75 07                      JNZ     GATE_A20_RETURN         ; EXIT IF 8042 UNABLE TO ACCEPT COMMAND
03DC 8A C4                      MOV     AL,AH                   ; 8042 PORT DATA
03DE E6 60                      OUT     PORT_A,AL               ; OUTPUT PORT DATA TO 8042
03E0 E8 03E5 R                  CALL    EMPTY_8042              ; WAIT FOR 8042 TO ACCEPT PORT DATA

                        ;-----  8042 OUTPUT WILL SWITCH WITHIN 20 MICRO SECONDS OF ACCEPTING PORT DATA

03E3                    GATE_A20_RETURN:
03E3 59                         POP     CX                      ; RESTORE USERS (CX)
03E4 C3                         RET
                        ;--------------------------------------------------------------------------------
                        ; EMPTY_8042                                                                   :
                        ;       THIS ROUTINE WAITS FOR THE 8042 INPUT BUFFER TO EMPTY.                 :
                        ; INPUT                                                                        :
                        ;       NONE                                                                   :
                        ; OUTPUT                                                                       :
                        ;       (AL)= 00H  8042 INPUT BUFFER EMPTY (ZERO FLAG SET)                     :
                        ;       (AL)= 02H  TIME OUT, 8042 INPUT BUFFER FULL (NON-ZERO FLAG SET)        :
                        ;       (CX)       - MODIFIED                                                  :
                        ;--------------------------------------------------------------------------------
03E5                    EMPTY_8042:
03E5 2B C9                      SUB     CX,CX                   ; (CX)=0, WILL BE USED AS TIME OUT VALUE
03E7                    EMPTY_L:
03E7 E4 64                      IN      AL,STATUS_PORT          ; READ 8042 STATUS PORT
03E9 24 02                      AND     AL,INPT_BUF_FULL        ; TEST INPUT BUFFER FULL FLAG (BIT 1)
03EB E0 FA                      LOOPNZ  EMPTY_L                 ; LOOP UNTIL BUFFER EMPTY OR TIME OUT
03ED C3                         RET
03EE                    GATE_A20        ENDP


                        ;--- INT 15 H -- ( FUNCTION 88 H - I/O MEMORY SIZE DETERMINE ) -----------------
                        ; EXT_MEMORY                                                                   :
                        ;       THIS ROUTINE RETURNS  THE AMOUNT OF MEMORY IN THE SYSTEM THAT IS       :
                        ;       LOCATED STARTING AT THE 1024K ADDRESSING RANGE, AS DETERMINED BY       :
                        ;       THE POST ROUTINES.                                                     :
                        ;       NOTE THAT THE SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS THERE    :
                        ;       IS A FULL COMPLEMENT OF 512K OR 640 BYTES ON THE PLANAR.  THIS SIZE    :
                        ;       SIZE IS STORED IN CMOS AT ADDRESS LOCATIONS 30H AND 31H.               :
                        ; INPUT                                                                        :
                        ;       AH = 88H                                                               :
                        ;                                                                              :
                        ;       THE I/O MEMORY SIZE VARIABLE IS SET DURING POWER ON                    :
                        ;       DIAGNOSTICS ACCORDING TO THE FOLLOWING ASSUMPTIONS:                    :
                        ;                                                                              :
                        ;       1. ALL INSTALLED MEMORY IS FUNCTIONAL.                                 :
                        ;       2. ALL MEMORY FROM 0 TO 640K MUST BE CONTIGUOUS.                       :
                        ;                                                                              :
                        ; OUTPUT                                                                       :
                        ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY A                      :
                        ;              AVAILABLE STARTING AT ADDRESS 1024K.                            :
                        ;                                                                              :
                        ;--------------------------------------------------------------------------------
03EE                    EXT_MEMORY      PROC

03EE B8 3031                    MOV     AX,CMOS_U_M_S_LO*H+CMOS_U_M_S_HI ; ADDRESS HIGH/LOW BYTES
03F1 E8 0000 E                  CALL    CMOS_READ               ; GET THE HIGH BYTE OF I/O MEMORY
03F4 86 C4                      XCHG    AL,AH                   ; PUT HIGH BYTE IN POSITION (AH)
03F6 E8 0000 E                  CALL    CMOS_READ               ; GET THE LOW BYTE OF I/O MEMORY
03F9 CF                         IRET                            ; RETURN TO USER

03FA                    EXT_MEMORY      ENDP
```

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                        PAGE
                        ;--- INT 15 H ( FUNCTION 89 H ) ----------------------------------------------
                        ; PURPOSE:                                                                    :
                        ;       THIS BIOS FUNCTION PROVIDES A MEANS TO THE USER TO SWITCH INTO        :
                        ;       VIRTUAL (PROTECTED) MODE.  UPON COMPLETION OF THIS FUNCTION THE       :
                        ;       PROCESSOR WILL BE IN  VIRTUAL (PROTECTED) MODE AND CONTROL WILL       :
                        ;       BE TRANSFERRED TO THE CODE SEGMENT THAT WAS SPECIFIED BY THE USER.    :
                        ;                                                                             :
                        ; ENTRY REQUIREMENTS:                                                         :
                        ;                                                                             :
                        ;       (ES:SI) POINTS TO A DESCRIPTOR TABLE (GDT) BUILT BEFORE INTERRUPTING  :
                        ;       TO THIS FUNCTION.  THESE DESCRIPTORS ARE USED BY THIS FUNCTION TO     :
                        ;       INITIALIZE THE IDTR, THE GDTR AND THE STACK SEGMENT SELECTOR.  THE    :
                        ;       DATA SEGMENT (DS) SELECTOR AND THE EXTRA SEGMENT (ES) SELECTOR WILL   :
                        ;       BE INITIALIZE TO DESCRIPTORS BUILT BY THE ROUTINE USING THIS FUNCTION.:
                        ;       BH - OFFSET INTO THE INTERRUPT DESCRIPTOR TABLE STATING WHERE THE      :
                        ;            FIRST EIGHT HARDWARE INTERRUPTS WILL BEGIN. ( INTERRUPT LEVEL 1 ) :
                        ;       BL - OFFSET INTO THE INTERRUPT DESCRIPTOR TABLE STATING WHERE THE      :
                        ;            SECOND EIGHT HARDWARE INTERRUPTS BEGIN. ( INTERRUPT LEVEL 2 )    :
                        ;                                                                             :
                        ; THE DESCRIPTORS ARE DEFINED AS FOLLOWS:                                     :
                        ;                                                                             :
                        ;       1.  THE FIRST DESCRIPTOR IS THE REQUIRED DUMMY.                       :
                        ;           (USER INITIALIZED TO 0)                                           :
                        ;       2.  THE SECOND DESCRIPTOR POINTS TO THE GDT TABLE AS                  :
                        ;           A DATA SEGMENT.                                                   :
                        ;           (USER INITIALIZED)                                                :
                        ;       3.  THE THIRD DESCRIPTOR POINTS TO THE USER DEFINED                   :
                        ;           INTERRUPT DESCRIPTOR TABLE (IDT).                                 :
                        ;           (USER INITIALIZED)                                                :
                        ;       4.  THE FORTH DESCRIPTOR POINTS TO THE USER'S DATA                    :
                        ;           SEGMENT (DS).                                                     :
                        ;           (USER INITIALIZED)                                                :
                        ;       5.  THE FIFTH DESCRIPTOR POINTS TO THE USER'S EXTRA                   :
                        ;           SEGMENT (ES).                                                     :
                        ;           (USER INITIALIZED)                                                :
                        ;       6.  THE SIXTH DESCRIPTOR POINTS TO THE USER'S STACK                   :
                        ;           SEGMENT (SS).                                                     :
                        ;           (USER INITIALIZED)                                                :
                        ;       7.  THE SEVENTH DESCRIPTOR POINTS TO THE CODE SEGMENT                 :
                        ;           THAT THIS FUNCTION WILL RETURN TO.                                :
                        ;           (USER INITIALIZED TO THE USER'S CODE SEGMENT.)                    :
                        ;       8.  THE EIGHTH DESCRIPTOR IS USED BY THIS FUNCTION TO                 :
                        ;           ESTABLISH A CODE SEGMENT FOR ITSELF. THIS IS                      :
                        ;           NEEDED SO THAT THIS FUNCTION CAN COMPLETE IT'S                    :
                        ;           EXECUTION WHILE IN PROTECTED MODE.  WHEN CONTROL                  :
                        ;           GETS PASSED TO THE USER'S CODE THIS DESCRIPTOR CAN                 :
                        ;           BE USED BY HIM IN ANY WAY HE CHOOSES.                             :
                        ;                                                                             :
                        ;   NOTE -  EACH DESCRIPTOR MUST CONTAIN ALL THE NECESSARY DATA               :
                        ;           I.E. THE LIMIT,  BASE ADDRESS AND THE ACCESS RIGHTS BYTE.         :
                        ;                                                                             :
                        ;       AH= 89H  (FUNCTION CALL)                                              :
                        ;       ES:SI = LOCATION OF THE GDT TABLE BUILD BY ROUTINE                    :
                        ;       USING THIS FUNCTION.                                                  :
                        ;                                                                             :
                        ; EXIT PARAMETERS:                                                            :
                        ;                                                                             :
                        ;       AH = 0  IF SUCCESSFUL                                                 :
                        ;       ALL SEGMENT REGISTERS ARE CHANGED, (AX) AND (BP) DESTROYED            :
                        ;                                                                             :
                        ; CONSIDERATIONS:                                                             :
                        ;                                                                             :
                        ;       1.  NO BIOS AVAILABLE TO USER.  USER MUST HANDLE ALL                  :
                        ;           I/O COMMANDS.                                                     :
                        ;       2.  INTERRUPTS - INTERRUPT VECTOR LOCATIONS MUST BE                   :
                        ;           MOVED,  DUE TO THE 286 RESERVED AREAS.  THE                       :
                        ;           HARDWARE INTERRUPT CONTROLLERS MUST BE REINITIALIZED               :
                        ;           TO DEFINE LOCATIONS THAT DO NOT RESIDE IN THE 286                 :
                        ;           RESERVED AREAS.                                                   :
                        ;       3.  EXCEPTION INTERRUPT TABLE AND HANDLER MUST BE                     :
                        ;           INITIALIZED BY THE USER.                                          :
                        ;       4.  THE INTERRUPT DESCRIPTOR TABLE MUST NOT OVERLAP                   :
                        ;           THE REAL MODE BIOS INTERRUPT DESCRIPTOR TABLE.                    :
                        ;       5.  THE FOLLOWING GIVES AN IDEA OF WHAT THE USER CODE                 :
                        ;           SHOULD LOOK LIKE WHEN INVOKING THIS FUNCTION.                     :
                        ;                                                                             :
                        ;       REAL MODE --->    "USER CODE"                                         :
                        ;                 "       MOV   AX,GDT SEGMENT                                :
                        ;                 "       MOV   ES,AX                                         :
                        ;                 "       MOV   SI,GDT OFFSET                                 :
                        ;                 "       MOV   BH,HARDWARE INT LEVEL 1 OFFSET                :
                        ;                 "       MOV   BL,HARDWARE INT LEVEL 2 OFFSET                :
                        ;                 "       MOV   AH,89H                                        :
                        ;                 "       INT   15H                                           :
                        ;   VIRTUAL MODE --->   "USER CODE"                                          :
                        ;                                                                             :
                        ; DESCRIPTION:                                                               :
                        ;                                                                             :
                        ;       1.  CLI (NO INTERRUPTS ALLOWED) WHILE THIS FUNCTION IS EXECUTING.     :
                        ;       2.  ADDRESS LINE 20 IS GATED ACTIVE.                                  :
                        ;       3.  THE CURRENT USER STACK SEGMENT DESCRIPTOR IS INITIALIZED.          :
                        ;       4.  THE GDTR IS LOADED WITH THE GDT BASE ADDRESS.                     :
                        ;       5.  THE IDTR IS LOADED WITH THE IDT BASE ADDRESS.                     :
                        ;       6.  THE 8259 IS REINITIALIZED WITH THE NEW INTERRUPT OFFSETS.         :
                        ;       7.  THE PROCESSOR IS PUT IN VIRTUAL MODE WITH THE CODE                :
                        ;           SEGMENT DESIGNATED FOR THIS FUNCTION.                             :
                        ;       8.  DATA SEGMENT IS LOADED WITH THE USER DEFINED                      :
                        ;           SELECTOR FOR THE DS REGISTER.                                     :
                        ;       9.  EXTRA SEGMENT IS LOADED WITH THE USER DEFINED                     :
                        ;           SELECTOR FOR THE ES REGISTER.                                     :
                        ;      10.  STACK SEGMENT IS LOADED WITH THE USER DEFINED                     :
                        ;           SELECTOR FOR THE SS REGISTER.                                     :
                        ;      11.  CODE SEGMENT DESCRIPTOR SELECTOR VALUE IS                         :
                        ;           SUBSTITUTED ON THE STACK FOR RETURN TO USER.                      :
                        ;      12.  WE TRANSFER CONTROL TO THE USER WITH INTERRUPTS DISABLED.         :
                        ;-------------------------------------------------------------------------------
```

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                        PAGE
                        ;
                        ;       THE FOLLOWING DIAGRAM DEPICTS THE ORGANIZATION
                        ;       OF GDT.
                        ;-----------------------------------------------------------------------------
                        ;                                G D T                                      :
                        ;                                                                           :
                        ;                                  .-------------.                          :
                        ;                                  v             |                          :
                        ;       (ES:SI)-->>  +00 .-----------------.    |                          :
                        ;                    |   |     DUMMY       |    |                          :
                        ;                    |   |-----------------|    |                          :
                        ;                    +08 |      GDT        |  ---'                          :
                        ;                    |   |-----------------|                               :
                        ;                    +10 |      IDT        |                               :
                        ;                    |   |-----------------|                               :
                        ;                    +18 |      DS         |                               :
                        ;                    |   |-----------------|                               :
                        ;                    +20 |      ES         |                               :
                        ;                    |   |-----------------|                               :
                        ;                    +28 |      SS         |                               :
                        ;                    |   |-----------------|                               :
                        ;                    +30 |      CS         |                               :
                        ;                    |   |-----------------|                               :
                        ;                    +38 |   TEMP_BIOS     |                               :
                        ;                        |      CS         |                               :
                        ;                        |-----------------|                               :
                        ;                                                                           :
                        ;-----------------------------------------------------------------------------

                        ;-----------------------------------------------------------------------------
                        ;     THE GLOBAL DESCRIPTOR TABLE (ACTUAL LOCATION POINTED TO BY ES:SI)      :
                        ;-----------------------------------------------------------------------------

                        VIRTUAL_ENABLE_GDT_DEF  STRUC
0000 ????????????????           DQ      ?               ; FIRST DESCRIPTOR NOT ACCESSIBLE
0008 ????????????????   GDTPTR  DQ      ?               ; GDT DESCRIPTOR
0010 ????????????????   IDTPTR  DQ      ?               ; IDT DESCRIPTOR
0018 ????????????????   USER_DS DQ      ?               ; USER DATA SEGMENT DESCRIPTOR
0020 ????????????????   USER_ES DQ      ?               ; USER EXTRA SEGMENT DESCRIPTOR
0028 ????????????????   USER_SS DQ      ?               ; USER STACK SEGMENT DESCRIPTOR
0030 ????????????????   USER_CS DQ      ?               ; USER CODE SEGMENT DESCRIPTOR
0038 ????????????????   BIO_CS  DQ      ?               ; TEMPORARY BIOS DESCRIPTOR
0040                    VIRTUAL_ENABLE_GDT_DEF  ENDS

                                ASSUME  DS:DATA

03FA                    X_VIRTUAL       PROC    FAR
03FA                    SET_VMODE:

                        ;-----  ENABLE ADDRESS LATCH BIT 20

03FA FA                         CLI                     ; NO INTERRUPTS ALLOWED
03FB B4 DF                      MOV     AH,ENABLE_BIT20 ; ENABLE BIT 20 FOR ADDRESS GATE
03FD E8 03CC R                  CALL    GATE_A20
0400 3C 00                      CMP     AL,0            ; WAS THE COMMAND ACCEPTED?
0402 74 04                      JZ      BIT20_ON        ; GO IF YES
0404 B4 FF                      MOV     AH,0FFH         ; SET THE ERROR FLAG
0406 F9                         STC                     ; SET CARRY
0407 CF                         IRET                    ; EARLY EXIT


0408                    BIT20_ON:
0408 06                         PUSH    ES              ; MOVE SEGMENT POINTER
0409 1F                         POP     DS              ; TO THE DATA SEGMENT

                        ;-----------------------------------------------------------------------------
                        ; REINITIALIZE THE 8259 INTERRUPT CONTROLLER #1 TO THE USER SPECIFIED OFFSET  :
                        ;-----------------------------------------------------------------------------

040A B0 11                      MOV     AL,11H          ; START INITIALIZATION SEQUENCE-ICW1
040C E6 20                      OUT     INTA00,AL       ; EDGE,INTERVAL-8,MASTER,ICW4 NEEDED
040E EB 00                      JMP     $+2
0410 8A C7                      MOV     AL,BH           ; HARDWARE INT'S START AT INT # (BH)
0412 E6 21                      OUT     INTA01,AL       ; SEND ICW2
0414 EB 00                      JMP     $+2
0416 B0 04                      MOV     AL,04H          ; SEND ICW3 - MASTER LEVEL 2
0418 E6 21                      OUT     INTA01,AL
041A EB 00                      JMP     $+2
041C B0 01                      MOV     AL,01H          ; SEND ICW4 - MASTER,8086 MODE
041E E6 21                      OUT     INTA01,AL
0420 EB 00                      JMP     $+2
0422 B0 FF                      MOV     AL,0FFH         ; MASK OFF ALL INTERRUPTS
0424 E6 21                      OUT     INTA01,AL

                        ;-----------------------------------------------------------------------------
                        ; REINITIALIZE THE 8259 INTERRUPT CONTROLLER #2 TO THE USER SPECIFIED OFFSET  :
                        ;-----------------------------------------------------------------------------

0426 B0 11                      MOV     AL,11H          ; INITIALIZE SEQUENCE-ICW1 FOR SLAVE
0428 E6 A0                      OUT     INTB00,AL       ; EDGE,INTERVAL-8,MASTER,ICW4 NEEDED
042A EB 00                      JMP     $+2
042C 8A C3                      MOV     AL,BL           ; HARDWARE INT'S START AT INT # (BL)
042E E6 A1                      OUT     INTB01,AL       ; SEND ICW2
0430 B0 02                      MOV     AL,02H
0432 EB 00                      JMP     $+2
0434 E6 A1                      OUT     INTB01,AL       ; SEND ICW3 - SLAVE LEVEL 2
0436 EB 00                      JMP     $+2
0438 B0 01                      MOV     AL,01H
043A E6 A1                      OUT     INTB01,AL       ; SEND ICW4 - SLAVE,8086 MODE
043C EB 00                      JMP     $+2
043E B0 FF                      MOV     AL,0FFH
0440 E6 A1                      OUT     INTB01,AL       ; MASK OFF ALL INTERRUPTS


                        ;-----------------------------------------
                        ; SETUP BIOS CODE SEGMENT DESCRIPTOR    :
                        ;-----------------------------------------
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```
                                        MOV     [SI].BIO_CS.SEG_LIMIT,MAX_SEG_LEN       ; SET LENGTH
                                        MOV     [SI].BIO_CS.BASE_HI_BYTE,CSEG@_HI       ; SET HIGH BYTE OF CS=0F
                                        MOV     [SI].BIO_CS.BASE_LO_WORD,CSEG@_LO       ; SET LOW WORD OF CS=0
                                        MOV     [SI].BIO_CS.DATA_ACC_RIGHTS,CPL0_CODE_ACCESS
                                        MOV     [SI].BIO_CS.DATA_RESERVED,0             ; ZERO RESERVED AREA

                                ;---------------------------------------
                                ;       ENABLE PROTECTED MODE           :
                                ;---------------------------------------
                                        LGDT    [SI].GDTPTR             ; LOAD GLOBAL DESCRIPTOR TABLE REGISTER
                                +       DB      00FH
                                + ??0005 LABEL  BYTE
                                +       MOV     DX,WORD PTR [SI].GDTPTR
                                + ??0006 LABEL  BYTE
                                +       ORG     OFFSET CS:??0005
                                +       DB      001H
                                +       ORG     OFFSET CS:??0006
                                        LIDT    [SI].IDTPTR             ; INTERRUPT DESCRIPTOR TABLE REGISTER
                                +       DB      00FH
                                + ??0007 LABEL  BYTE
                                +       MOV     BX,WORD PTR [SI].IDTPTR
                                + ??0008 LABEL  BYTE
                                +       ORG     OFFSET CS:??0007
                                +       DB      001H
                                +       ORG     OFFSET CS:??0008

                                        MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                        LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
                                +       DB      00FH,001H,0F0H
                                         DB     0EAH                    ; PURGE PRE-FETCH QUEUE WITH FAR JUMP
                                         DW     OFFSET VMODE            ;  - TO OFFSET
                                         DW     BIO_CS                  ;  - IN SEGMENT -PROTECTED MODE SELECTOR

                                VMODE:
                                ;---------------------------------------
                                ;       SETUP USER SEGMENT REGISTERS    :
                                ;---------------------------------------
                                        MOV     AX,USER_DS              ; SETUP USER'S DATA SEGMENT
                                        MOV     DS,AX                   ; TO PROTECTED MODE SELECTORS
                                        MOV     AX,USER_ES              ; SETUP USER'S EXTRA SEGMENT
                                        MOV     ES,AX
                                        MOV     AX,USER_SS              ; SETUP USER'S STACK SEGMENT
                                        MOV     SS,AX
                                ;---------------------------------------
                                ;       PUT TRANSFER ADDRESS ON STACK   :
                                ;       AND RETURN TO THE USER          :
                                ;---------------------------------------
                                        POP     BX                      ; GET RETURN IP FROM THE STACK
                                        ADD     SP,4                    ; NORMALIZE STACK POINTER
                                        PUSH    USER_CS                 ; SET STACK FOR A RETURN FAR
                                        PUSH    BX
                                        RET                             ; RETURN TO USER IN VIRTUAL MODE

                                X_VIRTUAL       ENDP

                                ;--- DEVICE BUSY AND INTERRUPT COMPLETE ------------------------
                                ;                                                               :
                                ;       THIS ROUTINE IS A TEMPORARY HANDLER FOR DEVICE BUSY      :
                                ;       AND INTERRUPT COMPLETE                                  :
                                ;                                                               :
                                ;       INPUT   - SEE PROLOGUE                                  :
                                ;---------------------------------------------------------------

                                DEVICE_BUSY     PROC    NEAR
                                        CLC                             ; TURN CARRY OFF
                                        JMP     CI_F                    ; RETURN WITH CARRY FLAG
                                DEVICE_BUSY     ENDP

                                INT_COMPLETE    PROC    NEAR
                                        IRET                            ; RETURN
                                INT_COMPLETE    ENDP

                                CODE    ENDS
                                        END
```

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                        PAGE 118,121
                        TITLE BIOS2 ---- 06/10/85  BIOS INTERRUPT ROUTINES
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  PRINT_SCREEN_1
                                PUBLIC  RTC_INT
                                PUBLIC  TIME_OF_DAY_1
                                PUBLIC  TIMER_INT_1

                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   CMOS_WRITE:NEAR         ; WRITE CMOS LOCATION ROUTINE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR

                        ;--- INT  1A H -- (TIME_OF_DAY) ----------------------------------------------------
                        ;       THIS BIOS ROUTINE ALLOWS THE CLOCKS TO BE SET OR READ                       :
                        ;                                                                                   :
                        ; PARAMETERS:                                                                       :
                        ;       (AH) = 00H  READ THE CURRENT CLOCK SETTING AND RETURN WITH,                  :
                        ;                       (CX) = HIGH PORTION OF COUNT                                :
                        ;                       (DX) = LOW PORTION OF COUNT                                 :
                        ;                       (AL) = 0 TIMER HAS NOT PASSED 24 HOURS SINCE LAST READ      :
                        ;                              1 IF ON ANOTHER DAY. (RESET TO ZERO AFTER READ)      :
                        ;                                                                                   :
                        ;       (AH) = 01H  SET THE CURRENT CLOCK USING,                                    :
                        ;                       (CX) = HIGH PORTION OF COUNT                                :
                        ;                       (DX) = LOW PORTION OF COUNT.                                :
                        ;                                                                                   :
                        ;                 NOTE: COUNTS OCCUR AT THE RATE OF 1193180/65536 COUNTS/SECOND     :
                        ;                       (OR ABOUT 18.2 PER SECOND -- SEE EQUATES)                   :
                        ;                                                                                   :
                        ;       (AH) = 02H  READ THE REAL TIME CLOCK AND RETURN WITH,                       :
                        ;                       (CH) = HOURS IN BCD (00-23)                                 :
                        ;                       (CL) = MINUTES IN BCD (00-59)                               :
                        ;                       (DH) = SECONDS IN BCD (00-59)                               :
                        ;                       (DL) = DAYLIGHT SAVINGS ENABLE (00-01).                     :
                        ;                                                                                   :
                        ;       (AH) = 03H  SET THE REAL TIME CLOCK USING,                                  :
                        ;                       (CH) = HOURS IN BCD (00-23)                                 :
                        ;                       (CL) = MINUTES IN BCD (00-59)                               :
                        ;                       (DH) = SECONDS IN BCD (00-59)                               :
                        ;                       (DL) = 01 IF DAYLIGHT SAVINGS ENABLE OPTION, ELSE 00.       :
                        ;                                                                                   :
                        ;                 NOTE: (DL)= 00 IF DAYLIGHT SAVINGS TIME ENABLE IS NOT ENABLED.    :
                        ;                       (DL)= 01 ENABLES TWO SPECIAL UPDATES THE LAST SUNDAY IN      :
                        ;                       APRIL   (1:59:59 --> 3:00:00 AM) AND THE LAST SUNDAY IN     :
                        ;                       OCTOBER (1:59:59 --> 1:00:00 AM) THE FIRST TIME.            :
                        ;                                                                                   :
                        ;       (AH) = 04H  READ THE DATE FROM THE REAL TIME CLOCK AND RETURN WITH,         :
                        ;                       (CH) = CENTURY IN BCD (19 OR 20)                            :
                        ;                       (CL) = YEAR IN BCD (00-99)                                  :
                        ;                       (DH) = MONTH IN BCD (01-12)                                 :
                        ;                       (DL) = DAY IN BCD (01-31).                                  :
                        ;                                                                                   :
                        ;       (AH) = 05H  SET THE DATE INTO THE REAL TIME CLOCK USING,                    :
                        ;                       (CH) = CENTURY IN BCD (19 OR 20)                            :
                        ;                       (CL) = YEAR IN BCD (00 - 99)                                :
                        ;                       (DH) = MONTH IN BCD (01 - 12)                               :
                        ;                       (DL) = DAY IN BCD (01-31).                                  :
                        ;                                                                                   :
                        ;       (AH) = 06H  SET THE ALARM TO INTERRUPT AT SPECIFIED TIME,                   :
                        ;                       (CH) = HOURS IN BCD (00-23 OR FFH))                         :
                        ;                       (CL) = MINUTES IN BCD (00-59 OR FFH))                       :
                        ;                       (DH) = SECONDS IN BCD (00-59 OR FFH)).                      :
                        ;                                                                                   :
                        ;       (AH) = 07H  RESET THE ALARM INTERRUPT FUNCTION.                             :
                        ;                                                                                   :
                        ; NOTES: FOR ALL RETURNS CY= 0 FOR SUCCESSFUL OPERATION.                             :
                        ;        FOR (AH)= 2, 4, 6 - CARRY FLAG SET IF REAL TIME CLOCK NOT OPERATING.       :
                        ;        FOR (AH)= 6 - CARRY FLAG SET IF ALARM ALREADY ENABLED.                     :
                        ;        FOR THE ALARM FUNCTION (AH = 6) THE USER MUST SUPPLY A ROUTINE AND         :
                        ;          INTERCEPT THE CORRECT ADDRESS IN THE VECTOR TABLE FOR INTERRUPT 4AH.      :
                        ;          USE OFFH FOR ANY "DO NOT CARE" POSITION FOR INTERVAL INTERRUPTS.          :
                        ;        INTERRUPTS ARE DISABLED DURING DATA MODIFICATION.                          :
                        ;        AH & AL ARE RETURNED MODIFIED AND NOT DEFINED EXCEPT WHERE INDICATED.      :
                        ;-------------------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    TIME_OF_DAY_1   PROC    FAR
0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 80 FC 08                   CMP     AH,(RTC_TBE-RTC_TB)/2   ; CHECK IF COMMAND IN VALID RANGE (0-7)
0004 F5                         CMC                             ; COMPLEMENT CARRY FOR ERROR EXIT
0005 72 17                      JC      TIME_9                  ; EXIT WITH CARRY = 1 IF NOT VALID

0007 1E                         PUSH    DS                      ; SAVE USERS (DS) SEGMENT
0008 E8 0000 E                  CALL    DDS                     ; GET DATA SEGMENT SELECTOR
000B 56                         PUSH    SI                      ; SAVE WORK REGISTER
000C C1 E8 08                   SHR     AX,8                    ; CONVERT FUNCTION TO BYTE OFFSET
000F 03 C0                      ADD     AX,AX                   ; CONVERT FUNCTION TO WORD OFFSET (CY=0)
0011 8B F0                      MOV     SI,AX                   ; PLACE INTO ADDRESSING REGISTER
0013 FA                         CLI                             ; NO INTERRUPTS DURING TIME FUNCTIONS
0014 2E: FF 94 0021 R           CALL    CS:[SI]+OFFSET RTC_TB   ; VECTOR TO FUNCTION REQUESTED WITH CY=0
                                                                ;  RETURN WITH CARRY FLAG SET FOR RESULT
0019 FB                         STI                             ; INTERRUPTS BACK ON
001A B4 00                      MOV     AH,0                    ; CLEAR (AH) TO ZERO
001C 5E                         POP     SI                      ; RECOVER USERS REGISTER
001D 1F                         POP     DS                      ; RECOVER USERS SEGMENT SELECTOR
001E                    TIME_9:                                 ; RETURN WITH CY= 0 IF NO ERROR
001E CA 0002                    RET     2

                                                                ;       ROUTINE VECTOR TABLE (AH)=
0021 0031 R             RTC_TB  DW      RTC_00                  ; 0 = READ CURRENT CLOCK COUNT
0023 0042 R                     DW      RTC_10                  ; 1 = SET CLOCK COUNT
0025 0050 R                     DW      RTC_20                  ; 2 = READ THE REAL TIME CLOCK TIME
0027 0075 R                     DW      RTC_30                  ; 3 = SET REAL TIME CLOCK TIME
0029 00A8 R                     DW      RTC_40                  ; 4 = READ THE REAL TIME CLOCK DATE
002B 00CB R                     DW      RTC_50                  ; 5 = SET REAL TIME CLOCK DATE
002D 0104 R                     DW      RTC_60                  ; 6 = SET THE REAL TIME CLOCK ALARM
002F 0145 R                     DW      RTC_70                  ; 7 = RESET ALARM
= 0031                  RTC_TBE EQU     $

0031                    TIME_OF_DAY_1   ENDP
```

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                        PAGE
0031                    RTC_00  PROC    NEAR                    ;       READ TIME COUNT
0031 A0 0070 R                  MOV     AL,@TIMER_OFL           ; GET THE OVERFLOW FLAG
0034 C6 06 0070 R 00            MOV     @TIMER_OFL,0            ; AND THEN RESET THE OVERFLOW FLAG
0039 8B 0E 006E R               MOV     CX,@TIMER_HIGH          ; GET COUNT OF TIME HIGH WORD
003D 8B 16 006C R               MOV     DX,@TIMER_LOW           ; GET COUNT OF TIME LOW WORD
0041 C3                         RET                             ; RETURN WITH NO CARRY

0042                    RTC_10:                                 ;       SET TIME COUNT
0042 89 16 006C R               MOV     @TIMER_LOW,DX           ; SET TIME COUNT LOW WORD
0046 89 0E 006E R               MOV     @TIMER_HIGH,CX          ; SET THE TIME COUNT HIGH WORD
004A C6 06 0070 R 00            MOV     @TIMER_OFL,0            ; RESET OVERFLOW FLAG
004F C3                         RET                             ; RETURN WITH NO CARRY

0050                    RTC_20:                                 ;       GET RTC TIME
0050 E8 016B R                  CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
0053 72 1F                      JC      RTC_29                  ; EXIT IF ERROR (CY= 1)

0055 B0 00                      MOV     AL,CMOS_SECONDS         ; SET ADDRESS OF SECONDS
0057 E8 0000 E                  CALL    CMOS_READ               ; GET SECONDS
005A 8A F0                      MOV     DH,AL                   ; SAVE
005C B0 0B                      MOV     AL,CMOS_REG_B           ; ADDRESS ALARM REGISTER
005E E8 0000 E                  CALL    CMOS_READ               ; READ CURRENT VALUE OF DSE BIT
0061 24 01                      AND     AL,00000001B            ; MASK FOR VALID DSE BIT
0063 8A D0                      MOV     DL,AL                   ; SET (DL) TO ZERO FOR NO DSE BIT
0065 B0 02                      MOV     AL,CMOS_MINUTES         ; SET ADDRESS OF MINUTES
0067 E8 0000 E                  CALL    CMOS_READ               ; GET MINUTES
006A 8A C8                      MOV     CL,AL                   ; SAVE
006C B0 04                      MOV     AL,CMOS_HOURS           ; SET ADDRESS OF HOURS
006E E8 0000 E                  CALL    CMOS_READ               ; GET HOURS
0071 8A E8                      MOV     CH,AL                   ; SAVE
0073 F8                         CLC                             ; SET CY= 0
0074                    RTC_29:
0074 C3                         RET                             ; RETURN WITH RESULT IN CARRY FLAG

0075                    RTC_30:                                 ;       SET RTC TIME
0075 E8 016B R                  CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
0078 73 03                      JNC     RTC_35                  ; GO AROUND IF CLOCK OPERATING
007A E8 0154 R                  CALL    RTC_STA                 ; ELSE TRY INITIALIZING CLOCK
007D                    RTC_35:
007D 8A E6                      MOV     AH,DH                   ; GET TIME BYTE - SECONDS
007F B0 00                      MOV     AL,CMOS_SECONDS         ; ADDRESS SECONDS
0081 E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE SECONDS
0084 8A E1                      MOV     AH,CL                   ; GET TIME BYTE - MINUTES
0086 B0 02                      MOV     AL,CMOS_MINUTES         ; ADDRESS MINUTES
0088 E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE MINUTES
008B 8A E5                      MOV     AH,CH                   ; GET TIME BYTE - HOURS
008D B0 04                      MOV     AL,CMOS_HOURS           ; ADDRESS HOURS
008F E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE ADDRESS
0092 B8 0B0B                    MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER
0095 E8 0000 E                  CALL    CMOS_READ               ; READ CURRENT VALUE
0098 24 62                      AND     AL,01100010B            ; MASK FOR VALID BIT POSITIONS
009A 0C 02                      OR      AL,00000010B            ; TURN ON 24 HOUR MODE
009C 80 E2 01                   AND     DL,00000001B            ; USE ONLY THE DSE BIT
009F 0A C2                      OR      AL,DL                   ; GET DAY LIGHT SAVINGS TIME BIT (DSE)
00A1 86 E0                      XCHG    AH,AL                   ; PLACE IN WORK REGISTER AND GET ADDRESS
00A3 E8 0000 E                  CALL    CMOS_WRITE              ; SET NEW ALARM BITS
00A6 F8                         CLC                             ; SET CY= 0
00A7 C3                         RET                             ; RETURN WITH CY= 0

00A8                    RTC_40:                                 ;       GET RTC DATE
00A8 E8 016B R                  CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
00AB 72 1D                      JC      RTC_49                  ; EXIT IF ERROR (CY= 1)

00AD B0 07                      MOV     AL,CMOS_DAY_MONTH       ; ADDRESS DAY OF MONTH
00AF E8 0000 E                  CALL    CMOS_READ               ; READ DAY OF MONTH
00B2 8A D0                      MOV     DL,AL                   ; SAVE
00B4 B0 08                      MOV     AL,CMOS_MONTH           ; ADDRESS MONTH
00B6 E8 0000 E                  CALL    CMOS_READ               ; READ MONTH
00B9 8A F0                      MOV     DH,AL                   ; SAVE
00BB B0 09                      MOV     AL,CMOS_YEAR            ; ADDRESS YEAR
00BD E8 0000 E                  CALL    CMOS_READ               ; READ YEAR
00C0 8A C8                      MOV     CL,AL                   ; SAVE
00C2 B0 32                      MOV     AL,CMOS_CENTURY         ; ADDRESS CENTURY LOCATION
00C4 E8 0000 E                  CALL    CMOS_READ               ; GET CENTURY BYTE
00C7 8A E8                      MOV     CH,AL                   ; SAVE
00C9 F8                         CLC                             ; SET CY=0
00CA                    RTC_49:
00CA C3                         RET                             ; RETURN WITH RESULTS IN CARRY FLAG

00CB                    RTC_50:                                 ;       SET RTC DATE
00CB E8 016B R                  CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
00CE 73 03                      JNC     RTC_55                  ; GO AROUND IF NO ERROR
00D0 E8 0154 R                  CALL    RTC_STA                 ; ELSE INITIALIZE CLOCK
00D3                    RTC_55:
00D3 B8 0006                    MOV     AX,CMOS_DAY_WEEK        ; ADDRESS OF DAY OF WEEK BYTE
00D6 E8 0000 E                  CALL    CMOS_WRITE              ; LOAD ZEROS TO DAY OF WEEK
00D9 8A E2                      MOV     AH,DL                   ; GET DAY OF MONTH BYTE
00DB B0 07                      MOV     AL,CMOS_DAY_MONTH       ; ADDRESS DAY OF MONTH BYTE
00DD E8 0000 E                  CALL    CMOS_WRITE              ; WRITE OF DAY OF MONTH REGISTER
00E0 8A E6                      MOV     AH,DH                   ; GET MONTH
00E2 B0 08                      MOV     AL,CMOS_MONTH           ; ADDRESS MONTH BYTE
00E4 E8 0000 E                  CALL    CMOS_WRITE              ; WRITE MONTH REGISTER
00E7 8A E1                      MOV     AH,CL                   ; GET YEAR BYTE
00E9 B0 09                      MOV     AL,CMOS_YEAR            ; ADDRESS YEAR REGISTER
00EB E8 0000 E                  CALL    CMOS_WRITE              ; WRITE YEAR REGISTER
00EE 8A E5                      MOV     AH,CH                   ; GET CENTURY BYTE
00F0 B0 32                      MOV     AL,CMOS_CENTURY         ; ADDRESS CENTURY BYTE
00F2 E8 0000 E                  CALL    CMOS_WRITE              ; WRITE CENTURY LOCATION
00F5 B8 0B0B                    MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER
00F8 E8 0000 E                  CALL    CMOS_READ               ; READ CURRENT SETTINGS
00FB 24 7F                      AND     AL,07FH                 ; CLEAR 'SET BIT'
00FD 86 E0                      XCHG    AH,AL                   ; MOVE TO WORK REGISTER
00FF E8 0000 E                  CALL    CMOS_WRITE              ;  AND START CLOCK UPDATING
0102 F8                         CLC                             ; SET CY= 0
0103 C3                         RET                             ; RETURN CY=0

0104                    RTC_60:                                 ;       SET RTC ALARM
0104 B0 0B                      MOV     AL,CMOS_REG_B           ; ADDRESS ALARM
0106 E8 0000 E                  CALL    CMOS_READ               ; READ ALARM REGISTER
0109 A8 20                      TEST    AL,20H                  ; CHECK FOR ALARM ALREADY ENABLED
010B F9                         STC                             ; SET CARRY IN CASE OF ERROR
010C 75 33                      JNZ     RTC_69                  ; ERROR EXIT IF ALARM SET
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010E E8 016B R                  CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
0111 73 03                      JNC     RTC_65                  ; SKIP INITIALIZATION IF NO ERROR
0113 E8 0154 R                  CALL    RTC_STA                 ; ELSE INITIALIZE CLOCK
0116                    RTC_65:
0116 8A E6                      MOV     AH,DH                   ; GET SECONDS BYTE
0118 B0 01                      MOV     AL,CMOS_SEC_ALARM       ; ADDRESS THE SECONDS ALARM REGISTER
011A E8 0000 E                  CALL    CMOS_WRITE              ; INSERT SECONDS
011D 8A E1                      MOV     AH,CL                   ; GET MINUTES PARAMETER
011F B0 03                      MOV     AL,CMOS_MIN_ALARM       ; ADDRESS MINUTES ALARM REGISTER
0121 E8 0000 E                  CALL    CMOS_WRITE              ; INSERT MINUTES
0124 8A E5                      MOV     AH,CH                   ; GET HOURS PARAMETER
0126 B0 05                      MOV     AL,CMOS_HR_ALARM        ; ADDRESS HOUR ALARM REGISTER
0128 E8 0000 E                  CALL    CMOS_WRITE              ; INSERT HOURS
012B E4 A1                      IN      AL,INTB01               ; READ SECOND INTERRUPT MASK REGISTER
012D 24 FE                      AND     AL,0FEH                 ; ENABLE ALARM TIMER BIT (CY= 0)
012F E6 A1                      OUT     INTB01,AL               ; WRITE UPDATED MASK
0131 B8 0B0B                    MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER
0134 E8 0000 E                  CALL    CMOS_READ               ; READ CURRENT ALARM REGISTER
0137 24 7F                      AND     AL,07FH                 ; ENSURE SET BIT TURNED OFF
0139 0C 20                      OR      AL,20H                  ; TURN ON ALARM ENABLE
013B 86 E0                      XCHG    AH,AL                   ; MOVE MASK TO OUTPUT REGISTER
013D E8 0000 E                  CALL    CMOS_WRITE              ; WRITE NEW ALARM MASK
0140 F8                         CLC                             ; SET CY= 0
0141                    RTC_69:
0141 B8 0000                    MOV     AX,0                    ; CLEAR AX REGISTER
0144 C3                         RET                             ; RETURN WITH RESULTS IN CARRY FLAG

0145                    RTC_70:                                 ;       RESET ALARM
0145 B8 0B0B                    MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER (TO BOTH AH,AL)
0148 E8 0000 E                  CALL    CMOS_READ               ; READ ALARM REGISTER
014B 24 57                      AND     AL,57H                  ; TURN OFF ALARM ENABLE
014D 86 E0                      XCHG    AH,AL                   ; SAVE DATA AND RECOVER ADDRESS
014F E8 0000 E                  CALL    CMOS_WRITE              ; RESTORE NEW VALUE
0152 F8                         CLC                             ; SET CY= 0
0153 C3                         RET                             ; RETURN WITH NO CARRY

0154                    RTC_00  ENDP

0154                    RTC_STA PROC    NEAR                    ;       INITIALIZE REAL TIME CLOCK
0154 B8 260A                    MOV     AX,26H*H+CMOS_REG_A     ; ADDRESS REGISTER A AND LOAD DATA MASK
0157 E8 0000 E                  CALL    CMOS_WRITE              ; INITIALIZE STATUS REGISTER A
015A B8 820B                    MOV     AX,82H*H+CMOS_REG_B     ; SET "SET BIT" FOR CLOCK INITIALIZATION
015D E8 0000 E                  CALL    CMOS_WRITE              ; AND 24 HOUR MODE TO REGISTER B
0160 B0 0C                      MOV     AL,CMOS_REG_C           ; ADDRESS REGISTER C
0162 E8 0000 E                  CALL    CMOS_READ               ; READ REGISTER C TO INITIALIZE
0165 B0 0D                      MOV     AL,CMOS_REG_D           ; ADDRESS REGISTER D
0167 E8 0000 E                  CALL    CMOS_READ               ; READ REGISTER D TO INITIALIZE
016A C3                         RET

016B                    RTC_STA ENDP

016B                    UPD_IPR PROC    NEAR                    ;       WAIT TILL UPDATE NOT IN PROGRESS
016B 51                         PUSH    CX                      ; SAVE CALLERS REGISTER
016C B9 0320                    MOV     CX,800                  ; SET TIMEOUT LOOP COUNT
016F                    UPD_10:
016F B0 0A                      MOV     AL,CMOS_REG_A           ; ADDRESS STATUS REGISTER A
0171 FA                         CLI                             ; NO TIMER INTERRUPTS DURING UPDATES
0172 E8 0000 E                  CALL    CMOS_READ               ; READ UPDATE IN PROCESS FLAG
0175 A8 80                      TEST    AL,80H                  ; IF UIP BIT IS ON ( CANNOT READ TIME )
0177 74 06                      JZ      UPD_90                  ; EXIT WITH CY= 0 IF CAN READ CLOCK NOW
0179 FB                         STI                             ; ALLOW INTERRUPTS WHILE WAITING
017A E2 F3                      LOOP    UPD_10                  ; LOOP TILL READY OR TIMEOUT
017C 33 C0                      XOR     AX,AX                   ; CLEAR RESULTS IF ERROR
017E F9                         STC                             ; SET CARRY FOR ERROR
017F                    UPD_90:
017F 59                         POP     CX                      ; RESTORE CALLERS REGISTER
0180 FA                         CLI                             ; INTERRUPTS OFF DURING SET
0181 C3                         RET                             ; RETURN WITH CY FLAG SET

0182                    UPD_IPR ENDP
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                        PAGE
                        ;--- HARDWARE INT  70 H -- ( IRQ LEVEL  8 ) ----------------------------------
                        ; ALARM INTERRUPT HANDLER (RTC)                                              :
                        ;       THIS ROUTINE HANDLES THE PERIODIC AND ALARM INTERRUPTS FROM THE CMOS  :
                        ;       TIMER.  INPUT FREQUENCY IS 1.024 KHZ OR APPROXIMATELY 1024 INTERRUPTS :
                        ;       EVERY SECOND FOR THE PERIODIC INTERRUPT.  FOR THE ALARM FUNCTION,     :
                        ;       THE INTERRUPT WILL OCCUR AT THE DESIGNATED TIME.                      :
                        ;                                                                             :
                        ;       INTERRUPTS ARE ENABLED WHEN THE EVENT OR ALARM FUNCTION IS ACTIVATED. :
                        ;       FOR THE EVENT INTERRUPT, THE HANDLER WILL DECREMENT THE WAIT COUNTER   :
                        ;       AND WHEN IT EXPIRES WILL SET THE DESIGNATED LOCATION TO 80H.  FOR      :
                        ;       THE ALARM INTERRUPT, THE USER MUST PROVIDE A ROUTINE TO INTERCEPT      :
                        ;       THE CORRECT ADDRESS FROM THE VECTOR TABLE INVOKED BY INTERRUPT 4AH     :
                        ;       PRIOR TO SETTING THE REAL TIME CLOCK ALARM (INT 1AH, AH= 06H).        :
                        ;-------------------------------------------------------------------------------

0182                    RTC_INT PROC    FAR                     ;       ALARM INTERRUPT
0182 1E                         PUSH    DS                      ; LEAVE INTERRUPTS DISABLED
0183 50                         PUSH    AX                      ; SAVE REGISTERS
0184 57                         PUSH    DI

0185                    RTC_I_1:                                ;       CHECK FOR SECOND INTERRUPT
0185 B8 8B8C                    MOV     AX,(CMOS_REG_B+NMI)*H+CMOS_REG_C+NMI ; ALARM AND STATUS
0188 E6 70                      OUT     CMOS_PORT,AL            ; WRITE ALARM FLAG MASK ADDRESS
018A 90                         NOP                             ; I/O DELAY
018B E4 71                      IN      AL,CMOS_DATA            ; READ AND RESET INTERRUPT REQUEST FLAGS
018D A8 60                      TEST    AL,01100000B            ; CHECK FOR EITHER INTERRUPT PENDING
018F 74 4D                      JZ      RTC_I_9                 ; EXIT IF NOT A VALID RTC INTERRUPT

0191 86 E0                      XCHG    AH,AL                   ; SAVE FLAGS AND GET ENABLE ADDRESS
0193 E6 70                      OUT     CMOS_PORT,AL            ; WRITE ALARM ENABLE MASK ADDRESS
0195 90                         NOP                             ; I/O DELAY
0196 E4 71                      IN      AL,CMOS_DATA            ; READ CURRENT ALARM ENABLE MASK
0198 22 C4                      AND     AL,AH                   ; ALLOW ONLY SOURCES THAT ARE ENABLED
019A A8 40                      TEST    AL,01000000B            ; CHECK FOR PERIODIC INTERRUPT
019C 74 30                      JZ      RTC_I_5                 ; SKIP IF NOT A PERIODIC INTERRUPT

                        ;-----  DECREMENT WAIT COUNT BY INTERRUPT INTERVAL

019E E8 0000 E                  CALL    DDS                     ; ESTABLISH DATA SEGMENT ADDRESSABILITY
01A1 81 2E 009C R 03D0          SUB     @RTC_LOW,0976           ; DECREMENT COUNT LOW BY 1/1024
01A7 83 1E 009E R 00            SBB     @RTC_HIGH,0             ; ADJUST HIGH WORD FOR LOW WORD BORROW
01AC 73 20                      JNC     RTC_I_5                 ; SKIP TILL 32 BIT WORD LESS THAN ZERO

                        ;-----  TURN OFF PERIODIC INTERRUPT ENABLE

01AE 50                         PUSH    AX                      ; SAVE INTERRUPT FLAG MASK
01AF B8 8B8B                    MOV     AX,X*(CMOS_REG_B+NMI)   ; INTERRUPT ENABLE REGISTER
01B2 E6 70                      OUT     CMOS_PORT,AL            ; WRITE ADDRESS TO CMOS CLOCK
01B4 90                         NOP                             ; I/O DELAY
01B5 E4 71                      IN      AL,CMOS_DATA            ; READ CURRENT ENABLES
01B7 24 BF                      AND     AL,0BFH                 ; TURN OFF PIE
01B9 86 C4                      XCHG    AL,AH                   ; GET CMOS ADDRESS AND SAVE VALUE
01BB E6 70                      OUT     CMOS_PORT,AL            ; ADDRESS REGISTER B
01BD 86 C4                      XCHG    AL,AH                   ; GET NEW INTERRUPT ENABLE MASK
01BF E6 71                      OUT     CMOS_DATA,AL            ; SET MASK IN INTERRUPT ENABLE REGISTER
01C1 C6 06 00A0 R 00            MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION ACTIVE FLAG OFF
01C6 C5 3E 0098 R               LDS     DI,DWORD PTR @USER_FLAG ; SET UP (DS:DI) TO POINT TO USER FLAG
01CA C6 05 80                   MOV     BYTE PTR [DI],80H       ; TURN ON USERS FLAG
01CD 58                         POP     AX                      ; GET INTERRUPT SOURCE BACK
01CE                    RTC_I_5:
01CE A8 20                      TEST    AL,00100000B            ; TEST FOR ALARM INTERRUPT
01D0 74 0A                      JZ      RTC_I_7                 ; SKIP USER INTERRUPT CALL IF NOT ALARM

01D2 B0 0D                      MOV     AL,CMOS_REG_D           ; POINT TO DEFAULT READ ONLY REGISTER
01D4 E6 70                      OUT     CMOS_PORT,AL            ; ENABLE NMI AND CMOS ADDRESS TO DEFAULT
01D6 FB                         STI                             ; INTERRUPTS BACK ON NOW
01D7 52                         PUSH    DX
01D8 CD 4A                      INT     4AH                     ; TRANSFER TO USER ROUTINE
01DA 5A                         POP     DX
01DB FA                         CLI                             ; BLOCK INTERRUPT FOR RETRY
01DC                    RTC_I_7:                                ; RESTART ROUTINE TO HANDLE DELAYED
01DC EB A7                      JMP     RTC_I_1                 ;  ENTRY AND SECOND EVENT BEFORE DONE


01DE                    RTC_I_9:                                ;       EXIT - NO PENDING INTERRUPTS
01DE B0 0D                      MOV     AL,CMOS_REG_D           ; POINT TO DEFAULT READ ONLY REGISTER
01E0 E6 70                      OUT     CMOS_PORT,AL            ; ENABLE NMI AND CMOS ADDRESS TO DEFAULT
01E2 B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT MASK TO 8259 - 2
01E4 E6 A0                      OUT     INTB00,AL               ;  TO 8259 - 2
01E6 E6 20                      OUT     INTA00,AL               ;  TO 8259 - 1
01E8 5F                         POP     DI                      ; RESTORE REGISTERS
01E9 58                         POP     AX
01EA 1F                         POP     DS
01EB CF                         IRET                            ; END OF INTERRUPT

01EC                    RTC_INT ENDP
```

SECTION 5

```
                        PAGE
                        ;--- INT  05 H ----------------------------------------------------------------
                        ; PRINT_SCREEN                                                               :
                        ;       THIS LOGIC WILL BE INVOKED BY INTERRUPT 05H TO PRINT THE SCREEN.     :
                        ;       THE CURSOR POSITION AT THE TIME THIS ROUTINE IS INVOKED WILL BE      :
                        ;       SAVED AND RESTORED UPON COMPLETION.  THE ROUTINE IS INTENDED TO      :
                        ;       RUN WITH INTERRUPTS ENABLED.   IF A SUBSEQUENT PRINT SCREEN KEY      :
                        ;       IS DEPRESSED WHILE THIS ROUTINE IS PRINTING IT WILL BE IGNORED.      :
                        ;       THE BASE PRINTERS STATUS IS CHECKED FOR NOT BUSY AND NOT OUT OF      :
                        ;       PAPER.  AN INITIAL STATUS ERROR WILL ABEND THE PRINT REQUEST.        :
                        ;       ADDRESS  0050:0000  CONTAINS THE STATUS OF THE PRINT SCREEN:         :
                        ;                                                                            :
                        ;       50:0    = 0     PRINT SCREEN HAS NOT BEEN CALLED OR UPON RETURN      :
                        ;                        FROM A CALL THIS INDICATES A SUCCESSFUL OPERATION.  :
                        ;               = 1     PRINT SCREEN IS IN PROGRESS - IGNORE THIS REQUEST.   :
                        ;               = 255   ERROR ENCOUNTERED DURING PRINTING.                   :
                        ;--------------------------------------------------------------------------
                        ;
01EC                    PRINT_SCREEN_1  PROC    FAR
                                                                ; DELAY INTERRUPT ENABLE TILL FLAG SET
01EC 1E                         PUSH    DS
01ED 50                         PUSH    AX                      ; SAVE WORK REGISTERS
01EE 53                         PUSH    BX
01EF 51                         PUSH    CX
01F0 52                         PUSH    DX                      ; USE 0040:0100 FOR STATUS AREA STORAGE
01F1 E8 0000 E                  CALL    DDS                     ; GET STATUS_BYTE DATA SEGMENT
01F4 80 3E 0100 R 01            CMP     @STATUS_BYTE,1          ; SEE IF PRINT ALREADY IN PROGRESS
01F9 74 74                      JE      PRI90                   ; EXIT IF PRINT ALREADY IN PROGRESS
01FB C6 06 0100 R 01            MOV     @STATUS_BYTE,1          ; INDICATE PRINT NOW IN PROGRESS
0200 FB                         STI                             ; MUST RUN WITH INTERRUPTS ENABLED
0201 B4 0F                      MOV     AH,0FH                  ; WILL REQUEST THE CURRENT SCREEN MODE
0203 CD 10                      INT     10H                     ;       (AL)= MODE
                                                                ;       (AH)= NUMBER COLUMNS/LINE
                                                                ;       (BH)= VISUAL PAGE
0205 8A CC                      MOV     CL,AH                   ; WILL MAKE USE OF (CX) REGISTER TO
0207 8A 2E 0084 R               MOV     CH,@ROWS                ;  CONTROL ROWS ON SCREEN & COLUMNS
020B FE C5                      INC     CH                      ; ADJUST ROWS ON DISPLAY COUNT
                                                                ;       (CL)= NUMBER COLUMNS/LINE
                                                                ;       (CH)= NUMBER OF ROWS ON DISPLAY
                                ;---------------------------------------------------------------
                                ;       AT THIS POINT WE KNOW THE COLUMNS/LINE COUNT IS IN (CL) :
                                ;       AND THE NUMBER OF ROWS ON THE DISPLAY IS IN (CH).       :
                                ;       THE PAGE IF APPLICABLE IS IN (BH).  THE STACK HAS       :
                                ;       (DS),(AX),(BX),(CX),(DX)  PUSHED.                       :
                                ;---------------------------------------------------------------
020D 33 D2                      XOR     DX,DX                   ; FIRST PRINTER
020F B4 02                      MOV     AH,02H                  ; SET PRINTER STATUS REQUEST COMMAND
0211 CD 17                      INT     17H                     ; REQUEST CURRENT PRINTER STATUS
0213 80 F4 80                   XOR     AH,080H                 ; CHECK FOR PRINTER BUSY (NOT CONNECTED)
0216 F6 C4 A0                   TEST    AH,0A0H                 ;  OR  OUT OF PAPER
0219 75 4E                      JNZ     PRI80                   ; ERROR EXIT IF PRINTER STATUS ERROR

021B E8 0275 R                  CALL    CRLF                    ; CARRIAGE RETURN LINE FEED TO PRINTER

021E 51                         PUSH    CX                      ; SAVE SCREEN BOUNDS
021F B4 03                      MOV     AH,03H                  ; NOW READ THE CURRENT CURSOR POSITION
0221 CD 10                      INT     10H                     ; AND RESTORE AT END OF ROUTINE
0223 59                         POP     CX                      ; RECALL SCREEN BOUNDS
0224 52                         PUSH    DX                      ; PRESERVE THE ORIGINAL POSITION
0225 33 D2                      XOR     DX,DX                   ; INITIAL CURSOR (0,0) AND FIRST PRINTER
                                ;---------------------------------------------------------------
                                ;       THIS LOOP IS TO READ EACH CURSOR POSITION FROM THE      :
                                ;       SCREEN AND PRINT IT.   (BH)= VISUAL PAGE   (CH)= ROWS   :
                                ;---------------------------------------------------------------
0227                    PRI10:
0227 B4 02                      MOV     AH,02H                  ; INDICATE CURSOR SET REQUEST
0229 CD 10                      INT     10H                     ; NEW CURSOR POSITION ESTABLISHED
022B B4 08                      MOV     AH,08H                  ; INDICATE READ CHARACTER FROM DISPLAY
022D CD 10                      INT     10H                     ; CHARACTER NOW IN (AL)
022F 0A C0                      OR      AL,AL                   ; SEE IF VALID CHAR
0231 75 02                      JNZ     PRI20                   ; JUMP IF VALID CHAR
0233 B0 20                      MOV     AL,' '                  ; ELSE MAKE IT A BLANK
0235                    PRI20:
0235 52                         PUSH    DX                      ; SAVE CURSOR POSITION
0236 33 D2                      XOR     DX,DX                   ; INDICATE FIRST PRINTER (DX= 0)
0238 32 E4                      XOR     AH,AH                   ; INDICATE PRINT CHARACTER IN (AL)
023A CD 17                      INT     17H                     ; PRINT THE CHARACTER
023C 5A                         POP     DX                      ; RECALL CURSOR POSITION
023D F6 C4 29                   TEST    AH,29H                  ; TEST FOR PRINTER ERROR
0240 75 22                      JNZ     PRI70                   ; EXIT IF ERROR DETECTED
0242 FE C2                      INC     DL                      ; ADVANCE TO NEXT COLUMN
0244 3A CA                      CMP     CL,DL                   ; SEE IF AT END OF LINE
0246 75 DF                      JNZ     PRI10                   ; IF NOT LOOP FOR NEXT COLUMN
0248 32 D2                      XOR     DL,DL                   ; BACK TO COLUMN 0
024A 8A E2                      MOV     AH,DL                   ; (AH)=0
024C 52                         PUSH    DX                      ; SAVE NEW CURSOR POSITION
024D E8 0275 R                  CALL    CRLF                    ; LINE FEED CARRIAGE RETURN
0250 5A                         POP     DX                      ; RECALL CURSOR POSITION
0251 FE C6                      INC     DH                      ; ADVANCE TO NEXT LINE
0253 3A EE                      CMP     CH,DH                   ; FINISHED?
0255 75 D0                      JNZ     PRI10                   ; IF NOT LOOP FOR NEXT LINE

0257 5A                         POP     DX                      ; GET CURSOR POSITION
0258 B4 02                      MOV     AH,02H                  ; INDICATE REQUEST CURSOR SET
025A CD 10                      INT     10H                     ; CURSOR POSITION RESTORED
025C FA                         CLI                             ; BLOCK INTERRUPTS TILL STACK CLEARED
025D C6 06 0100 R 00            MOV     @STATUS_BYTE,0          ; MOVE OK RESULTS FLAG TO STATUS_BYTE
0262 EB 0B                      JMP     SHORT PRI90             ; EXIT PRINTER ROUTINE

0264                    PRI70:                                  ;       ERROR EXIT
0264 5A                         POP     DX                      ; GET CURSOR POSITION
0265 B4 02                      MOV     AH,02H                  ; INDICATE REQUEST CURSOR SET
0267 CD 10                      INT     10H                     ; CURSOR POSITION RESTORED
0269                    PRI80:
0269 FA                         CLI                             ; BLOCK INTERRUPTS TILL STACK CLEARED
026A C6 06 0100 R FF            MOV     @STATUS_BYTE,0FFH       ; SET ERROR FLAG
026F                    PRI90:
026F 5A                         POP     DX                      ;       EXIT ROUTINE
0270 59                         POP     CX                      ; RESTORE ALL THE REGISTERS USED
0271 5B                         POP     BX
0272 58                         POP     AX
0273 1F                         POP     DS
0274 CF                         IRET                            ; RETURN WITH INITIAL INTERRUPT MASK
0275                    PRINT_SCREEN_1  ENDP
```

```
                        ;-----  CARRIAGE RETURN, LINE FEED SUBROUTINE

0275                    CRLF    PROC    NEAR
                                                        ;       SEND CR,LF TO FIRST PRINTER
0275 33 D2                      XOR     DX,DX           ; ASSUME FIRST PRINTER (DX= 0)
0277 B8 000D                    MOV     AX,CR           ; GET THE PRINT CHARACTER COMMAND AND
027A CD 17                      INT     17H             ;   THE CARRIAGE RETURN CHARACTER
027C B8 000A                    MOV     AX,LF           ; NOW GET THE LINE FEED AND
027F CD 17                      INT     17H             ;   SEND IT TO THE BIOS PRINTER ROUTINE
0281 C3                         RET
0282                    CRLF    ENDP


                        ;-- HARDWARE INT  08 H -- ( IRQ LEVEL 0 ) ------------------------------------
                        ;                                                                              :
                        ;       THIS ROUTINE HANDLES THE TIMER INTERRUPT FROM FROM CHANNEL 0 OF         :
                        ;       THE 8254 TIMER.  INPUT FREQUENCY IS 1.19318 MHZ AND THE DIVISOR        :
                        ;       IS 65536, RESULTING IN APPROXIMATELY 18.2 INTERRUPTS EVERY SECOND.     :
                        ;                                                                              :
                        ;       THE INTERRUPT HANDLER MAINTAINS A COUNT (40:6C) OF INTERRUPTS SINCE     :
                        ;       POWER ON TIME, WHICH MAY BE USED TO ESTABLISH TIME OF DAY.             :
                        ;       THE INTERRUPT HANDLER ALSO DECREMENTS THE MOTOR CONTROL COUNT (40:40)  :
                        ;       OF THE DISKETTE, AND WHEN IT EXPIRES, WILL TURN OFF THE                :
                        ;       DISKETTE MOTOR(S), AND RESET THE MOTOR RUNNING FLAGS.                  :
                        ;       THE INTERRUPT HANDLER WILL ALSO INVOKE A USER ROUTINE THROUGH           :
                        ;       INTERRUPT 1CH AT EVERY TIME TICK.  THE USER MUST CODE A                :
                        ;       ROUTINE AND PLACE THE CORRECT ADDRESS IN THE VECTOR TABLE.             :
                        ;------------------------------------------------------------------------------

0282                    TIMER_INT_1     PROC    FAR
0282 FB                         STI                     ; INTERRUPTS BACK ON
0283 1E                         PUSH    DS
0284 50                         PUSH    AX
0285 52                         PUSH    DX              ; SAVE MACHINE STATE
0286 E8 0000 E                  CALL    DDS             ; ESTABLISH ADDRESSABILITY
0289 FF 06 006C R               INC     @TIMER_LOW      ; INCREMENT TIME
028D 75 04                      JNZ     T4              ; GO TO TEST_DAY
028F FF 06 006E R               INC     @TIMER_HIGH     ; INCREMENT HIGH WORD OF TIME
                                                        ;       TEST_DAY
0293 83 3E 006E R 18    T4:     CMP     @TIMER_HIGH,018H        ; TEST FOR COUNT EQUALING 24 HOURS
0298 75 15                      JNZ     T5              ; GO TO DISKETTE_CTL
029A 81 3E 006C R 00B0          CMP     @TIMER_LOW,0B0H
02A0 75 0D                      JNZ     T5              ; GO TO DISKETTE_CTL

                        ;-----  TIMER HAS GONE 24 HOURS

02A2 2B C0                      SUB     AX,AX
02A4 A3 006E R                  MOV     @TIMER_HIGH,AX
02A7 A3 006C R                  MOV     @TIMER_LOW,AX
02AA C6 06 0070 R 01            MOV     @TIMER_OFL,1

                        ;-----  TEST FOR DISKETTE TIME OUT

02AF                    T5:
02AF FE 0E 0040 R               DEC     @MOTOR_COUNT            ; DECREMENT DISKETTE MOTOR CONTROL
02B3 75 0B                      JNZ     T6              ; RETURN IF COUNT NOT OUT
02B5 80 26 003F R F0            AND     @MOTOR_STATUS,0F0H      ; TURN OFF MOTOR RUNNING BITS
02BA B0 0C                      MOV     AL,0CH
02BC BA 03F2                    MOV     DX,03F2H        ; FDC CTL PORT
02BF EE                         OUT     DX,AL           ; TURN OFF THE MOTOR

02C0                    T6:                             ;       TIMER TICK INTERRUPT
02C0 CD 1C                      INT     1CH             ; TRANSFER CONTROL TO A USER ROUTINE

02C2 5A                         POP     DX              ; RESTORE (DX)
02C3 B0 20                      MOV     AL,EOI          ; GET END OF INTERRUPT MASK
02C5 FA                         CLI                     ; DISABLE INTERRUPTS TILL STACK CLEARED
02C6 E6 20                      OUT     INTA00,AL       ; END OF INTERRUPT TO 8259 - 1
02C8 58                         POP     AX
02C9 1F                         POP     DS              ; RESET MACHINE STATE
02CA CF                         IRET                    ; RETURN FROM INTERRUPT

02CB                    TIMER_INT_1     ENDP

02CB                    CODE    ENDS
                                END
```

```
                        PAGE 118,121
                        TITLE ORGS ----- 06/10/85  COMPATIBILITY MODULE
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  A1
                                PUBLIC  CONF_TBL
                                PUBLIC  CRT_CHAR_GEN
                                PUBLIC  D1
                                PUBLIC  D2
                                PUBLIC  D2A
                                PUBLIC  DISK_BASE
                                PUBLIC  DUMMY_RETURN
                                PUBLIC  E101
                                PUBLIC  E102
                                PUBLIC  E103
                                PUBLIC  E104
                                PUBLIC  E105
                                PUBLIC  E106
                                PUBLIC  E107
                                PUBLIC  E108
                                PUBLIC  E109
                                PUBLIC  E161
                                PUBLIC  E162
                                PUBLIC  E163
                                PUBLIC  E164
                                PUBLIC  E201
                                PUBLIC  E202
                                PUBLIC  E203
                                PUBLIC  E301
                                PUBLIC  E302
                                PUBLIC  E303
                                PUBLIC  E304
                                PUBLIC  E401
                                PUBLIC  E501
                                PUBLIC  E601
                                PUBLIC  E602
                                PUBLIC  F1780
                                PUBLIC  F1781
                                PUBLIC  F1782
                                PUBLIC  F1790
                                PUBLIC  F1791
                                PUBLIC  F3A
                                PUBLIC  F3D
                                PUBLIC  F3D1
                                PUBLIC  FD_TBL
                                PUBLIC  FLOPPY
                                PUBLIC  HRD
                                PUBLIC  K10
                                PUBLIC  K11
                                PUBLIC  K12
                                PUBLIC  K13
                                PUBLIC  K14
                                PUBLIC  K15
                                PUBLIC  K6
                                PUBLIC  K6L
                                PUBLIC  K7
                                PUBLIC  K8
                                PUBLIC  K9
                                PUBLIC  M4
                                PUBLIC  M5
                                PUBLIC  M6
                                PUBLIC  M7
                                PUBLIC  NMI_INT
                                PUBLIC  PRINT_SCREEN
                                PUBLIC  P_O_R
                                PUBLIC  SEEKS_1
                                PUBLIC  SLAVE_VECTOR_TABLE
                                PUBLIC  TUTOR
                                PUBLIC  VECTOR_TABLE
                                PUBLIC  VIDEO_PARMS

                                EXTRN   BOOT_STRAP_1:NEAR
                                EXTRN   CASSETTE_IO_1:NEAR
                                EXTRN   D11:NEAR
                                EXTRN   DISK_INT_1:NEAR
                                EXTRN   DISK_SETUP:NEAR
                                EXTRN   DISKETTE_IO_1:NEAR
                                EXTRN   DSKETTE_SETUP:NEAR
                                EXTRN   EQUIPMENT_1:NEAR
                                EXTRN   INT_287:NEAR
                                EXTRN   K16:NEAR
                                EXTRN   KEYBOARD_IO_1:NEAR
                                EXTRN   KB_INT_1:NEAR
                                EXTRN   MEMORY_SIZE_DET_1:NEAR
                                EXTRN   NMI_INT_1:NEAR
                                EXTRN   PRINT_SCREEN_1:NEAR
                                EXTRN   PRINTER_IO_1:NEAR
                                EXTRN   RE_DIRECT:NEAR
                                EXTRN   RS232_IO_1:NEAR
                                EXTRN   RTC_INT:NEAR
                                EXTRN   SEEK:NEAR
                                EXTRN   START_1:NEAR
                                EXTRN   TIME_OF_DAY_1:NEAR
                                EXTRN   TIMER_INT_1:NEAR
                                EXTRN   VIDEO_IO_1:NEAR

                                ASSUME  CS:CODE,DS:DATA

                        ;-----------------------------------------------------------------------------
                        ;                                                                             :
                        ;  THIS MODULE HAS BEEN ADDED TO FACILITATE THE EXPANSION OF THIS PROGRAM.    :
                        ;  IT ALLOWS FOR THE FIXED ORG STATEMENT ENTRY POINTS THAT HAVE TO REMAIN     :
                        ;  AT THE SAME ADDRESSES.   THE USE OF ENTRY POINTS AND TABLES WITHIN THIS    :
                        ;  MODULE SHOULD BE AVOIDED AND ARE INCLUDED ONLY TO SUPPORT EXISTING CODE    :
                        ;  THAT VIOLATE THE STRUCTURE AND DESIGN OF BIOS.   ALL BIOS ACCESS SHOULD    :
                        ;  USE THE DOCUMENTED INTERRUPT VECTOR INTERFACE FOR COMPATIBILITY.           :
                        ;                                                                             :
                        ;-----------------------------------------------------------------------------
```

```
                                PAGE
                                ;--------------------------------
                                ;       COPYRIGHT NOTICE        :
                                ;--------------------------------
                                ;;-     ORG     0E000H
0000                            ;       ORG     00000H
0000 36 34 38 30 30 39          DB      '6480090 COPR. IBM 1981, 1985
     30 20 43 4F 50 52
     2E 20 49 42 4D 20
     31 39 38 31 2C 20
     31 39 38 35 20 20
     20 20
                                ;----------------------------------------
                                ;       PARITY ERROR MESSAGES           :
                                ;----------------------------------------
0020 50 41 52 49 54 59          D1      DB      'PARITY CHECK 1',CR,LF  ; PLANAR BOARD PARITY CHECK LATCH SET
     20 43 48 45 43 4B
     20 31 0D 0A
0030 50 41 52 49 54 59          D2      DB      'PARITY CHECK 2',CR,LF  ; I/O CHANNEL CHECK LATCH SET
     20 43 48 45 43 4B
     20 32 0D 0A
0040 3F 3F 3F 3F 3F 0D          D2A     DB      '?????',CR,LF
     0A
= 0047                          IP      =       $
                                ;;-     ORG     0E05BH
005B                            ;       ORG     0005BH
005B                            RESET:
005B E9 0000 E                          JMP     START_1                 ; VECTOR ON TO THE MOVED POST CODE
                                ;--------------------------------
                                ;       POST ERROR MESSAGES     :
                                ;--------------------------------
005E 20 31 30 31 2D 53          E101    DB      ' 101-System Board Error',CR,LF ; INTERRUPT FAILURE
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
0077 20 31 30 32 2D 53          E102    DB      ' 102-System Board Error',CR,LF ; TIMER FAILURE
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
0090 20 31 30 33 2D 53          E103    DB      ' 103-System Board Error',CR,LF ; TIMER INTERRUPT FAILURE
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
00A9 20 31 30 34 2D 53          E104    DB      ' 104-System Board Error',CR,LF ; PROTECTED MODE FAILURE
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
00C2 20 31 30 35 2D 53          E105    DB      ' 105-System Board Error',CR,LF ; LAST 8042 COMMAND NOT ACCEPTED
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
00DB 20 31 30 36 2D 53          E106    DB      ' 106-System Board Error',CR,LF ; CONVERTING LOGIC TEST
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
00F4 20 31 30 37 2D 53          E107    DB      ' 107-System Board Error',CR,LF ; HOT NMI TEST
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
010D 20 31 30 38 2D 53          E108    DB      ' 108-System Board Error',CR,LF ; TIMER BUS TEST
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
0126 20 31 30 39 2D 53          E109    DB      ' 109-System Board Error',CR,LF ; LOW MEG CHIP SELECT TEST
     79 73 74 65 6D 20
     42 6F 61 72 64 20
     45 72 72 6F 72 0D
     0A
013F 20 31 36 31 2D 53          E161    DB      ' 161-System Options Not Set-(Run SETUP)',CR,LF ; DEAD BATTERY
     79 73 74 65 6D 20
     4F 70 74 69 6F 6E
     73 20 4E 6F 74 20
     53 65 74 2D 28 52
     75 6E 20 53 45 54
     55 50 29 0D 0A
0168 20 31 36 32 2D 53          E162    DB      ' 162-System Options Not Set-(Run SETUP)',CR,LF ;CHECKSUM/CONFIG
     79 73 74 65 6D 20
     4F 70 74 69 6F 6E
     73 20 4E 6F 74 20
     53 65 74 2D 28 52
     75 6E 20 53 45 54
     55 50 29 0D 0A
0191 20 31 36 33 2D 54          E163    DB      ' 163-Time & Date Not Set-(Run SETUP)',CR,LF ;CLOCK NOT UPDATING
     69 6D 65 20 26 20
     44 61 74 65 20 4E
     6F 74 20 53 65 74
     2D 28 52 75 6E 20
     53 45 54 55 50 29
     0D 0A
01B7 20 31 36 34 2D 4D          E164    DB      ' 164-Memory Size Error-(Run SETUP)',CR,LF ; CMOS DOES NOT MATCH
     65 6D 6F 72 79 20
     53 69 7A 65 20 45
     72 72 6F 72 2D 28
     52 75 6E 20 53 45
     54 55 50 29 0D 0A
01DB 20 32 30 31 2D 4D          E201    DB      ' 201-Memory Error',CR,LF
     65 6D 6F 72 79 20
     45 72 72 6F 72 0D
     0A
01EE 20 32 30 32 2D 4D          E202    DB      ' 202-Memory Address Error',CR,LF               ; LINE ERROR 00->15
     65 6D 6F 72 79 20
```

SECTION 5

```
                                41 64 64 72 65 73
                                73 20 45 72 72 6F
                                72 0D 0A
0209 20 32 30 33 2D 4D  E203    DB      ' 203-Memory Address Error',CR,LF             ; LINE ERROR 16->23
     65 6D 6F 72 79 20
     41 64 64 72 65 73
     73 20 45 72 72 6F
     72 0D 0A
0224 20 33 30 31 2D 4B  E301    DB      ' 301-Keyboard Error',CR,LF                   ; KEYBOARD ERROR
     65 79 62 6F 61 72
     64 20 45 72 72 6F
     72 0D 0A
0239 20 33 30 32 2D 53  E302    DB      ' 302-System Unit Keylock is Locked',CR,LF    ; KEYBOARD LOCK ON
     79 73 74 65 6D 20
     55 6E 69 74 20 4B
     65 79 6C 6F 63 6B
     20 69 73 20 4C 6F
     63 6B 65 64 0D 0A
025D 20 28 52 45 53 55  F3D     DB      ' (RESUME = "F1" KEY)',CR,LF
     4D 45 20 3D 20 22
     46 31 22 20 4B 45
     59 29 0D 0A

                                ;-----  NMI ENTRY

= 0273                          IP      =       $
                                ;;-     ORG     0E2C3H
02C3                                    ORG     002C3H
= 02C3                          NMI_INT EQU     $
02C3 E9 0000 E                          JMP     NMI_INT_1               ; VECTOR ON TO MOVED NMI CODE

02C6 20 33 30 33 2D 4B  E303    DB      ' 303-Keyboard Or System Unit Error',CR,LF
     65 79 62 6F 61 72
     64 20 4F 72 20 53
     79 73 74 65 6D 20
     55 6E 69 74 20 45
     72 72 6F 72 0D 0A

                                ;-----  KEYBOARD/SYSTEM ERROR
02EA 20 33 30 34 2D 4B  E304    DB      ' 304-Keyboard Or System Unit Error',CR,LF ; KEYBOARD CLOCK HIGH
     65 79 62 6F 61 72
     64 20 4F 72 20 53
     79 73 74 65 6D 20
     55 6E 69 74 20 45
     72 72 6F 72 0D 0A
030E 20 34 30 31 2D 43  E401    DB      ' 401-CRT Error',CR,LF                        ; MONOCHROME
     52 54 20 45 72 72
     6F 72 0D 0A
031E 20 35 30 31 2D 43  E501    DB      ' 501-CRT Error',CR,LF                        ; COLOR
     52 54 20 45 72 72
     6F 72 0D 0A
032E 20 36 30 31 2D 44  E601    DB      ' 601-Diskette Error',CR,LF                   ; DISKETTE ERROR
     69 73 6B 65 74 74
     65 20 45 72 72 6F
     72 0D 0A

                                ;-----  DISKETTE BOOT RECORD IS NOT VALID
0343 20 36 30 32 2D 44  E602    DB      ' 602-Diskette Boot Record Error',CR,LF
     69 73 6B 65 74 74
     65 20 42 6F 6F 74
     20 52 65 63 6F 72
     64 20 45 72 72 6F
     72 0D 0A

                                ;-----  HARD FILE ERROR MESSAGE
0364 31 37 38 30 2D 44  F1780   DB      '1780-Disk 0 Failure',CR,LF
     69 73 6B 20 30 20
     46 61 69 6C 75 72
     65 0D 0A
0379 31 37 38 31 2D 44  F1781   DB      '1781-Disk 1 Failure',CR,LF
     69 73 6B 20 31 20
     46 61 69 6C 75 72
     65 0D 0A
038E 31 37 38 32 2D 44  F1782   DB      '1782-Disk Controller Failure',CR,LF
     69 73 6B 20 43 6F
     6E 74 72 6F 6C 6C
     65 72 20 46 61 69
     6C 75 72 65 0D 0A
03AC 31 37 39 30 2D 44  F1790   DB      '1790-Disk 0 Error',CR,LF
     69 73 6B 20 30 20
     45 72 72 6F 72 0D
     0A
03BF 31 37 39 31 2D 44  F1791   DB      '1791-Disk 1 Error',CR,LF
     69 73 6B 20 31 20
     45 72 72 6F 72 0D
     0A

03D2 52 4F 4D 20 20 45  F3A     DB      'ROM  Error ',CR,LF                   ; ROM CHECKSUM
     72 72 6F 72 20 0D
     0A
03DF 20 20 20 20 2D 55  F3D1    DB      '    -Unlock System Unit Keylock ',CR,LF
     6E 6C 6F 63 6B 20
     53 79 73 74 65 6D
     20 55 6E 69 74 20
     4B 65 79 6C 6F 63
     6B 20 0D 0A
```

```
                        PAGE
                        ;--------------------------------------------------------
                        ; INITIALIZE DRIVE CHARACTERISTICS                      :
                        ;                                                      :
                        ; FIXED DISK PARAMETER TABLE                           :
                        ;                                                      :
                        ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:    :
                        ;                                                      :
                        ;  +0   (1 WORD) - MAXIMUM NUMBER OF CYLINDERS        :
                        ;  +2   (1 BYTE) - MAXIMUM NUMBER OF HEADS            :
                        ;  +3   (1 WORD) - NOT USED/SEE PC-XT                 :
                        ;  +5   (1 WORD) - STARTING WRITE PRECOMPENSATION CYL :
                        ;  +7   (1 BYTE) - NOT USED/SEE PC-XT                 :
                        ;  +8   (1 BYTE) - CONTROL BYTE                       :
                        ;                   BIT    7 DISABLE RETRIES -OR-   :
                        ;                   BIT    6 DISABLE RETRIES        :
                        ;                   BIT    3 MORE THAN 8 HEADS      :
                        ;  +9   (3 BYTES)- NOT USED/SEE PC-XT                 :
                        ; +12   (1 WORD) - LANDING ZONE                       :
                        ; +14   (1 BYTE) - NUMBER OF SECTORS/TRACK            :
                        ; +15   (1 BYTE) - RESERVED FOR FUTURE USE            :
                        ;                                                      :
                        ;        - TO DYNAMICALLY DEFINE A SET OF PARAMETERS   :
                        ;          BUILD A TABLE FOR UP TO 15 TYPES AND PLACE  :
                        ;          THE CORRESPONDING VECTOR INTO INTERRUPT 41  :
                        ;          FOR DRIVE 0 AND INTERRUPT 46 FOR DRIVE 1.   :
                        ;                                                      :
                        ;--------------------------------------------------------

 0401                   FD_TBL:

                        ;-----  DRIVE TYPE 01

 0401 0132                      DW      0306D                   ; CYLINDERS
 0403 04                        DB      04D                     ; HEADS
 0404 0000                      DW      0
 0406 0080                      DW      0128D                   ; WRITE PRE-COMPENSATION CYLINDER
 0408 00                        DB      0
 0409 00                        DB      0                       ; CONTROL BYTE
 040A 00 00 00                  DB      0,0,0
 040D 0131                      DW      0305D                   ; LANDING ZONE
 040F 11                        DB      17D                     ; SECTORS/TRACK
 0410 00                        DB      0

                        ;-----  DRIVE TYPE 02

 0411 0267                      DW      0615D                   ; CYLINDERS
 0413 04                        DB      04D                     ; HEADS
 0414 0000                      DW      0
 0416 012C                      DW      0300D                   ; WRITE PRE-COMPENSATION CYLINDER
 0418 00                        DB      0
 0419 00                        DB      0                       ; CONTROL BYTE
 041A 00 00 00                  DB      0,0,0
 041D 0267                      DW      0615D                   ; LANDING ZONE
 041F 11                        DB      17D                     ; SECTORS/TRACK
 0420 00                        DB      0

                        ;-----  DRIVE TYPE 03

 0421 0267                      DW      0615D                   ; CYLINDERS
 0423 06                        DB      06D                     ; HEADS
 0424 0000                      DW      0
 0426 012C                      DW      0300D                   ; WRITE PRE-COMPENSATION CYLINDER
 0428 00                        DB      0
 0429 00                        DB      0                       ; CONTROL BYTE
 042A 00 00 00                  DB      0,0,0
 042D 0267                      DW      0615D                   ; LANDING ZONE
 042F 11                        DB      17D                     ; SECTORS/TRACK
 0430 00                        DB      0

                        ;-----  DRIVE TYPE 04

 0431 03AC                      DW      0940D                   ; CYLINDERS
 0433 08                        DB      08D                     ; HEADS
 0434 0000                      DW      0
 0436 0200                      DW      0512D                   ; WRITE PRE-COMPENSATION CYLINDER
 0438 00                        DB      0
 0439 00                        DB      0                       ; CONTROL BYTE
 043A 00 00 00                  DB      0,0,0
 043D 03AC                      DW      0940D                   ; LANDING ZONE
 043F 11                        DB      17D                     ; SECTORS/TRACK
 0440 00                        DB      0

                        ;-----  DRIVE TYPE 05

 0441 03AC                      DW      0940D                   ; CYLINDERS
 0443 06                        DB      06D                     ; HEADS
 0444 0000                      DW      0
 0446 0200                      DW      0512D                   ; WRITE PRE-COMPENSATION CYLINDER
 0448 00                        DB      0
 0449 00                        DB      0                       ; CONTROL BYTE
 044A 00 00 00                  DB      0,0,0
 044D 03AC                      DW      0940D                   ; LANDING ZONE
 044F 11                        DB      17D                     ; SECTORS/TRACK
 0450 00                        DB      0

                        ;-----  DRIVE TYPE 06

 0451 0267                      DW      0615D                   ; CYLINDERS
 0453 04                        DB      04D                     ; HEADS
 0454 0000                      DW      0
 0456 FFFF                      DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
 0458 00                        DB      0
 0459 00                        DB      0                       ; CONTROL BYTE
 045A 00 00 00                  DB      0,0,0
 045D 0267                      DW      0615D                   ; LANDING ZONE
 045F 11                        DB      17D                     ; SECTORS/TRACK
 0460 00                        DB      0

                        ;-----  DRIVE TYPE 07

 0461 01CE                      DW      0462D                   ; CYLINDERS
 0463 08                        DB      08D                     ; HEADS
 0464 0000                      DW      0
```

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                                ;-----  DRIVE TYPE 07

0466 0100                               DW      0256D                   ; WRITE PRE-COMPENSATION CYLINDER
0468 00                                 DB      0
0469 00                                 DB      0                       ; CONTROL BYTE
046A 00 00 00                           DB      0,0,0
046D 01FF                               DW      0511D                   ; LANDING ZONE
046F 11                                 DB      17D                     ; SECTORS/TRACK
0470 00                                 DB      0

                                ;-----  DRIVE TYPE 08

0471 02DD                               DW      0733D                   ; CYLINDERS
0473 05                                 DB      05D                     ; HEADS
0474 0000                               DW      0
0476 FFFF                               DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
0478 00                                 DB      0
0479 00                                 DB      0                       ; CONTROL BYTE
047A 00 00 00                           DB      0,0,0
047D 02DD                               DW      0733D                   ; LANDING ZONE
047F 11                                 DB      17D                     ; SECTORS/TRACK
0480 00                                 DB      0

                                ;-----  DRIVE TYPE 09

0481 0384                               DW      0900D                   ; CYLINDERS
0483 0F                                 DB      15D                     ; HEADS
0484 0000                               DW      0
0486 FFFF                               DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
0488 00                                 DB      0
0489 08                                 DB      008H                    ; CONTROL BYTE
048A 00 00 00                           DB      0,0,0
048D 0385                               DW      0901D                   ; LANDING ZONE
048F 11                                 DB      17D                     ; SECTORS/TRACK
0490 00                                 DB      0

                                ;-----  DRIVE TYPE 10

0491 0334                               DW      0820D                   ; CYLINDERS
0493 03                                 DB      03D                     ; HEADS
0494 0000                               DW      0
0496 FFFF                               DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
0498 00                                 DB      0
0499 00                                 DB      0                       ; CONTROL BYTE
049A 00 00 00                           DB      0,0,0
049D 0334                               DW      0820D                   ; LANDING ZONE
049F 11                                 DB      17D                     ; SECTORS/TRACK
04A0 00                                 DB      0

                                ;-----  DRIVE TYPE 11

04A1 0357                               DW      0855D                   ; CYLINDERS
04A3 05                                 DB      05D                     ; HEADS
04A4 0000                               DW      0
04A6 FFFF                               DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
04A8 00                                 DB      0
04A9 00                                 DB      0                       ; CONTROL BYTE
04AA 00 00 00                           DB      0,0,0
04AD 0357                               DW      0855D                   ; LANDING ZONE
04AF 11                                 DB      17D                     ; SECTORS/TRACK
04B0 00                                 DB      0

                                ;-----  DRIVE TYPE 12

04B1 0357                               DW      0855D                   ; CYLINDERS
04B3 07                                 DB      07D                     ; HEADS
04B4 0000                               DW      0
04B6 FFFF                               DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
04B8 00                                 DB      0
04B9 00                                 DB      0                       ; CONTROL BYTE
04BA 00 00 00                           DB      0,0,0
04BD 0357                               DW      0855D                   ; LANDING ZONE
04BF 11                                 DB      17D                     ; SECTORS/TRACK
04C0 00                                 DB      0

                                ;-----  DRIVE TYPE 13

04C1 0132                               DW      0306D                   ; CYLINDERS
04C3 08                                 DB      08D                     ; HEADS
04C4 0000                               DW      0
04C6 0080                               DW      0128D                   ; WRITE PRE-COMPENSATION CYLINDER
04C8 00                                 DB      0
04C9 00                                 DB      0                       ; CONTROL BYTE
04CA 00 00 00                           DB      0,0,0
04CD 013F                               DW      0319D                   ; LANDING ZONE
04CF 11                                 DB      17D                     ; SECTORS/TRACK
04D0 00                                 DB      0

                                ;-----  DRIVE TYPE 14

04D1 02DD                               DW      0733D                   ; CYLINDERS
04D3 07                                 DB      07D                     ; HEADS
04D4 0000                               DW      0
04D6 FFFF                               DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
04D8 00                                 DB      0
04D9 00                                 DB      0                       ; CONTROL BYTE
04DA 00 00 00                           DB      0,0,0
04DD 02DD                               DW      0733D                   ; LANDING ZONE
04DF 11                                 DB      17D                     ; SECTORS/TRACK
04E0 00                                 DB      0

                                ;-----  DRIVE TYPE 15    RESERVED       ****  DO NOT USE****

04E1 0000                               DW      0000D                   ; CYLINDERS
04E3 00                                 DB      00D                     ; HEADS
04E4 0000                               DW      0
04E6 0000                               DW      0000D                   ; WRITE PRE-COMPENSATION CYLINDER
04E8 00                                 DB      0
04E9 00                                 DB      0                       ; CONTROL BYTE
04EA 00 00 00                           DB      0,0,0
04ED 0000                               DW      0000D                   ; LANDING ZONE
04EF 00                                 DB      00D                     ; SECTORS/TRACK
04F0 00                                 DB      0

                                ;-----  DRIVE TYPE 16
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04F1 0264                       DW      0612D                   ; CYLINDERS
04F3 04                         DB      04D                     ; HEADS
04F4 0000                       DW      0
04F6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION ALL CYLINDER
04F8 00                         DB      0
04F9 00                         DB      0                       ; CONTROL BYTE
04FA 00 00 00                   DB      0,0,0
04FD 0297                       DW      0663D                   ; LANDING ZONE
04FF 11                         DB      17D                     ; SECTORS/TRACK
0500 00                         DB      0

                        ;-----  DRIVE TYPE 17

0501 03D1                       DW      0977D                   ; CYLINDERS
0503 05                         DB      05D                     ; HEADS
0504 0000                       DW      0
0506 012C                       DW      0300D                   ; WRITE PRE-COMPENSATION CYL
0508 00                         DB      0
0509 00                         DB      0                       ; CONTROL BYTE
050A 00 00 00                   DB      0,0,0
050D 03D1                       DW      0977D                   ; LANDING ZONE
050F 11                         DB      17D                     ; SECTORS/TRACK
0510 00                         DB      0

                        ;-----  DRIVE TYPE 18

0511 03D1                       DW      0977D                   ; CYLINDERS
0513 07                         DB      07D                     ; HEADS
0514 0000                       DW      0
0516 FFFF                       DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
0518 00                         DB      0
0519 00                         DB      0                       ; CONTROL BYTE
051A 00 00 00                   DB      0,0,0
051D 03D1                       DW      0977D                   ; LANDING ZONE
051F 11                         DB      17D                     ; SECTORS/TRACK
0520 00                         DB      0

                        ;-----  DRIVE TYPE 19

0521 0400                       DW      1024D                   ; CYLINDERS
0523 07                         DB      07D                     ; HEADS
0524 0000                       DW      0
0526 0200                       DW      0512D                   ; WRITE PRE-COMPENSATION CYLINDER
0528 00                         DB      0
0529 00                         DB      0                       ; CONTROL BYTE
052A 00 00 00                   DB      0,0,0
052D 03FF                       DW      1023D                   ; LANDING ZONE
052F 11                         DB      17D                     ; SECTORS/TRACK
0530 00                         DB      0

                        ;-----  DRIVE TYPE 20

0531 02DD                       DW      0733D                   ; CYLINDERS
0533 05                         DB      05D                     ; HEADS
0534 0000                       DW      0
0536 012C                       DW      0300D                   ; WRITE PRE-COMPENSATION CYL
0538 00                         DB      0
0539 00                         DB      0                       ; CONTROL BYTE
053A 00 00 00                   DB      0,0,0
053D 02DC                       DW      0732D                   ; LANDING ZONE
053F 11                         DB      17D                     ; SECTORS/TRACK
0540 00                         DB      0

                        ;-----  DRIVE TYPE 21

0541 02DD                       DW      0733D                   ; CYLINDERS
0543 07                         DB      07D                     ; HEADS
0544 0000                       DW      0
0546 012C                       DW      0300D                   ; WRITE PRE-COMPENSATION CYL
0548 00                         DB      0
0549 00                         DB      0                       ; CONTROL BYTE
054A 00 00 00                   DB      0,0,0
054D 02DC                       DW      0732D                   ; LANDING ZONE
054F 11                         DB      17D                     ; SECTORS/TRACK
0550 00                         DB      0

                        ;-----  DRIVE TYPE 22

0551 02DD                       DW      0733D                   ; CYLINDERS
0553 05                         DB      05D                     ; HEADS
0554 0000                       DW      0
0556 012C                       DW      0300D                   ; WRITE PRE-COMPENSATION CYL
0558 00                         DB      0
0559 00                         DB      0                       ; CONTROL BYTE
055A 00 00 00                   DB      0,0,0
055D 02DD                       DW      0733D                   ; LANDING ZONE
055F 11                         DB      17D                     ; SECTORS/TRACK
0560 00                         DB      0

                        ;-----  DRIVE TYPE 23

0561 0132                       DW      0306D                   ; CYLINDERS
0563 04                         DB      04D                     ; HEADS
0564 0000                       DW      0
0566 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION ALL CYL
0568 00                         DB      0
0569 00                         DB      0                       ; CONTROL BYTE
056A 00 00 00                   DB      0,0,0
056D 0150                       DW      0336D                   ; LANDING ZONE
056F 11                         DB      17D                     ; SECTORS/TRACK
0570 00                         DB      0

                        ;-----  DRIVE TYPE 24    *** RESERVED***

0571 0000                       DW      0000D                   ; CYLINDERS
0573 00                         DB      00D                     ; HEADS
0574 0000                       DW      0
0576 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0578 00                         DB      0
0579 00                         DB      0                       ; CONTROL BYTE
057A 00 00 00                   DB      0,0,0
057D 0000                       DW      0000D                   ; LANDING ZONE
057F 00                         DB      00D                     ; SECTORS/TRACK
0580 00                         DB      0
```

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                        ;-----  DRIVE TYPE 25    *** RESERVED***
0581 0000                       DW      0000D                   ; CYLINDERS
0583 00                         DB      00D                     ; HEADS
0584 0000                       DW      0
0586 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0588 00                         DB      0
0589 00                         DB      0                       ; CONTROL BYTE
058A 00 00 00                   DB      0,0,0
058D 0000                       DW      0000D                   ; LANDING ZONE
058F 00                         DB      00D                     ; SECTORS/TRACK
0590 00                         DB      0

                        ;-----  DRIVE TYPE 26    *** RESERVED***

0591 0000                       DW      0000D                   ; CYLINDERS
0593 00                         DB      00D                     ; HEADS
0594 0000                       DW      0
0596 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0598 00                         DB      0
0599 00                         DB      0                       ; CONTROL BYTE
059A 00 00 00                   DB      0,0,0
059D 0000                       DW      0000D                   ; LANDING ZONE
059F 00                         DB      00D                     ; SECTORS/TRACK
05A0 00                         DB      0

                        ;-----  DRIVE TYPE 27    *** RESERVED***

05A1 0000                       DW      0000D                   ; CYLINDERS
05A3 00                         DB      00D                     ; HEADS
05A4 0000                       DW      0
05A6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05A8 00                         DB      0
05A9 00                         DB      0                       ; CONTROL BYTE
05AA 00 00 00                   DB      0,0,0
05AD 0000                       DW      0000D                   ; LANDING ZONE
05AF 00                         DB      00D                     ; SECTORS/TRACK
05B0 00                         DB      0

                        ;-----  DRIVE TYPE 28    *** RESERVED***

05B1 0000                       DW      0000D                   ; CYLINDERS
05B3 00                         DB      00D                     ; HEADS
05B4 0000                       DW      0
05B6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05B8 00                         DB      0
05B9 00                         DB      0                       ; CONTROL BYTE
05BA 00 00 00                   DB      0,0,0
05BD 0000                       DW      0000D                   ; LANDING ZONE
05BF 00                         DB      00D                     ; SECTORS/TRACK
05C0 00                         DB      0

                        ;-----  DRIVE TYPE 29    *** RESERVED***

05C1 0000                       DW      0000D                   ; CYLINDERS
05C3 00                         DB      00D                     ; HEADS
05C4 0000                       DW      0
05C6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05C8 00                         DB      0
05C9 00                         DB      0                       ; CONTROL BYTE
05CA 00 00 00                   DB      0,0,0
05CD 0000                       DW      0000D                   ; LANDING ZONE
05CF 00                         DB      00D                     ; SECTORS/TRACK
05D0 00                         DB      0

                        ;-----  DRIVE TYPE 30    *** RESERVED***

05D1 0000                       DW      0000D                   ; CYLINDERS
05D3 00                         DB      00D                     ; HEADS
05D4 0000                       DW      0
05D6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05D8 00                         DB      0
05D9 00                         DB      0                       ; CONTROL BYTE
05DA 00 00 00                   DB      0,0,0
05DD 0000                       DW      0000D                   ; LANDING ZONE
05DF 00                         DB      00D                     ; SECTORS/TRACK
05E0 00                         DB      0

                        ;-----  DRIVE TYPE 31    *** RESERVED***

05E1 0000                       DW      0000D                   ; CYLINDERS
05E3 00                         DB      00D                     ; HEADS
05E4 0000                       DW      0
05E6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05E8 00                         DB      0
05E9 00                         DB      0                       ; CONTROL BYTE
05EA 00 00 00                   DB      0,0,0
05ED 0000                       DW      0000D                   ; LANDING ZONE
05EF 00                         DB      00D                     ; SECTORS/TRACK
05F0 00                         DB      0

                        ;-----  DRIVE TYPE 32    *** RESERVED***

05F1 0000                       DW      0000D                   ; CYLINDERS
05F3 00                         DB      00D                     ; HEADS
05F4 0000                       DW      0
05F6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05F8 00                         DB      0
05F9 00                         DB      0                       ; CONTROL BYTE
05FA 00 00 00                   DB      0,0,0
05FD 0000                       DW      0000D                   ; LANDING ZONE
05FF 00                         DB      00D                     ; SECTORS/TRACK
0600 00                         DB      0

                        ;-----  DRIVE TYPE 33    *** RESERVED***

0601 0000                       DW      0000D                   ; CYLINDERS
0603 00                         DB      00D                     ; HEADS
0604 0000                       DW      0
0606 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0608 00                         DB      0
0609 00                         DB      0                       ; CONTROL BYTE
060A 00 00 00                   DB      0,0,0
```

```
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 34    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 35    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 36    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 37    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 38    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 39    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 40    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 41    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
                                DB      0
                                DB      0                       ; CONTROL BYTE
                                DB      0,0,0
                                DW      0000D                   ; LANDING ZONE
                                DB      00D                     ; SECTORS/TRACK
                                DB      0

                        ;-----  DRIVE TYPE 42    *** RESERVED***

                                DW      0000D                   ; CYLINDERS
                                DB      00D                     ; HEADS
                                DW      0
                                DW      0000D                   ; WRITE PRE-COMPENSATION CYL
```

```
06A8 00                         DB      0
06A9 00                         DB      0                       ; CONTROL BYTE
06AA 00 00 00                   DB      0,0,0
06AD 0000                       DW      0000D                   ; LANDING ZONE
06AF 00                         DB      00D                     ; SECTORS/TRACK
06B0 00                         DB      0

                        ;-----  DRIVE TYPE 44    *** RESERVED***

06B1 0000                       DW      0000D                   ; CYLINDERS
06B3 00                         DB      00D                     ; HEADS
06B4 0000                       DW      0
06B6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
06B8 00                         DB      0
06B9 00                         DB      0                       ; CONTROL BYTE
06BA 00 00 00                   DB      0,0,0
06BD 0000                       DW      0000D                   ; LANDING ZONE
06BF 00                         DB      00D                     ; SECTORS/TRACK
06C0 00                         DB      0

                        ;-----  DRIVE TYPE 45    *** RESERVED***

06C1 0000                       DW      0000D                   ; CYLINDERS
06C3 00                         DB      00D                     ; HEADS
06C4 0000                       DW      0
06C6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
06C8 00                         DB      0
06C9 00                         DB      0                       ; CONTROL BYTE
06CA 00 00 00                   DB      0,0,0
06CD 0000                       DW      0000D                   ; LANDING ZONE
06CF 00                         DB      00D                     ; SECTORS/TRACK
06D0 00                         DB      0

                        ;-----  DRIVE TYPE 46    *** RESERVED***

06D1 0000                       DW      0000D                   ; CYLINDERS
06D3 00                         DB      00D                     ; HEADS
06D4 0000                       DW      0
06D6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
06D8 00                         DB      0
06D9 00                         DB      0                       ; CONTROL BYTE
06DA 00 00 00                   DB      0,0,0
06DD 0000                       DW      0000D                   ; LANDING ZONE
06DF 00                         DB      00D                     ; SECTORS/TRACK
06E0 00                         DB      0

                        ;-----  DRIVE TYPE 47    *** RESERVED***

06E1 0000                       DW      0000D                   ; CYLINDERS
06E3 00                         DB      00D                     ; HEADS
06E4 0000                       DW      0
06E6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
06E8 00                         DB      0
06E9 00                         DB      0                       ; CONTROL BYTE
06EA 00 00 00                   DB      0,0,0
06ED 0000                       DW      0000D                   ; LANDING ZONE
06EF 00                         DB      00D                     ; SECTORS/TRACK
06F0 00                         DB      0


                        ;-----  BOOT LOADER INTERRUPT

= 06F1                  IP      =       $
                        ;;-     ORG     0E6F2H
06F2                            ORG     006F2H
= 06F2                  BOOT_STRAP      EQU     $
06F2 E9 0000 E                  JMP     BOOT_STRAP_1            ; VECTOR ON TO MOVED BOOT CODE

                                                                ;       USE INT 15 H  AH= 0C0H
06F5                    CONF_TBL:                               ; CONFIGURATION TABLE FOR THIS SYSTEM
06F5 0008                       DW      CONF_E-CONF_TBL-2       ; LENGTH OF FOLLOWING TABLE
06F7 FC                         DB      MODEL_BYTE              ; SYSTEM MODEL BYTE
06F8 00                         DB      SUB_MODEL_BYTE          ; SYSTEM SUB MODEL TYPE BYTE
06F9 01                         DB      BIOS_LEVEL              ; BIOS REVISION LEVEL
06FA 70                         DB      01110000B               ; 10000000 = DMA CHANNEL 3 USE BY BIOS
                                                                ; 01000000 = CASCADED INTERRUPT LEVEL 2
                                                                ; 00100000 = REAL TIME CLOCK AVAILABLE
                                                                ; 00010000 = KEYBOARD SCAN CODE HOOK 1AH
06FB 00                         DB      0                       ; RESERVED
06FC 00                         DB      0                       ; RESERVED
06FD 00                         DB      0                       ; RESERVED
06FE 00                         DB      0                       ; RESERVED
= 06FF                  CONF_E  EQU     $                       ; RESERVED FOR EXPANSION


                        ;-----  BAUD RATE INITIALIZATION TABLE

= 06FF                  IP      =       $
                        ;;-     ORG     0E729H
0729                            ORG     00729H
0729 0417               A1      DW      1047                    ; 110 BAUD      ; TABLE OF VALUES
072B 0300                       DW      768                     ; 150           ; FOR INITIALIZATION
072D 0180                       DW      384                     ; 300
072F 00C0                       DW      192                     ; 600
0731 0060                       DW      96                      ; 1200
0733 0030                       DW      48                      ; 2400
0735 0018                       DW      24                      ; 4800
0737 000C                       DW      12                      ; 9600


                        ;-----  RS232


                        ;;-     ORG     0E739H
```

```
                        ORG     00739H
= 0739                  RS232_IO        EQU     $
0739 E9 0000 E                  JMP     RS232_IO_1              ; VECTOR ON TO MOVED RS232 CODE

                        ;-----  KEYBOARD

                        ;;-     ORG     0E82EH
                                ORG     0082EH
= 082E                  KEYBOARD_IO     EQU     $
082E E9 0000 E                  JMP     KEYBOARD_IO_1           ; VECTOR ON TO MOVED KEYBOARD CODE

                        ;-----  TABLE OF SHIFT KEYS AND MASK VALUES (EARLY PC)

                        ;;-     ORG     0E87EH
                                ORG     0087EH
087E 52                 K6      DB      INS_KEY                 ; INSERT KEY
087F 3A 45 46 38 1D             DB      CAPS_KEY,NUM_KEY,SCROLL_KEY,ALT_KEY,CTL_KEY
0884 2A 36                      DB      LEFT_KEY,RIGHT_KEY
= 0008                  K6L     EQU     $-K6

                        ;-----  SHIFT_MASK_TABLE

0886 80                 K7      DB      INS_SHIFT               ; INSERT MODE SHIFT
0887 40 20 10 08 04             DB      CAPS_SHIFT,NUM_SHIFT,SCROLL_SHIFT,ALT_SHIFT,CTL_SHIFT
088C 02 01                      DB      LEFT_SHIFT,RIGHT_SHIFT

                        ;-----  SCAN CODE TABLES

088E 1B FF 00 FF FF FF  K8      DB      27,-1,0,-1,-1,-1,30,-1,-1,-1,-1,31
     1E FF FF FF FF 1F
089A FF 7F FF 11 17 05          DB      -1,127,-1,17,23,5,18,20,25,21,9,15
     12 14 19 15 09 0F
08A6 10 1B 1D 0A FF 01          DB      16,27,29,10,-1,1,19,4,6,7,8,10
     13 04 06 07 08 0A
08B2 0B 0C FF FF FF FF          DB      11,12,-1,-1,-1,-1,28,26,24,3,22,2
     1C 1A 18 03 16 02
08BE 0E 0D FF FF FF FF          DB      14,13,-1,-1,-1,-1,-1,-1,' ',-1
     FF FF 20 FF

                        ;-----  CTL TABLE SCAN

08C8 5E 5F 60 61 62 63  K9      DB      94,95,96,97,98,99,100,101,102,103,-1,-1
     64 65 66 67 FF FF
08D4 77 FF 84 FF 73 FF          DB      119,-1,132,-1,115,-1,116,-1,117,-1,118,-1
     74 FF 75 FF 76 FF
08E0 FF                         DB      -1

                        ;-----  LC TABLE

08E1 1B 31 32 33 34 35  K10     DB      01BH,'1234567890-=',08H,09H
     36 37 38 39 30 2D
     3D 08 09
08F0 71 77 65 72 74 79          DB      'qwertyuiop[]',0DH,-1,'asdfghjkl;',027H
     75 69 6F 70 5B 5D
     0D FF 61 73 64 66
     67 68 6A 6B 6C 3B
     27
0909 60 FF 5C 7A 78 63          DB      60H,-1,5CH,'zxcvbnm,./',-1,'*',-1,' '
     76 62 6E 6D 2C 2E
     2F FF 2A FF 20
091A FF                         DB      -1

                        ;-----  UC TABLE

091B 1B 21 40 23 24 25  K11     DB      27,'!@#$',37,05EH,'&*()_+',08H,0
     5E 26 2A 28 29 5F
     2B 08 00
092A 51 57 45 52 54 59          DB      'QWERTYUIOP{}',0DH,-1,'ASDFGHJKL:"'
     55 49 4F 50 7B 7D
     0D FF 41 53 44 46
     47 48 4A 4B 4C 3A
     22
0943 7E FF 7C 5A 58 43          DB      07EH,-1,'|ZXCVBNM<>?',-1,0,-1,' ',-1
     56 42 4E 4D 3C 3E
     3F FF 00 FF 20 FF

                        ;-----  UC TABLE SCAN

0955 54 55 56 57 58 59  K12     DB      84,85,86,87,88,89
095B 5A 5B 5C 5D                DB      90,91,92,93
                        ;-----  ALT TABLE SCAN

095F 68 69 6A 6B 6C     K13     DB      104,105,106,107,108
0964 6D 6E 6F 70 71             DB      109,110,111,112,113

                        ;-----  NUM STATE TABLE

0969 37 38 39 2D 34 35  K14     DB      '789-456+1230.'
     36 2B 31 32 33 30
     2E

                        ;-----  BASE CASE TABLE

0976 47 48 49 FF 4B FF  K15     DB      71,72,73,-1,75,-1
097C 4D FF 4F 50 51 52          DB      77,-1,79,80,81,82,83
     53

                        ;-----  KEYBOARD INTERRUPT

                        ;;-     ORG     0E987H
                                ORG     00987H
= 0987                  KB_INT  EQU     $
0987 E9 0000 E                  JMP     KB_INT_1                ; VECTOR ON TO MOVED KEYBOARD HANDLER
```

```
                        PAGE
                        ;-----  DISKETTE I/O
                        ;;-     ORG     0EC59H
                                ORG     00C59H
= 0C59                  DISKETTE_IO     EQU     $
0C59 E9 0000 E                  JMP     DISKETTE_IO_1           ; VECTOR ON TO MOVED DISKETTE CODE
                        ;-----  DISKETTE INTERRUPT
                        ;;-     ORG     0EF57H
                                ORG     00F57H
= 0F57                  DISK_INT        EQU     $
0F57 E9 0000 E                  JMP     DISK_INT_1              ; VECTOR ON TO MOVED DISKETTE HANDLER
                        ;-----  DISKETTE PARAMETERS
                        ;;-     ORG     0EFC7H
                                ORG     00FC7H
                        ;--------------------------------------------------------------
                        ; DISK_BASE                                                   :
                        ;       THIS IS THE SET OF PARAMETERS REQUIRED FOR           :
                        ;       DISKETTE OPERATION.  THEY ARE POINTED AT BY THE      :
                        ;       DATA VARIABLE @DISK_POINTER.  TO MODIFY THE PARAMETERS, :
                        ;       BUILD ANOTHER PARAMETER BLOCK AND POINT AT IT        :
                        ;--------------------------------------------------------------
0FC7                    DISK_BASE       LABEL   BYTE
0FC7 DF                         DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FC8 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FC9 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0FCA 02                         DB      2               ; 512 BYTES/SECTOR
0FCB 0F                         DB      15              ; EOT ( LAST SECTOR ON TRACK)
0FCC 1B                         DB      01BH            ; GAP LENGTH
0FCD FF                         DB      0FFH            ; DTL
0FCE 54                         DB      054H            ; GAP LENGTH FOR FORMAT
0FCF F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0FD0 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0FD1 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
                        ;-----  PRINTER I/O
                        ;;-     ORG     0EFD2H
                                ORG     00FD2H
= 0FD2                  PRINTER_IO      EQU     $
0FD2 E9 0000 E                  JMP     PRINTER_IO_1            ; VECTOR ON TO MOVED PRINTER CODE
                        ;-----  FOR POSSIBLE COMPATIBILITY ENTRY POINTS
                        ;;-     ORG     0F045H
1045                            ORG     01045H
                                ASSUME  CS:CODE,DS:DATA
                                EXTRN   SET_MODE:NEAR
                                EXTRN   SET_CTYPE:NEAR
                                EXTRN   SET_CPOS:NEAR
                                EXTRN   READ_CURSOR:NEAR
                                EXTRN   READ_LPEN:NEAR
                                EXTRN   ACT_DISP_PAGE:NEAR
                                EXTRN   SCROLL_UP:NEAR
                                EXTRN   SCROLL_DOWN:NEAR
                                EXTRN   READ_AC_CURRENT:NEAR
                                EXTRN   WRITE_AC_CURRENT:NEAR
                                EXTRN   WRITE_C_CURRENT:NEAR
                                EXTRN   SET_COLOR:NEAR
                                EXTRN   WRITE_DOT:NEAR
                                EXTRN   READ_DOT:NEAR
                                EXTRN   WRITE_TTY:NEAR
                                EXTRN   VIDEO_STATE:NEAR
1045 1045 0000 E        M1      DW      OFFSET  SET_MODE        ;  TABLE OF ROUTINES WITHIN VIDEO I/O
1047 1047 0000 E                DW      OFFSET  SET_CTYPE       ;       EXIT STACK VALUES MAY BE
1049 1049 0000 E                DW      OFFSET  SET_CPOS        ;       DIFFERENT DEPENDING ON THE
104B 104B 0000 E                DW      OFFSET  READ_CURSOR     ;       SYSTEM AND MODEL
104D 104D 0000 E                DW      OFFSET  READ_LPEN
104F 104F 0000 E                DW      OFFSET  ACT_DISP_PAGE
1051 1051 0000 E                DW      OFFSET  SCROLL_UP
1053 1053 0000 E                DW      OFFSET  SCROLL_DOWN
1055 1055 0000 E                DW      OFFSET  READ_AC_CURRENT
1057 1057 0000 E                DW      OFFSET  WRITE_AC_CURRENT
1059 1059 0000 E                DW      OFFSET  WRITE_C_CURRENT
105B 105B 0000 E                DW      OFFSET  SET_COLOR
105D 105D 0000 E                DW      OFFSET  WRITE_DOT
105F 105F 0000 E                DW      OFFSET  READ_DOT
1061 1061 0000 E                DW      OFFSET  WRITE_TTY
1063 1063 0000 E                DW      OFFSET  VIDEO_STATE
= 0020                  M1L     EQU     $-M1
                        ;;-     ORG     0F065H
1065                            ORG     01065H
= 1065                  VIDEO_IO        EQU     $
1065 E9 0000 E                  JMP     VIDEO_IO_1              ; VECTOR ON TO MOVED VIDEO CODE
                        ;-----  VIDEO PARAMETERS --- INIT_TABLE
                        ;;-     ORG     0F0A4H
10A4                            ORG     010A4H
10A4                    VIDEO_PARMS     LABEL   BYTE
10A4 38 28 2D 0A 1F 06          DB      38H,28H,2DH,0AH,1FH,6,19H       ; SET UP FOR 40X25
     19
10AB 1C 02 07 06 07             DB      1CH,2,7,6,7
10B0 00 00 00 00                DB      0,0,0,0
= 0010                  M4      EQU     $-VIDEO_PARMS
10B4 71 50 5A 0A 1F 06          DB      71H,50H,5AH,0AH,1FH,6,19H       ; SET UP FOR 80X25
     19
10BB 1C 02 07 06 07             DB      1CH,2,7,6,7
10C0 00 00 00 00                DB      0,0,0,0
10C4 38 28 2D 0A 7F 06          DB      38H,28H,2DH,0AH,7FH,6,64H       ; SET UP FOR GRAPHICS
     64
```

```
10CB 70 02 01 06 07                DB      70H,2,1,6,7
10D0 00 00 00 00                   DB      0,0,0,0

10D4 61 50 52 0F 19 06             DB      61H,50H,52H,0FH,19H,6,19H       ; SET UP FOR 80X25 B&W CARD
     19
10DB 19 02 0D 0B 0C                DB      19H,2,0DH,0BH,0CH
10E0 00 00 00 00                   DB      0,0,0,0

                                                                           ; TABLE OF REGEN LENGTHS
10E4 0800                  M5      DW      2048                            ; 40X25
10E6 1000                          DW      4096                            ; 80X25
10E8 4000                          DW      16384                           ; GRAPHICS
10EA 4000                          DW      16384

                           ;-----  COLUMNS

10EC 28 28 50 50 28 28     M6      DB      40,40,80,80,40,40,80,80
     50 50

                           ;-----  C_REG_TAB

10F4 2C 28 2D 29 2A 2E     M7      DB      2CH,28H,2DH,29H,2AH,2EH,1EH,29H ; TABLE OF MODE SETS
     1E 29

                           ;-----  MEMORY SIZE

                           ;;-     ORG     0F841H
1841                               ORG     01841H
= 1841                     MEMORY_SIZE_DET EQU  $
1841 E9 0000 E                     JMP     MEMORY_SIZE_DET_I               ; VECTOR ON TO MOVED BIOS CODE

                           ;-----  EQUIPMENT DETERMINE

                           ;;-     ORG     0F84DH
184D                               ORG     0184DH
= 184D                     EQUIPMENT       EQU     $
184D E9 0000 E                     JMP     EQUIPMENT_I                     ; VECTOR ON TO MOVED BIOS CODE

                           ;-----  CASSETTE (NO BIOS SUPPORT)

                           ;;-     ORG     0F859H
1859                               ORG     01859H
= 1859                     CASSETTE_IO     EQU     $
1859 E9 0000 E                     JMP     CASSETTE_IO_I                   ; VECTOR ON TO MOVED BIOS CODE

                           ;--------------------------------------------------------------------------
                           ; CHARACTER GENERATOR GRAPHICS FOR 320X200 AND 640X200 GRAPHICS          :
                           ;--------------------------------------------------------------------------
                           ;;-     ORG     0FA6EH
1A6E                               ORG     01A6EH
1A6E                       CRT_CHAR_GEN    LABEL   BYTE
1A6E 00 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_00    BLANK
     00 00
1A76 7E 81 A5 81 BD 99             DB      07EH,081H,0A5H,081H,0BDH,099H,081H,07EH ; D_01    SMILING FACE
     81 7E
1A7E 7E FF DB FF C3 E7             DB      07EH,0FFH,0DBH,0FFH,0C3H,0E7H,0FFH,07EH ; D_02    SMILING FACE N
     FF 7E
1A86 6C FE FE FE 7C 38             DB      06CH,0FEH,0FEH,0FEH,07CH,038H,010H,000H ; D_03    HEART
     10 00
1A8E 10 38 7C FE 7C 38             DB      010H,038H,07CH,0FEH,07CH,038H,010H,000H ; D_04    DIAMOND
     10 00
1A96 38 7C 38 FE FE 7C             DB      038H,07CH,038H,0FEH,0FEH,07CH,038H,07CH ; D_05    CLUB
     38 7C
1A9E 10 10 38 7C FE 7C             DB      010H,010H,038H,07CH,0FEH,07CH,038H,07CH ; D_06    SPADE
     38 7C
1AA6 00 00 18 3C 3C 18             DB      000H,000H,018H,03CH,03CH,018H,000H,000H ; D_07    BULLET
     00 00
1AAE FF FF E7 C3 C3 E7             DB      0FFH,0FFH,0E7H,0C3H,0C3H,0E7H,0FFH,0FFH ; D_08    BULLET NEG
     FF FF
1AB6 00 3C 66 42 42 66             DB      000H,03CH,066H,042H,042H,066H,03CH,000H ; D_09    CIRCLE
     3C 00
1ABE FF C3 99 BD BD 99             DB      0FFH,0C3H,099H,0BDH,0BDH,099H,0C3H,0FFH ; D_0A    CIRCLE NEG
     C3 FF
1AC6 0F 07 0F 7D CC CC             DB      00FH,007H,00FH,07DH,0CCH,0CCH,0CCH,078H ; D_0B    MALE
     CC 78
1ACE 3C 66 66 66 3C 18             DB      03CH,066H,066H,066H,03CH,018H,07EH,018H ; D_0C    FEMALE
     7E 18
1AD6 3F 33 3F 30 30 70             DB      03FH,033H,03FH,030H,030H,070H,0F0H,0E0H ; D_0D    EIGHTH NOTE
     F0 E0
1ADE 7F 63 7F 63 63 67             DB      07FH,063H,07FH,063H,063H,067H,0E6H,0C0H ; D_0E    TWO 1/16 NOTE
     E6 C0
1AE6 99 5A 3C E7 E7 3C             DB      099H,05AH,03CH,0E7H,0E7H,03CH,05AH,099H ; D_0F    SUN
     5A 99

1AEE 80 E0 F8 FE F8 E0             DB      080H,0E0H,0F8H,0FEH,0F8H,0E0H,080H,000H ; D_10    R ARROWHEAD
     80 00
1AF6 02 0E 3E FE 3E 0E             DB      002H,00EH,03EH,0FEH,03EH,00EH,002H,000H ; D_11    L ARROWHEAD
     02 00
1AFE 18 3C 7E 18 18 7E             DB      018H,03CH,07EH,018H,018H,07EH,03CH,018H ; D_12    ARROW 2 VERT
     3C 18
1B06 66 66 66 66 66 00             DB      066H,066H,066H,066H,066H,000H,066H,000H ; D_13    2 EXCLAMATIONS
     66 00
1B0E 7F DB DB 7B 1B 1B             DB      07FH,0DBH,0DBH,07BH,01BH,01BH,01BH,000H ; D_14    PARAGRAPH
     1B 00
1B16 3E 63 38 6C 6C 38             DB      03EH,063H,038H,06CH,06CH,038H,0CCH,078H ; D_15    SECTION
     CC 78
1B1E 00 00 00 00 7E 7E             DB      000H,000H,000H,000H,07EH,07EH,07EH,000H ; D_16    RECTANGLE
     7E 00
1B26 18 3C 7E 18 7E 3C             DB      018H,03CH,07EH,018H,07EH,03CH,018H,0FFH ; D_17    ARROW 2 VRT UP
     18 FF
1B2E 18 3C 7E 18 18 18             DB      018H,03CH,07EH,018H,018H,018H,018H,000H ; D_18    ARROW VRT UP
     18 00
1B36 18 18 18 18 7E 3C             DB      018H,018H,018H,018H,07EH,03CH,018H,000H ; D_19    ARROW VRT DOWN
     18 00
1B3E 00 18 0C FE 0C 18             DB      000H,018H,00CH,0FEH,00CH,018H,000H,000H ; D_1A    ARROW RIGHT
     00 00
1B46 00 30 60 FE 60 30             DB      000H,030H,060H,0FEH,060H,030H,000H,000H ; D_1B    ARROW LEFT
     00 00
1B4E 00 00 C0 C0 C0 FE             DB      000H,000H,0C0H,0C0H,0C0H,0FEH,000H,000H ; D_1C    NOT INVERTED
     00 00
1B56 00 24 66 FF 66 24             DB      000H,024H,066H,0FFH,066H,024H,000H,000H ; D_1D    ARROW 2 HORZ
     00 00
1B5E 00 18 3C 7E FF FF             DB      000H,018H,03CH,07EH,0FFH,0FFH,000H,000H ; D_1E    ARROWHEAD UP
     00 00
1B66 00 FF FF 7E 3C 18             DB      000H,0FFH,0FFH,07EH,03CH,018H,000H,000H ; D_1F    ARROWHEAD DOWN
     00 00
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1329 1B6E 00 00 00 00 00 00      DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_20   SPACE
1330      00 00
1331 1B76 30 78 78 30 30 00      DB      030H,078H,078H,030H,030H,000H,030H,000H ; D_21 !  EXCLAMATION
1332      30 00
1333 1B7E 6C 6C 6C 00 00 00      DB      06CH,06CH,06CH,000H,000H,000H,000H,000H ; D_22 "  QUOTATION
1334      00 00
1335 1B86 6C 6C FE 6C FE 6C      DB      06CH,06CH,0FEH,06CH,0FEH,06CH,06CH,000H ; D_23 #  LB.
1336      6C 00
1337 1B8E 30 7C C0 78 0C F8      DB      030H,07CH,0C0H,078H,00CH,0F8H,030H,000H ; D_24 $  DOLLAR SIGN
1338      30 00
1339 1B96 00 C6 CC 18 30 66      DB      000H,0C6H,0CCH,018H,030H,066H,0C6H,000H ; D_25 %  PERCENT
1340      C6 00
1341 1B9E 38 6C 38 76 DC CC      DB      038H,06CH,038H,076H,0DCH,0CCH,076H,000H ; D_26 &  AMPERSAND
1342      76 00
1343 1BA6 60 60 C0 00 00 00      DB      060H,060H,0C0H,000H,000H,000H,000H,000H ; D_27 '  APOSTROPHE
1344      00 00
1345 1BAE 18 30 60 60 60 30      DB      018H,030H,060H,060H,060H,030H,018H,000H ; D_28 (  L. PARENTHESIS
1346      18 00
1347 1BB6 60 30 18 18 18 30      DB      060H,030H,018H,018H,018H,030H,060H,000H ; D_29 )  R. PARENTHESIS
1348      60 00
1349 1BBE 00 66 3C FF 3C 66      DB      000H,066H,03CH,0FFH,03CH,066H,000H,000H ; D_2A *  ASTERISK
1350      00 00
1351 1BC6 00 30 30 FC 30 30      DB      000H,030H,030H,0FCH,030H,030H,000H,000H ; D_2B +  PLUS
1352      00 00
1353 1BCE 00 00 00 00 00 30      DB      000H,000H,000H,000H,000H,030H,030H,060H ; D_2C ,  COMMA
1354      30 60
1355 1BD6 00 00 00 FC 00 00      DB      000H,000H,000H,0FCH,000H,000H,000H,000H ; D_2D -  DASH
1356      00 00
1357 1BDE 00 00 00 00 00 30      DB      000H,000H,000H,000H,000H,030H,030H,000H ; D_2E .  PERIOD
1358      30 00
1359 1BE6 06 0C 18 30 60 C0      DB      006H,00CH,018H,030H,060H,0C0H,080H,000H ; D_2F /  SLASH
1360      80 00
1361
1362 1BEE 7C C6 CE DE F6 E6      DB      07CH,0C6H,0CEH,0DEH,0F6H,0E6H,07CH,000H ; D_30 0
1363      7C 00
1364 1BF6 30 70 30 30 30 30      DB      030H,070H,030H,030H,030H,030H,0FCH,000H ; D_31 1
1365      FC 00
1366 1BFE 78 CC 0C 38 60 CC      DB      078H,0CCH,00CH,038H,060H,0CCH,0FCH,000H ; D_32 2
1367      FC 00
1368 1C06 78 CC 0C 38 0C CC      DB      078H,0CCH,00CH,038H,00CH,0CCH,078H,000H ; D_33 3
1369      78 00
1370 1C0E 1C 3C 6C CC FE 0C      DB      01CH,03CH,06CH,0CCH,0FEH,00CH,01EH,000H ; D_34 4
1371      1E 00
1372 1C16 FC C0 F8 0C 0C CC      DB      0FCH,0C0H,0F8H,00CH,00CH,0CCH,078H,000H ; D_35 5
1373      78 00
1374 1C1E 38 60 C0 F8 CC CC      DB      038H,060H,0C0H,0F8H,0CCH,0CCH,078H,000H ; D_36 6
1375      78 00
1376 1C26 FC CC 0C 18 30 30      DB      0FCH,0CCH,00CH,018H,030H,030H,030H,000H ; D_37 7
1377      30 00
1378 1C2E 78 CC CC 78 CC CC      DB      078H,0CCH,0CCH,078H,0CCH,0CCH,078H,000H ; D_38 8
1379      78 00
1380 1C36 78 CC CC 7C 0C 18      DB      078H,0CCH,0CCH,07CH,00CH,018H,070H,000H ; D_39 9
1381      70 00
1382 1C3E 00 30 30 00 00 30      DB      000H,030H,030H,000H,000H,030H,030H,000H ; D_3A :  COLON
1383      30 00
1384 1C46 00 30 30 00 00 30      DB      000H,030H,030H,000H,000H,030H,030H,060H ; D_3B ;  SEMICOLON
1385      30 60
1386 1C4E 18 30 60 C0 60 30      DB      018H,030H,060H,0C0H,060H,030H,018H,000H ; D_3C <  LESS THAN
1387      18 00
1388 1C56 00 00 FC 00 00 FC      DB      000H,000H,0FCH,000H,000H,0FCH,000H,000H ; D_3D =  EQUAL
1389      00 00
1390 1C5E 60 30 18 0C 18 30      DB      060H,030H,018H,00CH,018H,030H,060H,000H ; D_3E >  GREATER THAN
1391      60 00
1392 1C66 78 CC 0C 18 30 00      DB      078H,0CCH,00CH,018H,030H,000H,030H,000H ; D_3F ?  QUESTION MARK
1393      30 00
1394
1395 1C6E 7C C6 DE DE DE C0      DB      07CH,0C6H,0DEH,0DEH,0DEH,0C0H,078H,000H ; D_40 @  AT
1396      78 00
1397 1C76 30 78 CC CC FC CC      DB      030H,078H,0CCH,0CCH,0FCH,0CCH,0CCH,000H ; D_41 A
1398      CC 00
1399 1C7E FC 66 66 7C 66 66      DB      0FCH,066H,066H,07CH,066H,066H,0FCH,000H ; D_42 B
1400      FC 00
1401 1C86 3C 66 C0 C0 C0 66      DB      03CH,066H,0C0H,0C0H,0C0H,066H,03CH,000H ; D_43 C
1402      3C 00
1403 1C8E F8 6C 66 66 66 6C      DB      0F8H,06CH,066H,066H,066H,06CH,0F8H,000H ; D_44 D
1404      F8 00
1405 1C96 FE 62 68 78 68 62      DB      0FEH,062H,068H,078H,068H,062H,0FEH,000H ; D_45 E
1406      FE 00
1407 1C9E FE 62 68 78 68 60      DB      0FEH,062H,068H,078H,068H,060H,0F0H,000H ; D_46 F
1408      F0 00
1409 1CA6 3C 66 C0 C0 CE 66      DB      03CH,066H,0C0H,0C0H,0CEH,066H,03EH,000H ; D_47 G
1410      3E 00
1411 1CAE CC CC CC FC CC CC      DB      0CCH,0CCH,0CCH,0FCH,0CCH,0CCH,0CCH,000H ; D_48 H
1412      CC 00
1413 1CB6 78 30 30 30 30 30      DB      078H,030H,030H,030H,030H,030H,078H,000H ; D_49 I
1414      78 00
1415 1CBE 1E 0C 0C 0C CC CC      DB      01EH,00CH,00CH,00CH,0CCH,0CCH,078H,000H ; D_4A J
1416      78 00
1417 1CC6 E6 66 6C 78 6C 66      DB      0E6H,066H,06CH,078H,06CH,066H,0E6H,000H ; D_4B K
1418      E6 00
1419 1CCE F0 60 60 60 62 66      DB      0F0H,060H,060H,060H,062H,066H,0FEH,000H ; D_4C L
1420      FE 00
1421 1CD6 C6 EE FE FE D6 C6      DB      0C6H,0EEH,0FEH,0FEH,0D6H,0C6H,0C6H,000H ; D_4D M
1422      C6 00
1423 1CDE C6 E6 F6 DE CE C6      DB      0C6H,0E6H,0F6H,0DEH,0CEH,0C6H,0C6H,000H ; D_4E N
1424      C6 00
1425 1CE6 38 6C C6 C6 C6 6C      DB      038H,06CH,0C6H,0C6H,0C6H,06CH,038H,000H ; D_4F O
1426      38 00
1427
1428 1CEE FC 66 66 7C 60 60      DB      0FCH,066H,066H,07CH,060H,060H,0F0H,000H ; D_50 P
1429      F0 00
1430 1CF6 78 CC CC CC DC 78      DB      078H,0CCH,0CCH,0CCH,0DCH,078H,01CH,000H ; D_51 Q
1431      1C 00
1432 1CFE FC 66 66 7C 6C 66      DB      0FCH,066H,066H,07CH,06CH,066H,0E6H,000H ; D_52 R
1433      E6 00
1434 1D06 78 CC E0 70 1C CC      DB      078H,0CCH,0E0H,070H,01CH,0CCH,078H,000H ; D_53 S
1435      78 00
1436 1D0E FC B4 30 30 30 30      DB      0FCH,0B4H,030H,030H,030H,030H,078H,000H ; D_54 T
1437      78 00
1438 1D16 CC CC CC CC CC CC      DB      0CCH,0CCH,0CCH,0CCH,0CCH,0CCH,0FCH,000H ; D_55 U
1439      FC 00
1440 1D1E CC CC CC CC CC 78      DB      0CCH,0CCH,0CCH,0CCH,0CCH,078H,030H,000H ; D_56 V
1441      30 00
1442 1D26 C6 C6 C6 D6 FE EE      DB      0C6H,0C6H,0C6H,0D6H,0FEH,0EEH,0C6H,000H ; D_57 W
```

```
                C6 00
1D2E C6 C6 6C 38 38 6C          DB      0C6H,0C6H,06CH,038H,038H,06CH,0C6H,000H ; D_58 X
                C6 00
1D36 CC CC CC 78 30 30          DB      0CCH,0CCH,0CCH,078H,030H,030H,078H,000H ; D_59 Y
                78 00
1D3E FE C6 8C 18 32 66          DB      0FEH,0C6H,08CH,018H,032H,066H,0FEH,000H ; D_5A Z
                FE 00
1D46 78 60 60 60 60 60          DB      078H,060H,060H,060H,060H,060H,078H,000H ; D_5B [  LEFT BRACKET
                78 00
1D4E C0 60 30 18 0C 06          DB      0C0H,060H,030H,018H,00CH,006H,002H,000H ; D_5C \  BACKSLASH
                02 00
1D56 78 18 18 18 18 18          DB      078H,018H,018H,018H,018H,018H,078H,000H ; D_5D ]  RIGHT BRACKET
                78 00
1D5E 10 38 6C C6 00 00          DB      010H,038H,06CH,0C6H,000H,000H,000H,000H ; D_5E ^  CIRCUMFLEX
                00 00
1D66 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,0FFH ; D_5F _  UNDERSCORE
                00 FF

1D6E 30 30 18 00 00 00          DB      030H,030H,018H,000H,000H,000H,000H,000H ; D_60 `  APOSTROPHE REV
                00 00
1D76 00 00 78 0C 7C CC          DB      000H,000H,078H,00CH,07CH,0CCH,076H,000H ; D_61 a
                76 00
1D7E E0 60 60 7C 66 66          DB      0E0H,060H,060H,07CH,066H,066H,0DCH,000H ; D_62 b
                DC 00
1D86 00 00 78 CC C0 CC          DB      000H,000H,078H,0CCH,0C0H,0CCH,078H,000H ; D_63 c
                78 00
1D8E 1C 0C 0C 7C CC CC          DB      01CH,00CH,00CH,07CH,0CCH,0CCH,076H,000H ; D_64 d
                76 00
1D96 00 00 78 CC FC C0          DB      000H,000H,078H,0CCH,0FCH,0C0H,078H,000H ; D_65 e
                78 00
1D9E 38 6C 60 F0 60 60          DB      038H,06CH,060H,0F0H,060H,060H,0F0H,000H ; D_66 f
                F0 00
1DA6 00 00 76 CC CC 7C          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,0F8H ; D_67 g
                0C F8
1DAE E0 60 6C 76 66 66          DB      0E0H,060H,06CH,076H,066H,066H,0E6H,000H ; D_68 h
                E6 00
1DB6 30 00 70 30 30 30          DB      030H,000H,070H,030H,030H,030H,078H,000H ; D_69 i
                78 00
1DBE 0C 00 0C 0C 0C CC          DB      00CH,000H,00CH,00CH,00CH,0CCH,0CCH,078H ; D_6A j
                CC 78
1DC6 E0 60 66 6C 78 6C          DB      0E0H,060H,066H,06CH,078H,06CH,0E6H,000H ; D_6B k
                E6 00
1DCE 70 30 30 30 30 30          DB      070H,030H,030H,030H,030H,030H,078H,000H ; D_6C l
                78 00
1DD6 00 00 CC FE FE D6          DB      000H,000H,0CCH,0FEH,0FEH,0D6H,0C6H,000H ; D_6D m
                C6 00
1DDE 00 00 F8 CC CC CC          DB      000H,000H,0F8H,0CCH,0CCH,0CCH,0CCH,000H ; D_6E n
                CC 00
1DE6 00 00 78 CC CC CC          DB      000H,000H,078H,0CCH,0CCH,0CCH,078H,000H ; D_6F o
                78 00

1DEE 00 00 DC 66 66 7C          DB      000H,000H,0DCH,066H,066H,07CH,060H,0F0H ; D_70 p
                60 F0
1DF6 00 00 76 CC CC 7C          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,01EH ; D_71 q
                0C 1E
1DFE 00 00 DC 76 66 60          DB      000H,000H,0DCH,076H,066H,060H,0F0H,000H ; D_72 r
                F0 00
1E06 00 00 7C C0 78 0C          DB      000H,000H,07CH,0C0H,078H,00CH,0F8H,000H ; D_73 s
                F8 00
1E0E 10 30 7C 30 30 34          DB      010H,030H,07CH,030H,030H,034H,018H,000H ; D_74 t
                18 00
1E16 00 00 CC CC CC CC          DB      000H,000H,0CCH,0CCH,0CCH,0CCH,076H,000H ; D_75 u
                76 00
1E1E 00 00 CC CC CC 78          DB      000H,000H,0CCH,0CCH,0CCH,078H,030H,000H ; D_76 v
                30 00
1E26 00 00 C6 D6 FE FE          DB      000H,000H,0C6H,0D6H,0FEH,0FEH,06CH,000H ; D_77 w
                6C 00
1E2E 00 00 C6 6C 38 6C          DB      000H,000H,0C6H,06CH,038H,06CH,0C6H,000H ; D_78 x
                C6 00
1E36 00 00 CC CC CC 7C          DB      000H,000H,0CCH,0CCH,0CCH,07CH,00CH,0F8H ; D_79 y
                0C F8
1E3E 00 00 FC 98 30 64          DB      000H,000H,0FCH,098H,030H,064H,0FCH,000H ; D_7A z
                FC 00
1E46 1C 30 30 E0 30 30          DB      01CH,030H,030H,0E0H,030H,030H,01CH,000H ; D_7B {  LEFT BRACE
                1C 00
1E4E 18 18 18 00 18 18          DB      018H,018H,018H,000H,018H,018H,018H,000H ; D_7C |  BROKEN STROKE
                18 00
1E56 E0 30 30 1C 30 30          DB      0E0H,030H,030H,01CH,030H,030H,0E0H,000H ; D_7D }  RIGHT BRACE
                E0 00
1E5E 76 DC 00 00 00 00          DB      076H,0DCH,000H,000H,000H,000H,000H,000H ; D_7E ~  TILDE
                00 00
1E66 00 10 38 6C C6 C6          DB      000H,010H,038H,06CH,0C6H,0C6H,0FEH,000H ; D_7F Δ  DELTA
                FE 00

                                ;-----  TIME OF DAY

                                ;:-     ORG     0FE6EH
                                        ORG     01E6EH
1E6E                    = 1E6E  TIME_OF_DAY     EQU     $
1E6E E9 0000 E                          JMP     TIME_OF_DAY_1           ; VECTOR ON TO MOVED BIOS CODE

                                ;-----  TIMER INTERRUPT

                                ;:-     ORG     0FEA5H
                                        ORG     01EA5H
1EA5                    = 1EA5  TIMER_INT       EQU     $
1EA5 E9 0000 E                          JMP     TIMER_INT_1             ; VECTOR ON TO MOVED BIOS CODE
```

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                        PAGE
                        ;-----  VECTOR TABLE
                        ;;-     ORG     0FEF3H
1EF3                    VECTOR_TABLE    ORG     01EF3H          ;       AT LOCATION 0FEF3H
1EF3                            LABEL   WORD                    ; VECTOR TABLE VALUES FOR POST TESTS
1EF3 1EA5 R                     DW      OFFSET TIMER_INT        ; INT 08H - HARDWARE TIMER 0    IRQ  0
1EF5 0987 R                     DW      OFFSET KB_INT           ; INT 09H - KEYBOARD            IRQ  1
1EF7 0000 E                     DW      OFFSET  DTI             ; INT 0AH - SLAVE INTERRUPT INPUT
1EF9 0000 E                     DW      OFFSET  DI1             ; INT 0BH -                     IRQ  3
1EFB 0000 E                     DW      OFFSET  DI1             ; INT 0CH -                     IRQ  4
1EFD 0000 E                     DW      OFFSET  DI1             ; INT 0DH -                     IRQ  5
1EFF 0F57 R                     DW      OFFSET DISK_INT         ; INT 0EH - DISKETTE            IRQ  6
1F01 0000 E                     DW      OFFSET  DI1             ; INT 0FH -                     IRQ  7

                        ;-----  SOFTWARE INTERRUPTS  ( BIOS CALLS AND POINTERS )

1F03 1065 R                     DW      OFFSET VIDEO_IO         ; INT 10H -- VIDEO DISPLAY
1F05 184D R                     DW      OFFSET EQUIPMENT        ; INT 11H -- GET EQUIPMENT FLAG WORD
1F07 1841 R                     DW      OFFSET MEMORY_SIZE_DET  ; INT 12H -- GET REAL MODE MEMORY SIZE
1F09 0C59 R                     DW      OFFSET DISKETTE_IO      ; INT 13H -- DISKETTE
1F0B 0739 R                     DW      OFFSET RS232_IO         ; INT 14H -- COMMUNICATION ADAPTER
1F0D 1859 R                     DW      OFFSET CASSETTE_IO      ; INT 15H -- EXPANDED BIOS FUNCTION CALL
1F0F 082E R                     DW      OFFSET KEYBOARD_IO      ; INT 16H -- KEYBOARD INPUT
1F11 0FD2 R                     DW      OFFSET PRINTER_IO       ; INT 17H -- PRINTER OUTPUT
1F13 0000                       DW      00000H                  ; INT 18H -- 0F600H INSERTED FOR BASIC
1F15 06F2 R                     DW      OFFSET BOOT_STRAP       ; INT 19H -- BOOT FROM SYSTEM MEDIA
1F17 1E6E R                     DW      OFFSET TIME_OF_DAY      ; INT 1AH -- TIME OF DAY
1F19 1F53 R                     DW      OFFSET DUMMY_RETURN     ; INT 1BH -- KEYBOARD BREAK ADDRESS
1F1B 1F53 R                     DW      OFFSET DUMMY_RETURN     ; INT 1CH -- TIMER BREAK ADDRESS
1F1D 10A4 R                     DW      OFFSET VIDEO_PARMS      ; INT 1DH -- VIDEO PARAMETERS
1F1F 0FC7 R                     DW      OFFSET DISK_BASE        ; INT 1EH -- DISKETTE PARAMETERS
1F21 0000                       DW      00000H                  ; INT 1FH -- POINTER TO VIDEO EXTENSION

1F23                    SLAVE_VECTOR_TABLE      LABEL WORD      ; ( INTERRUPT 70H THRU 7FH )

1F23 0000 E                     DW      OFFSET RTC_INT          ; INT 70H - REAL TIME CLOCK     IRQ  8
1F25 0000 E                     DW      OFFSET RE_DIRECT        ; INT 71H - REDIRECT TO INT 0AH IRQ  9
1F27 0000 E                     DW      OFFSET  DTI             ; INT 72H -                     IRQ 10
1F29 0000 E                     DW      OFFSET  DI1             ; INT 73H -                     IRQ 11
1F2B 0000 E                     DW      OFFSET  DI1             ; INT 74H -                     IRQ 12
1F2D 0000 E                     DW      OFFSET INT_287          ; INT 75H -  -MATH COPROCESSOR  IRQ 13
1F2F 0000 E                     DW      OFFSET  DIT             ; INT 76H -  -FIXED DISK        IRQ 14
1F31 0000 E                     DW      OFFSET  DI1             ; INT 77H -                     IRQ 15

                        ;-----  DUMMY INTERRUPT HANDLER

                        ;;-     ORG     0FF53H
1F53                            ORG     01F53H

= 1F53                  DUMMY_RETURN    EQU     $               ; BIOS DUMMY (NULL) INTERRUPT RETURN

1F53 CF                         IRET

                        ;-----  PRINT SCREEN

                        ;;-     ORG     0FF54H
1F54                            ORG     01F54H
= 1F54                  PRINT_SCREEN    EQU     $
1F54 E9 0000 E                  JMP     PRINT_SCREEN_1          ; VECTOR ON TO MOVED BIOS CODE
                        .LIST                                   ; TUTOR
                        ;-----------------------------------------
                        ;                                       :
                        ;       POWER ON RESET VECTOR           :
                        ;                                       :
                        ;-----------------------------------------
                        ;;-     ORG     0FFF0H
1FF0                            ORG     01FF0H

                        ;-----  POWER ON RESET

1FF0                    P_O_R   LABEL   FAR                     ; POWER ON RESTART EXECUTION LOCATION

1FF0 EA                         DB      0EAH                    ; HARD CODE FAR JUMP TO SET
1FF1 005B R                      DW      OFFSET  RESET          ;  OFFSET
1FF3 F000                        DW      0F000H                 ;   SEGMENT

1FF5 30 36 2F 31 30 2F          DB      '06/10/85'              ; RELEASE MARKER
     38 35

1FFE                            ORG     01FFEH
1FFE FC                         DB      MODEL_BYTE              ; THIS PC'S ID ( MODEL BYTE )

1FFF                    CODE    ENDS                            ; CHECKSUM AT LAST LOCATION
                        END
```

SECTION 6. INSTRUCTION SET

Contents

Notes:

80286 Instruction Set

Data Transfer

MOV = move

Register to Register/Memory

1000100w	mod reg r/w		

Register/Memory to Register

1000101w	mod reg r/w		

Immediate to Register/Memory

1100011w	mod 000 r/w	data	data if w = 1

Immediate to Register

1011wreg	data	data if w = 1

Memory to Accumulator

1010000w	addr-low	addr-high

Accumulator to Memory

1010001w	addr-low	addr-high

Register/Memory to Segment Register

10001110	mod0reg r/w reg ≠ 01

Segment Register to Register/Memory

10001100	mod0reg r/w

PUSH = Push

Memory

11111111	mod110 r/w

Register

01010reg

Segment Register

000reg110

Immediate

011010s0	data	data if s = 0

PUSHA = Push All

01100000

POP = Pop

Memory

10001111	mod000 r/m

Register

01011reg

Segment Register

000reg111	reg ≠ 01

POPA = Pop All

01100001

XCHG = Exchange

Register/Memory with Register

1000011w	mod reg r/m

Register with Accumulator

10010reg

IN = Input From

Fixed Port

1110010w	port

Variable Port

1110110w

OUT = Output To

Fixed Port

1110011w	port

Variable Port

1110111w

XLAT = Translate Byte to AL

11010111

LEA = Load EA to Register

10001101	mod reg r/m

LDS = Load Pointer to DS

11000101	mod reg r/m mod ≠ 11

LES = Load Pointer to ES

11000100	mod reg r/m mod ≠ 11

LAHF = Load AH with Flags

10011111

SAHF = Store AH with Flags

10011110

PUSHF = Push Flags

10011100

POPF = Pop Flags

10011101

Arithmetic

ADD = Add

Register/Memory with Register to Either

0000000w	mod reg r/m

Immediate to Register Memory

100000sw	mod000 r/m	data	data if sw = 01

Immediate to Accumulator

0000010w	data	data if w = 1

ADC = Add with Carry

Register/Memory with Register to Either

000100dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod000 r/m	data	data if sw = 01

Immediate to Accumulator

0001010w	data	data if w = 1

INC = Increment

Register/Memory

1111111w	mod000 r/m

Register

01000reg

SUB = Subtract

Register/Memory with Register to Either

001010dw	mod reg r/m

Immediate from Register/Memory

100000sw	mod101 r/m	data	data if sw = 01

Immediate from Accumulator

0010110w	data	data if w = 1

SBB = Subtract with Borrow

Register/Memory with Register to Either

000110dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod011 r/m	data	data if sw = 01

Immediate to Accumulator

0001110w	data	data if w = 1

DEC = Decrement

Register/Memory

1111111w	mod001 r/m

Register

01001reg

CMP = Compare

Register/Memory with Register

0011101w	mod reg r/m

Register with Register/Memory

0011100w	mod reg r/m

Immediate with Register/Memory

100000sw	mod111 r/m	data	data if sw = 01

Immediate with Accumulator

0001110w	data	data if w = 1

NEG = Change Sign

1111011w	mod011 r/m

AAA = ASCII Adjust for Add

00110111

DEC = Decimal Adjust for Add

00100111

AAS = ASCII Adjust for Subtract

00111111

DAS = Decimal Adjust for Subtract

00110111

MUL = Multiply (Unsigned)

1111011w	mod100 r/m

IMUL = Integer Multiply (Signed)

1111011w	mod101 r/m

IIMUL = Integer Immediate Multiply (Signed)

011010s1	mod reg r/m	Data	Data if s = 0

DIV = Divide (Unsigned)

1111011w	mod110 r/m

IDIV = Integer Divide (Signed)

1111011w	mod111 r/m

AAM = ASCII Adjust for Multiply

11010100	00001010

AAD = ASCII Adjust for Divide

11010101	00001010

CBW = Convert Byte to Word

10011000

CWD = Convert Word to Double Word

10011001

Logic

Shift/Rotate Instructions

Register/Memory by 1

1101000w	mod TTT r/m

Register/Memory by CL

1101001w	mod TTT r/m

Register/Memory by Count

1100000w	mod TTT r/m	count

T T T	Instruction
000	ROL
001	ROR
010	RCL
011	RCR
100	SHL/SAL
101	SHR
111	SAR

AND = And

Register/Memory and Register to Either

001000dw	mod reg r/m

Immmediate to Register/Memory

1000000w	mod000 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

TEST = AND Function to Flags; No Result

Register/Memory and Register

1000010w	mod reg r/m

Immediate Data and Register/Memory

1111011w	mod000 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

Or = Or

Register/Memory and Register to Either

0000 0dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod001 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

XOR = Exclusive OR

Register/Memory and Register to Either

001100dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod110 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

NOT = Invert Register/Memory

1111011w	mod010 r/m

String Manipulation

MOVS = Move Byte Word

1010010w

CMPS = Compare Byte Word

1010011w

SCAS = Scan Byte Word

1010111w

LODS = Load Byte Word to AL/AX

1010110w

STOS = Store Byte Word from AL/AX

1010101w

INS = Input Byte from DX Port

0110110w

OUTS = Output Byte Word to DX Port

0110111w

REP/REPNE, REPZ/REPNZ = Repeat String

Repeat Move String

11110011	1010010w

Repeat Compare String (z/Not z)

1111001z	1010011w

Repeat Scan String (z/Not z)

1111001z	1010111w

Repeat Load String

11110011	1010110w

Repeat Store String

11110011	1010101w

Repeat Input String

11110011	0110110w

Repeat Output String

11110011	1010011w

Control Transfer

CALL = Call

Direct Within Segment

11101000	disp-low	disp-high

Register/Memory Indirect Within Segment

11111111	mod010 r/m

Direct Intersegment

10011010	Segment Offset	Segment Selector

Indirect Intersegment

11111111	mod011 r/m (mod ≠ 11)

JMP = Unconditional Jump

Short/Long

11101011	disp-low

Direct within Segment

11101001	disp-low	disp-high

Register/Memory Indirect Within Segment

11111111	mod100 r/m

Direct Intersegment

11101010	Segment Offset	Segment Selector

Indirect Intersegment

11111111	mod101 r/m (mod ≠ 11)

RET = Return from Call

Within Segment

11000011

Within Segment Adding Immediate to SP

11000010	data-low	data-high

Intersegment

11001011

Intersegment Adding Immediate to SP

11001010	data-low	data-high

JE/JZ = Jump on Equal/Zero

01110100	disp

JL/JNGE = Jump on Less/Not Greater, or Equal

01111100	disp

JLE/JNG = Jump on Less, or Equal/Not Greater

01111110	disp

JB/JNAE = Jump on Below/Not Above, or Equal

01110010	disp

JBE/JNA = Jump on Below, or Equal/Not Above

01110110	disp

JP/JPE = Jump on Parity/Parity Even

01111010	disp

JO = Jump on Overflow

01110000	disp

JS = Jump on Sign

01111000	disp

JNE/JNZ = Jump on Not Equal/Not Zero

01110101	disp

JNL/JGE = Jump on Not Less/Greater, or Equal

01111101	disp

JNLE/JG = Jump on Not Less, or Equal/Greater

01111111	disp

JNB/JAE = Jump on Not Below/Above, or Equal

01110011	disp

JNBE/JA = Jump on Not Below, or Equal/Above

01110111	disp

JNP/JPO = Jump on Not Parity/Parity Odd

01111011	disp

JNO = Jump on Not Overflow

01110001	disp

JNS = Jump on Not Sign

01111011	disp

LOOP = Loop CX Times

11100010	disp

LOOPZ/LOOPE = Loop while Zero/Equal

11100001	disp

LOOPNZ/LOOPNE = Loop while Not Zero/Not Equal

11100000	disp

JCXZ = Jump on CX Zero

11100011	disp

ENTER = Enter Procedure

11001000	data-low	data-high

LEAVE = Leave Procedure

11001001

INT = Interrupt

Type Specified

11001101	Type

Type 3

11001100

INTO = Interrupt on Overflow

11001110

IRET = Interrupt Return

11001111

BOUND = Detect Value Out of Range

01100010	mod reg r/m

Processor Control

CLC = Clear Carry

11111000

CMC = Complement Carry

11110101

STC = Set Carry

11111001

CLD = Clear Direction

11111100

STD = Set Direction

11111101

CLI Clear Interrupt

11111010

STI = Set Interrupt

11111011

HLT = Halt

11110100

WAIT = Wait

10011011

LOCK = Bus Lock Prefix

11110000

CTS = Clear Task Switched Flag

00001111	00000110

ESC = Processor Extension Escape

11011TTT	modLLL r/m

Protection Control

LGDT = Load Global Descriptor Table Register

00001111	00000001	mod010 r/m

SGDT = Store Global Descriptor Table Register

00001111	00000001	mod000 r/m

LIDT = Load Interrupt Descriptor Table Register

00001111	00000001	mod011 r/m

SIDT = Store Interrupt Descriptor Table Register

00001111	00000001	mod001 r/m

LLDT = Load Local Descriptor Table Register from Register/Memory

00001111	00000000	mod010 r/m

SLDT = Store Local Descriptor Table Register from Register/Memory

00001111	00000000	mod000 r/m

LTR = Load Task Register from Register/Memory

00001111	00000000	mod011 r/m

STR = Store Task Register to Register/Memory

00001111	00000000	mod001 r/m

LMSW = Load Machine Status Word from Register/Memory

00001111	00000001	mod110 r/m

SMSW = Store Machine Status Word

00001111	00000001	mod100 r/m

LAR = Load Access Rights from Register/Memory

00001111	00000010	mod reg r/m

LSL = Load Segment Limit from Register/Memory

00001111	00000011	mod reg r/m

ARPL = Adjust Requested Privilege Level from Register/Memory

	01100011	mod reg r/m

VERR = Verify Read Access; Register/Memory

00001111	00000000	mod100 r/m

VERR = Verify Write Access

00001111	00000000	mod101 r/m

The effective address (EA) of the memory operand is computed according to the mod and r/m fields:

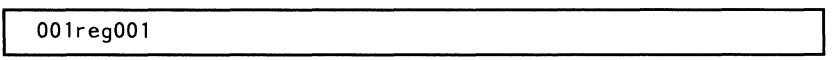
If mod = 11, then r/m is treated as a reg field.
If mod = 00, then disp = 0, disp-low and disp-high are absent.
If mod = 01, then disp = disp-low sign-extended to 16 bits, disp-high is absent.
If mod = 10, then disp = disp-high:disp-low.

If r/m = 000, then EA = (BX) + (SI) + DISP
If r/m = 001, then EA = (BX) + (SI) + DISP
If r/m = 010, then EA = (BP) + (SI) + DISP
If r/m = 011, then EA = (BP) + (DI) + DISP
If r/m = 100, then EA = (SI) + DISP
If r/m = 101, then EA = (DI) + DISP
If r/m = 110, then EA = (BP) + DISP
If r/m = 111, then EA = (BX) + DISP

DISP follows the second byte of the instruction (before data if required).

Note: An exception to the above statements occurs when mod=00 and r/m=110, in which case EA = disp-high; disp-low.

Segment Override Prefix



The 2-bit and 3-bit reg fields are defined as follows:

2-Bit reg Field

reg	Segment Register	reg	Segment Register
00	ES	10	SS
01	CS	11	DS

3-Bit reg Field

16-bit (w = 1)	8-bit (w = 0)
000 AX	000 AL
001 CX	001 CL
010 DX	010 DL
011 BX	011 BL
100 SP	100 AH
101 BP	101 CH
110 SI	110 DH
111 DI	111 BH

The physical addresses of all operands addressed by the BP register are computed using the SS segment register. The physical addresses of the destination operands of the string primitive operations (those addressed by the DI register) are computed using the ES segment, which may not be overridden.

80287 Coprocessor Instruction Set

The following is an instruction set summary for the 80287 coprocessor. In the following, the bit pattern for escape is 11011.

Data Transfer

FLD = Load

Integer/Real Memory to ST(0)

escape MF 1	mod 000 r/m

Long Integer Memory to ST(0)

escape 111	mod 101 r/m

Temporary Real Memory to ST(0)

escape 011	mod 101 r/m

BCD Memory to ST(0)

escape 111	mod 100 r/m

ST(i) to ST(0)

escape 001	11000ST(i)

FST = Store

ST(0) to Integer/Real Memory

escape MF 1	mod 010 r/m

ST(0) to ST(i)

escape 101	11010 ST(i)

FSTP = Store and Pop

ST(0) to Integer/Real Memory

escape MF 1	mod 011 r/m

ST(0) to Long Integer Memory

escape 111	mod 111 r/m

ST(0) to Temporary Real Memory

escape 011	mod 111 r/m

ST(0) to BCD Memory

escape 111	mod 110 r/m

ST(0) to ST(i)

escape 101	11011 ST(i)

FXCH = Exchange ST(i) and ST(0)

escape 001	11001 ST(i)

Comparison

FCOM = Compare

Integer/Real Memory to ST(0)

escape MF 0	mod 010 r/m

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMP = Compare and Pop

Integer/Real Memory to ST(0)

escape MF 0	mod 011 r/m

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMPP = Compare ST(i) to ST(0) and Pop Twice

escape 110	11011001

FTST = Test ST(0)

escape 001	11100100

FXAM = Examine ST(0)

escape 001	11100101

Constants

FLDZ = Load + 0.0 into ST(0)

escape 000	11101110

FLD1 = Load + 1.0 into ST(0)

escape 001	11101000

FLDP1 = Load π into ST(0)

escape 001	11101011

FLDL2T = Load $\log_2 10$ into ST(0)

escape 001	11101001

FLDLG2 = Load $\log_{10} 2$ into ST(0)

escape 001	11101100

FLDLN2 = Load $\log_e 2$ into ST(0)

escape 001	11101101

Arithmetic

FADD = Addition

Integer/Real Memory with ST(0)

escape MF 0	mod 000 r/m

ST(i) and ST(0)

escape dP0	11000 ST(i)

FSUB = Subtraction

Integer/Real Memory with ST(0)

escape MF 0	mod 10R r/m

ST(i) and ST(0)

escape dP0	1110R r/m

FMUL = Multiplication

Integer/Real Memory with ST(0)

escape MF 0	mod 001 r/m

ST(i) and ST(0)

escape dP0	11001 r/m

FDIV = Division

Integer/Real Memory with ST(0)

escape MF 0	mod 11R r/m

ST(i) and ST(0)

escape dP0	1111R r/m

FSQRT = Square Root of ST(0)

escape 001	11111010

FSCALE = Scale ST(0) by ST(1)

escape 001	11111101

FPREM = Partial Remainder of ST(0) + ST(1)

escape 001	11111000

FRNDINT = Round ST(0) to Integer

escape 001	11111100

FXTRACT = Extract Components of ST(0)

escape 001	11110100

FABS = Absolute Value of ST(0)

escape 001	11100001

FCHS = Change Sign of ST(0)

escape 001	11100000

Transcendental

FPTAN = Partial Tangent of ST(0)

escape 001	11110010

FPATAN = Partial Arctangent of ST(0) ÷ ST(1)

escape 001	11110011

F2XM1 = $2^{ST(0)}$ -1

escape 001	11110000

FYL2X = ST(1) x Log_2 [ST(0)]

escape 001	11110001

FYL2XP1 = ST(1) x Log_2 [ST(0) + 1]

escape 001	11111001

FINIT = Initialize NPX

escape 011	11100011

FSETPM = Enter Protected Mode

escape 011	11100100

FSTSWAX = Store Control Word

escape 111	11100000

FLDCW = Load Control Word

escape 001	mod 101 r/m

FSTCW = Store Control Word

escape 001	mod 111 r/m

FSTSW = Store Status Word

escape 101	mod 101 r/m

FCLEX = Clear Exceptions

escape 011	11100010

FSTENV = Store Environment

escape 001	mod 110 r/m

FLDENV = Load Environment

escape 001	mod 100 r/m

FSAVE = Save State

escape 101	mod 110 r/m

FRSTOR = Restore State

escape 101	mod 100 r/m

FINCSTP = Increment Stack Pointer

escape 001	11110111

FDECSTP = Decrement Stack Pointer

escape 001	111100110

FFREE = Free ST(i)

escape 101	11000ST(i)

FNOP = No Operation

escape 101	11010000

MF is assigned as follows:

MF	Memory Format
00	32-bit Real
01	32-bit Integer
10	64-bit Real
11	16-bit Integer

The other abbreviations are as follows:

Term	Definition	Bit = 0	Bit ≠ 0
ST	Stack top	Stack top	(i)= ith register from the top
d	Destination	Dest. is ST(0)	Dest. is ST(i)
P	Pop	No pop	Pop
R	Reverse*	Dest. (op) source	Source (op) dest.
* When d=1, reverse the sense of R.			

Notes:

SECTION 7. CHARACTERS, KEYSTROKES, AND COLORS

Contents

Notes:

Character Codes

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
00	0	Blank (Null)	Ctrl 2		Black	Black	Non-Display
01	1	☺	Ctrl A		Black	Blue	Underline
02	2	☻	Ctrl B		Black	Green	Normal
03	3	♥	Ctrl C		Black	Cyan	Normal
04	4	♦	Ctrl D		Black	Red	Normal
05	5	♣	Ctrl E		Black	Magenta	Normal
06	6	♠	Ctrl F		Black	Brown	Normal
07	7	•	Ctrl G		Black	Light Grey	Normal
08	8	◘	Ctrl H, Backspace, Shift Backspace		Black	Dark Grey	Non-Display
09	9	○	Ctrl I		Black	Light Blue	High Intensity Underline
0A	10	◙	Ctrl J, Ctrl ↵		Black	Light Green	High Intensity
0B	11	♂	Ctrl K		Black	Light Cyan	High Intensity
0C	12	♀	Ctrl L		Black	Light Red	High Intensity
0D	13	♪	Ctrl M, ↵, Shift ↵		Black	Light Magenta	High Intensity
0E	14	♫	Ctrl N		Black	Yellow	High Intensity
0F	15	☼	Ctrl O		Black	White	High Intensity
10	16	►	Ctrl P		Blue	Black	Normal
11	17	◄	Ctrl Q		Blue	Blue	Underline
12	18	↕	Ctrl R		Blue	Green	Normal
13	19	‼	Ctrl S		Blue	Cyan	Normal
14	20	¶	Ctrl T		Blue	Red	Normal
15	21	§	Ctrl U		Blue	Magenta	Normal
16	22	▬	Ctrl V		Blue	Brown	Normal
17	23	↨	Ctrl W		Blue	Light Grey	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
18	24	↑	Ctrl X		Blue	Dark Grey	High Intensity
19	25	↓	Ctrl Y		Blue	Light Blue	High Intensity Underline
1A	26	→	Ctrl Z		Blue	Light Green	High Intensity
1B	27	←	Ctrl [, Esc, Shift Esc, Crtl Esc		Blue	Light Cyan	High Intensity
1C	28	└	Ctrl \		Blue	Light Red	High Intensity
1D	29	↔	Ctrl]		Blue	Light Magenta	High Intensity
1E	30	▲	Ctrl 6		Blue	Yellow	High Intensity
1F	31	▼	Ctrl —		Blue	White	High Intensity
20	32	Blank Space	Space Bar, Shift, Space, Ctrl Space, Alt Space		Green	Black	Normal
21	33	!	!	Shift	Green	Blue	Underline
22	34	"	"	Shift	Green	Green	Normal
23	35	#	#	Shift	Green	Cyan	Normal
24	36	$	$	Shift	Green	Red	Normal
25	37	%	%	Shift	Green	Magenta	Normal
26	38	&	&	Shift	Green	Brown	Normal
27	39	'	'		Green	Light Grey	Normal
28	40	(	(	Shift	Green	Dark Grey	High Intensity
29	41	)	)	Shift	Green	Light Blue	High Intensity Underline
2A	42	*	*	Note 1	Green	Light Green	High Intensity
2B	43	+	+	Shift	Green	Light Cyan	High Intensity
2C	44	,	,		Green	Light Red	High Intensity
2D	45	-	-		Green	Light Magenta	High Intensity
2E	46	.	.	Note 2	Green	Yellow	High Intensity

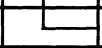
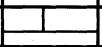
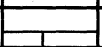
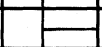
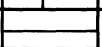
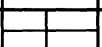
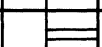
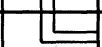
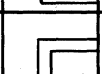
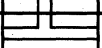
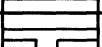
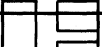
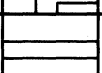
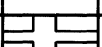
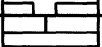
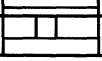
Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
2F	47	/	/		Green	White	High Intensity
30	48	0	0	Note 3	Cyan	Black	Normal
31	49	1	1	Note 3	Cyan	Blue	Underline
32	50	2	2	Note 3	Cyan	Green	Normal
33	51	3	3	Note 3	Cyan	Cyan	Normal
34	52	4	4	Note 3	Cyan	Red	Normal
35	53	5	5	Note 3	Cyan	Magenta	Normal
36	54	6	6	Note 3	Cyan	Brown	Normal
37	55	7	7	Note 3	Cyan	Light Grey	Normal
38	56	8	8	Note 3	Cyan	Dark Grey	High Intensity
39	57	9	9	Note 3	Cyan	Light Blue	High Intensity Underline
3A	58	:	:	Shift	Cyan	Light Green	High Intensity
3B	59	;	;		Cyan	Light Cyan	High Intensity
3C	60	<	<	Shift	Cyan	Light Red	High Intensity
3D	61	=	=		Cyan	Light Magenta	High Intensity
3E	62	>	>	Shift	Cyan	Yellow	High Intensity
3F	63	?	?	Shift	Cyan	White	High Intensity
40	64	@	@	Shift	Red	Black	Normal
41	65	A	A	Note 4	Red	Blue	Underline
42	66	B	B	Note 4	Red	Green	Normal
43	67	C	C	Note 4	Red	Cyan	Normal
44	68	D	D	Note 4	Red	Red	Normal
45	69	E	E	Note 4	Red	Magenta	Normal
46	70	F	F	Note 4	Red	Brown	Normal
47	71	G	G	Note 4	Red	Light Grey	Normal
48	72	H	H	Note 4	Red	Dark Grey	High Intensity
49	73	I	I	Note 4	Red	Light Blue	High Intensity Underline
4A	74	J	J	Note 4	Red	Light Green	High Intensity

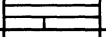
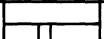
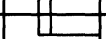
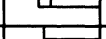
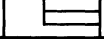
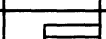
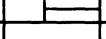
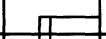
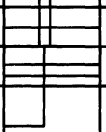
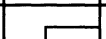
Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
4B	75	K	K	Note 4	Red	Light Cyan	High Intensity
4C	76	L	L	Note 4	Red	Light Red	High Intensity
4D	77	M	M	Note 4	Red	Light Magenta	High Intensity
4E	78	N	N	Note 4	Red	Yellow	High Intensity
4F	79	O	O	Note 4	Red	White	High Intensity
50	80	P	P	Note 4	Magenta	Black	Normal
51	81	Q	Q	Note 4	Magenta	Blue	Underline
52	82	R	R	Note 4	Magenta	Green	Normal
53	83	S	S	Note 4	Magenta	Cyan	Normal
54	84	T	T	Note 4	Magenta	Red	Normal
55	85	U	U	Note 4	Magenta	Magenta	Normal
56	86	V	V	Note 4	Magenta	Brown	Normal
57	87	W	W	Note 4	Magenta	Light Grey	Normal
58	88	X	X	Note 4	Magenta	Dark Grey	High Intensity
59	89	Y	Y	Note 4	Magenta	Light Blue	High Intensity Underline
5A	90	Z	Z	Note 4	Magenta	Light Green	High Intensity
5B	91	[	[		Magenta	Light Cyan	High Intensity
5C	92	\	\		Magenta	Light Red	High Intensity
5D	93	]	]		Magenta	Light Magenta	High Intensity
5E	94	^	^	Shift	Magenta	Yellow	High Intensity
5F	95	—	—	Shift	Magenta	White	High Intensity
60	96	`	`		Brown	Black	Normal
61	97	a	a	Note 5	Brown	Blue	Underline
62	98	b	b	Note 5	Brown	Green	Normal
63	99	c	c	Note 5	Brown	Cyan	Normal
64	100	d	d	Note 5	Brown	Red	Normal
65	101	e	e	Note 5	Brown	Magenta	Normal
66	102	f	f	Note 5	Brown	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
67	103	g	g	Note 5	Brown	Light Grey	Normal
68	104	h	h	Note 5	Brown	Dark Grey	High Intensity
69	105	i	i	Note 5	Brown	Light Blue	High Intensity Underline
6A	106	j	j	Note 5	Brown	Light Green	High Intensity
6B	107	k	k	Note 5	Brown	Light Cyan	High Intensity
6C	108	l	l	Note 5	Brown	Light Red	High Intensity
6D	109	m	m	Note 5	Brown	Light Magenta	High Intensity
6E	110	n	n	Note 5	Brown	Yellow	High Intensity
6F	111	o	o	Note 5	Brown	White	High Intensity
70	112	p	p	Note 5	Light Grey	Black	Reverse Video
71	113	q	q	Note 5	Light Grey	Blue	Underline
72	114	r	r	Note 5	Light Grey	Green	Normal
73	115	s	s	Note 5	Light Grey	Cyan	Normal
74	116	t	t	Note 5	Light Grey	Red	Normal
75	117	u	u	Note 5	Light Grey	Magenta	Normal
76	118	v	v	Note 5	Light Grey	Brown	Normal
77	119	w	w	Note 5	Light Grey	Light Grey	Normal
78	120	x	x	Note 5	Light Grey	Dark Grey	Reverse Video
79	121	y	y	Note 5	Light Grey	Light Blue	High Intensity Underline
7A	122	z	z	Note 5	Light Grey	Light Green	High Intensity
7B	123	{	{	Shift	Light Grey	Light Cyan	High Intensity
7C	124	¦	¦	Shift	Light Grey	Light Red	High Intensity
7D	125	}	}	Shift	Light Grey	Light Magenta	High Intensity
7E	126	~	~	Shift	Light Grey	Yellow	High Intensity
7F	127	△	Ctrl ←		Light Grey	White	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
* * * * 80 to FF Hex are Flashing in both Color & IBM Monochrome * * * *							
80	128	Ç	Alt 128	Note 6	Black	Black	Non-Display
81	129	ü	Alt 129	Note 6	Black	Blue	Underline
82	130	é	Alt 130	Note 6	Black	Green	Normal
83	131	â	Alt 131	Note 6	Black	Cyan	Normal
84	132	ä	Alt 132	Note 6	Black	Red	Normal
85	133	à	Alt 133	Note 6	Black	Magenta	Normal
86	134	å	Alt 134	Note 6	Black	Brown	Normal
87	135	ç	Alt 135	Note 6	Black	Light Grey	Normal
88	136	ê	Alt 136	Note 6	Black	Dark Grey	Non-Display
89	137	ë	Alt 137	Note 6	Black	Light Blue	High Intensity Underline
8A	138	è	Alt 138	Note 6	Black	Light Green	High Intensity
8B	139	ï	Alt 139	Note 6	Black	Light Cyan	High Intensity
8C	140	î	Alt 140	Note 6	Black	Light Red	High Intensity
8D	141	ì	Alt 141	Note 6	Black	Light Magenta	High Intensity
8E	142	Ä	Alt 142	Note 6	Black	Yellow	High Intensity
8F	143	Å	Alt 143	Note 6	Black	White	High Intensity
90	144	É	Alt 144	Note 6	Blue	Black	Normal
91	145	æ	Alt 145	Note 6	Blue	Blue	Underline
92	146	Æ	Alt 146	Note 6	Blue	Green	Normal
93	147	ô	Alt 147	Note 6	Blue	Cyan	Normal
94	148	ö	Alt 148	Note 6	Blue	Red	Normal
95	149	ò	Alt 149	Note 6	Blue	Magenta	Normal
96	150	û	Alt 150	Note 6	Blue	Brown	Normal
97	151	ù	Alt 151	Note 6	Blue	Light Grey	Normal
98	152	ÿ	Alt 152	Note 6	Blue	Dark Grey	High Intensity
99	153	Ö	Alt 153	Note 6	Blue	Light Blue	High Intensity Underline
9A	154	Ü	Alt 154	Note 6	Blue	Light Green	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
9B	155	¢	Alt 155	Note 6	Blue	Light Cyan	High Intensity
9C	156	£	Alt 156	Note 6	Blue	Light Red	High Intensity
9D	157	¥	Alt 157	Note 6	Blue	Light Magenta	High Intensity
9E	158	Pt	Alt 158	Note 6	Blue	Yellow	High Intensity
9F	159	*f*	Alt 159	Note 6	Blue	White	High Intensity
A0	160	á	Alt 160	Note 6	Green	Black	Normal
A1	161	í	Alt 161	Note 6	Green	Blue	Underline
A2	162	ó	Alt 162	Note 6	Green	Green	Normal
A3	163	ú	Alt 163	Note 6	Green	Cyan	Normal
A4	164	ñ	Alt 164	Note 6	Green	Red	Normal
A5	165	Ñ	Alt 165	Note 6	Green	Magenta	Normal
A6	166	a	Alt 166	Note 6	Green	Brown	Normal
A7	167	o	Alt 167	Note 6	Green	Light Grey	Normal
A8	168	¿	Alt 168	Note 6	Green	Dark Grey	High Intensity
A9	169	⌐	Alt 169	Note 6	Green	Light Blue	High Intensity Underline
AA	170	¬	Alt 170	Note 6	Green	Light Green	High Intensity
AB	171	½	Alt 171	Note 6	Green	Light Cyan	High Intensity
AC	172	¼	Alt 172	Note 6	Green	Light Red	High Intensity
AD	173	i	Alt 173	Note 6	Green	Light Magenta	High Intensity
AE	174	<<	Alt 174	Note 6	Green	Yellow	High Intensity
AF	175	>>	Alt 175	Note 6	Green	White	High Intensity
B0	176	⁙	Alt 176	Note 6	Cyan	Black	Normal
B1	177	▒	Alt 177	Note 6	Cyan	Blue	Underline
B2	178	▓	Alt 178	Note 6	Cyan	Green	Normal
B3	179	│	Alt 179	Note 6	Cyan	Cyan	Normal
B4	180	┤	Alt 180	Note 6	Cyan	Red	Normal
B5	181	╡	Alt 181	Note 6	Cyan	Magenta	Normal
B6	182	╢	Alt 182	Note 6	Cyan	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
B7	183		Alt 183	Note 6	Cyan	Light Grey	Normal
B8	184		Alt 184	Note 6	Cyan	Dark Grey	High Intensity
B9	185		Alt 185	Note 6	Cyan	Light Blue	High Intensity Underline
BA	186		Alt 186	Note 6	Cyan	Light Green	High Intensity
BB	187		Alt 187	Note 6	Cyan	Light Cyan	High Intensity
BC	188		Alt 188	Note 6	Cyan	Light Red	High Intensity
BD	189		Alt 189	Note 6	Cyan	Light Magenta	High Intensity
BE	190		Alt 190	Note 6	Cyan	Yellow	High Intensity
BF	191		Alt 191	Note 6	Cyan	White	High Intensity
C0	192		Alt 192	Note 6	Red	Black	Normal
C1	193		Alt 193	Note 6	Red	Blue	Underline
C2	194		Alt 194	Note 6	Red	Green	Normal
C3	195		Alt 195	Note 6	Red	Cyan	Normal
C4	196		Alt 196	Note 6	Red	Red	Normal
C5	197		Alt 197	Note 6	Red	Magenta	Normal
C6	198		Alt 198	Note 6	Red	Brown	Normal
C7	199		Alt 199	Note 6	Red	Light Grey	Normal
C8	200		Alt 200	Note 6	Red	Dark Grey	High Intensity
C9	201		Alt 201	Note 6	Red	Light Blue	High Intensity Underline
CA	202		Alt 202	Note 6	Red	Light Green	High Intensity
CB	203		Alt 203	Note 6	Red	Light Cyan	High Intensity
CC	204		Alt 204	Note 6	Red	Light Red	High Intensity
CD	205		Alt 205	Note 6	Red	Light Magenta	High Intensity
CE	206		Alt 206	Note 6	Red	Yellow	High Intensity
CF	207		Alt 207	Note 6	Red	White	High Intensity
D0	208		Alt 208	Note 6	Magenta	Black	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
D1	209		Alt 209	Note 6	Magenta	Blue	Underline
D2	210		Alt 210	Note 6	Magenta	Green	Normal
D3	211		Alt 211	Note 6	Magenta	Cyan	Normal
D4	212		Alt 212	Note 6	Magenta	Red	Normal
D5	213		Alt 213	Note 6	Magenta	Magenta	Normal
D6	214		Alt 214	Note 6	Magenta	Brown	Normal
D7	215		Alt 215	Note 6	Magenta	Light Grey	Normal
D8	216		Alt 216	Note 6	Magenta	Dark Grey	High Intensity
D9	217		Alt 217	Note 6	Magenta	Light Blue	High Intensity Underline
DA	218		Alt 218	Note 6	Magenta	Light Green	High Intensity
DB	219		Alt 219	Note 6	Magenta	Light Cyan	High Intensity
DC	220		Alt 220	Note 6	Magenta	Light Red	High Intensity
DD	221		Alt 221	Note 6	Magenta	Light Magenta	High Intensity
DE	222		Alt 222	Note 6	Magenta	Yellow	High Intensity
DF	223		Alt 223	Note 6	Magenta	White	High Intensity
E0	224	α	Alt 224	Note 6	Brown	Black	Normal
E1	225	β	Alt 225	Note 6	Brown	Blue	Underline
E2	226	Γ	Alt 226	Note 6	Brown	Green	Normal
E3	227	π	Alt 227	Note 6	Brown	Cyan	Normal
E4	228	Σ	Alt 228	Note 6	Brown	Red	Normal
E5	229	σ	Alt 229	Note 6	Brown	Magenta	Normal
E6	230	μ	Alt 230	Note 6	Brown	Brown	Normal
E7	231	τ	Alt 231	Note 6	Brown	Light Grey	Normal
E8	232	Φ	Alt 232	Note 6	Brown	Dark Grey	High Intensity
E9	233	θ	Alt 233	Note 6	Brown	Light Blue	High Intensity Underline
EA	234	Ω	Alt 234	Note 6	Brown	Light Green	High Intensity
EB	235	δ	Alt 235	Note 6	Brown	Light Cyan	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
EC	236	∞	Alt 236	Note 6	Brown	Light Red	High Intensity
ED	237	φ	Alt 237	Note 6	Brown	Light Magenta	High Intensity
EE	238	ϵ	Alt 238	Note 6	Brown	Yellow	High Intensity
EF	239	∩	Alt 239	Note 6	Brown	White	High Intensity
F0	240	≡	Alt 240	Note 6	Light Grey	Black	Reverse Video
F1	241	±	Alt 241	Note 6	Light Grey	Blue	Underline
F2	242	≥	Alt 242	Note 6	Light Grey	Green	Normal
F3	243	≤	Alt 243	Note 6	Light Grey	Cyan	Normal
F4	244	⌠	Alt 244	Note 6	Light Grey	Red	Normal
F5	245	⌡	Alt 245	Note 6	Light Grey	Magenta	Normal
F6	246	÷	Alt 246	Note 6	Light Grey	Brown	Normal
F7	247	≈	Alt 247	Note 6	Light Grey	Light Grey	Normal
F8	248	°	Alt 248	Note 6	Light Grey	Dark Grey	Reverse Video
F9	249	∙	Alt 249	Note 6	Light Grey	Light Blue	High Intensity Underline
FA	250	·	Alt 250	Note 6	Light Grey	Light Green	High Intensity
FB	251	√	Alt 251	Note 6	Light Grey	Light Cyan	High Intensity
FC	252	^{n}	Alt 252	Note 6	Light Grey	Light Red	High Intensity
FD	253	^{2}	Alt 253	Note 6	Light Grey	Light Magenta	High Intensity
FE	254	■	Alt 254	Note 6	Light Grey	Yellow	High Intensity
FF	255	**BLANK**	Alt 255	Note 6	Light Grey	White	High Intensity

Notes

1. Asterisk (*) can be typed using two methods: press the (*) key or, in the shift mode, press the 8 key.

2. Period (.) can be typed using two methods: press the . key or, in the shift or Num Lock mode, press the Del key.

3. Numeric characters 0-9 can be typed using two methods: press the numeric keys on the top row of the keyboard or, in the shift or Num Lock mode, press the numeric keys in the keypad portion of the keyboard.

4. Uppercase alphabetic characters (A-Z) can be typed in two modes: the shift mode or the Caps Lock mode.

5. Lowercase alphabetic characters (a-z) can be typed in two modes: in the normal mode or in Caps Lock and shift mode combined.

6. The three digits after the Alt key must be typed from the numeric keypad. Character codes 1-255 may be entered in this fashion (with Caps Lock activated, character codes 97-122 will display uppercase).

Quick Reference

DECIMAL VALUE	➡	0	16	32	48	64	80	96	112
⬇	HEXA-DECIMAL VALUE	0	1	2	3	4	5	6	7
0	0	BLANK (NULL)	►	BLANK (SPACE)	0	@	P	‘	p
1	1	☺	◄	!	1	A	Q	a	q
2	2	☻	↕	"	2	B	R	b	r
3	3	♥	!!	#	3	C	S	c	s
4	4	♦	¶	$	4	D	T	d	t
5	5	♣	§	%	5	E	U	e	u
6	6	♠	▬	&	6	F	V	f	v
7	7	•	↨	’	7	G	W	g	w
8	8	◘	↑	(	8	H	X	h	x
9	9	○	↓	)	9	I	Y	i	y
10	A	◙	→	*	:	J	Z	j	z
11	B	♂	←	+	;	K	[	k	{
12	C	♀	∟	,	<	L	\	l	¦
13	D	♪	↔	—	=	M	]	m	}
14	E	♫	▲	.	>	N	^	n	~
15	F	☼	▼	/	?	O	_	o	△

DECIMAL VALUE	➡	128	144	160	176	192	208	224	240
⬇	HEXA-DECIMAL VALUE	8	9	A	B	C	D	E	F
0	0	Ç	É	á	▒	└	╥	∝	≡
1	1	ü	æ	í	▒	┴	═	β	±
2	2	é	Æ	ó	▒	┬	╘	Γ	≥
3	3	â	ô	ú	│	├	╙	π	≤
4	4	ä	ö	ñ	┤	─	╒	Σ	⌠
5	5	à	ò	Ñ	╡	┼	╓	σ	⌡
6	6	å	û	ª	╢	╞	╫	μ	÷
7	7	ç	ù	º	╖	╟	╪	τ	≈
8	8	ê	ÿ	¿	╕	╚	┘	Φ	°
9	9	ë	Ö	⌐	╣	╔	┌	Θ	•
10	A	è	Ü	¬	║	╩	╭	Ω	•
11	B	ï	¢	½	╗	╦	■	δ	√
12	C	î	£	¼	╝	╠	▄	∞	n
13	D	ì	¥	¡	╜	═	▌	φ	2
14	E	Ä	₧	«	╛	╬	▐	∈	▮
15	F	Å	ƒ	»	┐	╧	▀	∩	BLANK 'FF'

Notes:

SECTION 8. COMMUNICATIONS

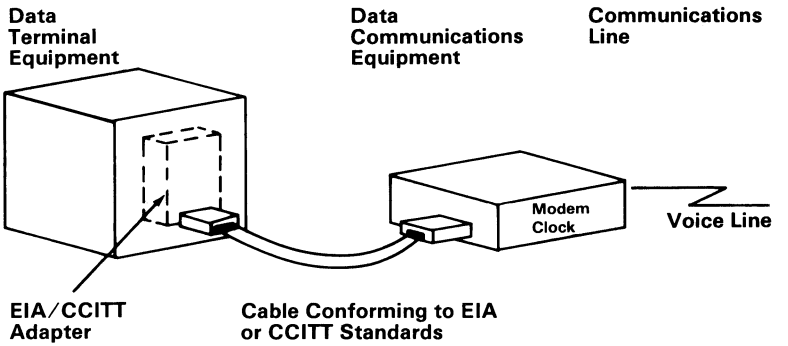
Contents

Notes:

Hardware

Information-processing equipment used for communication is called data terminal equipment (DTE.) Equipment used to connect the DTE to the communication line is called data communication equipment (DCE.)

An adapter connects the data terminal equipment to the data communication line as shown in the following figure:



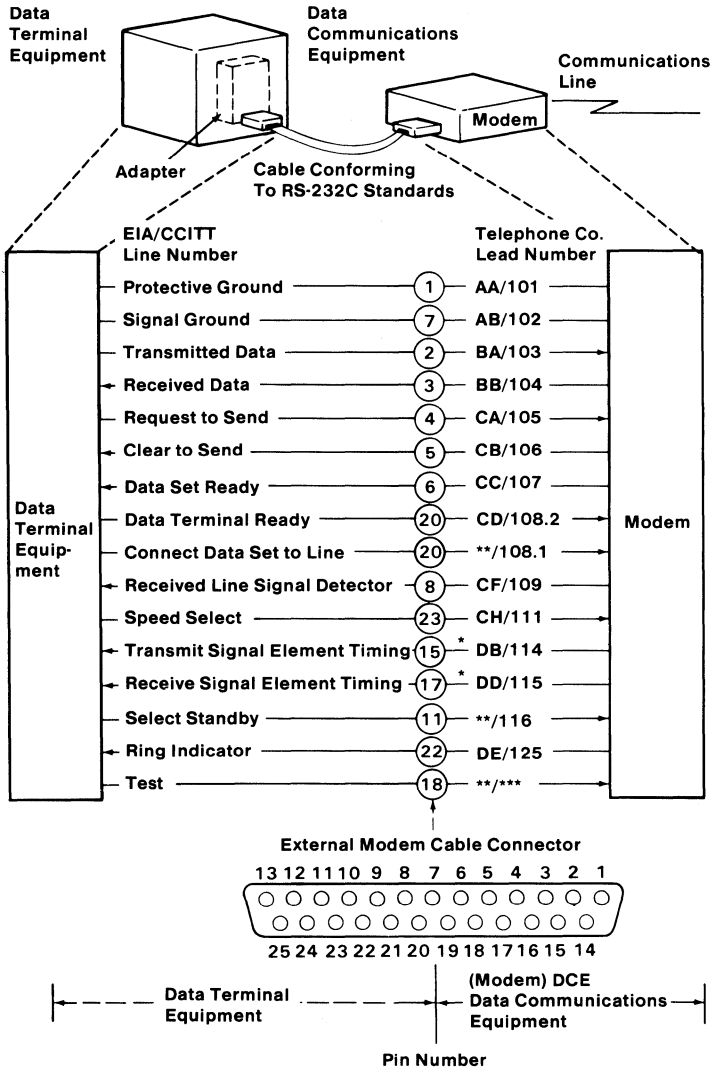
The EIA/CCITT adapter allows the data terminal equipment to be connected to the data communications equipment using EIA or CCITT standardized connections. An external modem is shown in the figure; however, other types of data communications equipment also can be connected to the data terminal equipment using EIA or CCITT standardized connections.

EIA standards are labeled RS-x (recommended standards-x), and CCITT standards are labeled V.x or X.x, where x is the number of the standard.

The EIA RS-232 interface standard defines the connector type, pin numbers, line names, and signal levels used to connect data terminal equipment to data communications equipment for the purpose of transmitting and receiving data. Since the RS-232 standard was developed, it has been revised three times. The three revised standards are RS-232A, RS-232B, and the presently used RS-232C.

The CCITT V.24 interface standard is equivalent to the RS-232C standard; therefore, the descriptions of the EIA standards also apply to the CCITT standards.

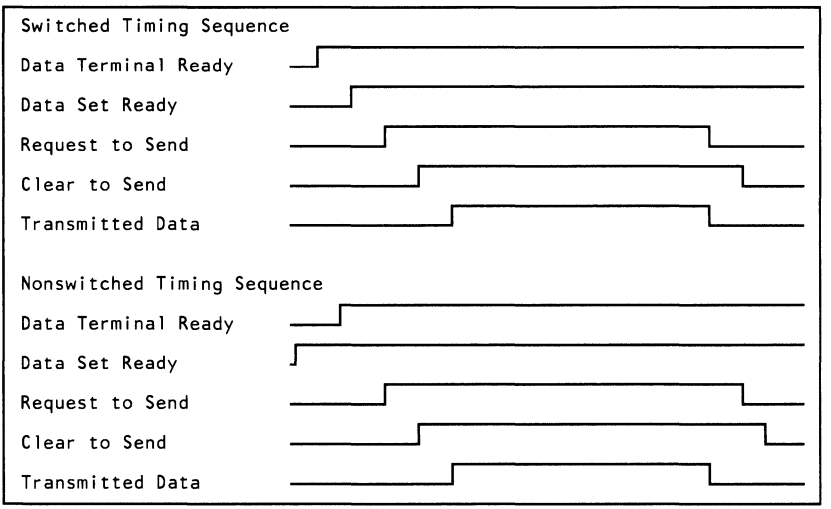
The following is an illustration of data terminal equipment connected to an external modem using connections defined by the RS-232C interface standard:



*Not used when business machine clocking is used.
**Not standardized by EIA (Electronics Industry Association).
***Not standardized by CCITT

Establishing a Communications Link

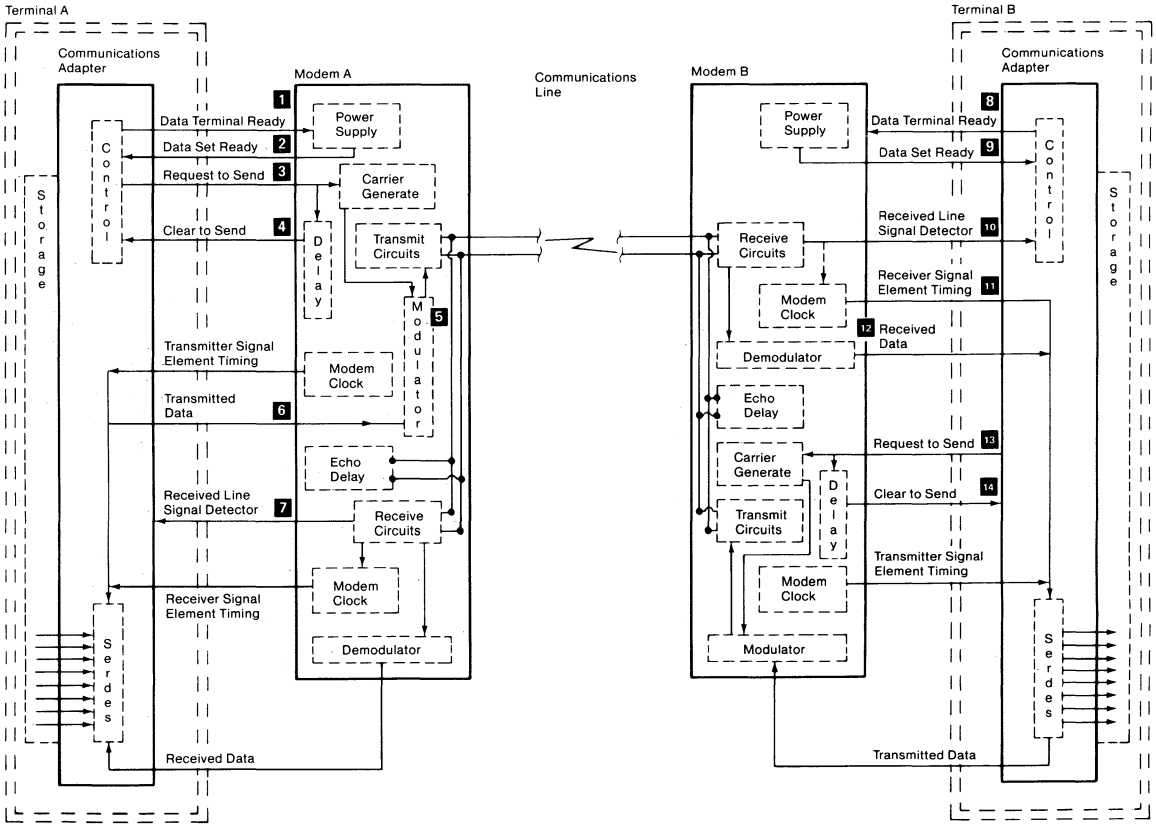
The following bar graphs represent normal timing sequences of operation during the establishment of communication for both switched (dial-up) and nonswitched (direct line) networks.



The following examples show how a link is established on a nonswitched point-to-point line, a nonswitched multipoint line, and a switched point-to-point line.

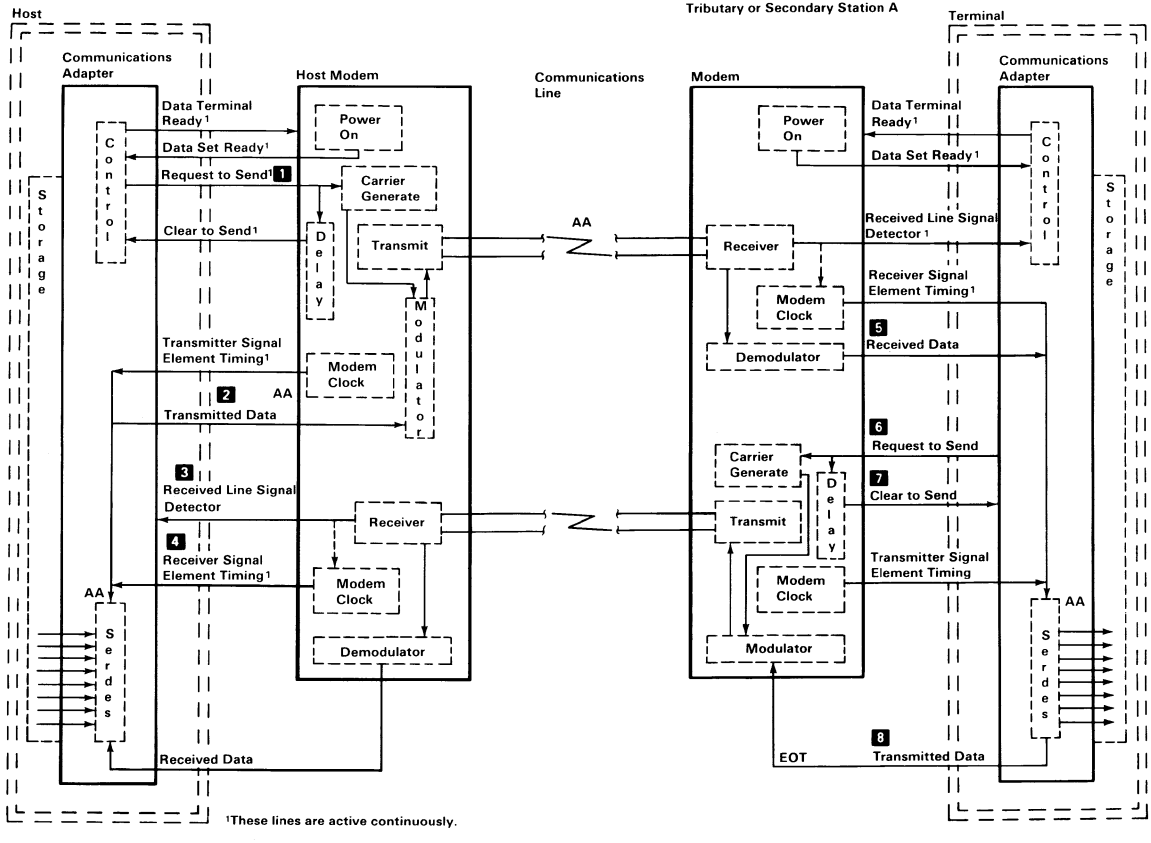
Establishing a Link on a Nonswitched Point-to-Point Line

1. The terminals at both locations activate the 'data terminal ready' lines 1 and 8.
2. Normally the 'data set ready' lines 2 and 9 from the modems are active whenever the modems are powered on.
3. Terminal A activates the 'request to send' line 3, which causes the modem at terminal A to generate a carrier signal.
4. Modem B detects the carrier, and activates the 'received line signal detector' line (sometimes called data carrier detect) 10. Modem B also activates the 'receiver signal element timing' line (sometimes called receive clock) 11 to send receive clock signals to the terminal. Some modems activate the clock signals whenever the modem is powered on.
5. After a specified delay, modem A activates the 'clear to send' line 4, which indicates to terminal A that the modem is ready to transmit data.
6. Terminal A serializes the data to be transmitted (through the serdes) and transmits the data one bit at a time (synchronized by the transmit clock) onto the 'transmitted data' line 6 to the modem.
7. The modem modulates the carrier signal with the data and transmits it to the modem B 5.
8. Modem B demodulates the data from the carrier signal and sends it to terminal B on the 'received data' line 12.
9. Terminal B deserializes the data (through the serdes) using the receive clock signals (on the 'receiver signal element timing' line) 11 from the modem.
10. After terminal A completes its transmission, it deactivates the 'request to send' line 3, which causes the modem to turn off the carrier and deactivate the 'clear to send' line 4.
11. Terminal A and modem A now become receivers and wait for a response from terminal B, indicating that all data has reached terminal B. Modem A begins an echo delay (50 to 150 milliseconds) to ensure that all echoes on the line have diminished before it begins receiving. An echo is a reflection of the transmitted signal. If the transmitting modem changed to receive too soon, it could receive a reflection (echo) of the signal it just transmitted.
12. Modem B deactivates the 'received line signal detector' line 10 and, if necessary, deactivates the receive clock signals on the 'receiver signal element timing' line 11.
13. Terminal B now becomes the transmitter to respond to the request from terminal A. To transmit data, terminal B activates the 'request to send' line 13, which causes modem B to transmit a carrier to modem A.
14. Modem B begins a delay that is longer than the echo delay at modem A before turning on the 'clear to send' line. The longer delay (called request-to-send to clear-to-send delay) ensures that modem A is ready to receive when terminal B begins transmitting data. After the delay, modem B activates the 'clear to send' line 14 to indicate that terminal B can begin transmitting its response.
15. After the echo delay at modem A, modem A senses the carrier from modem B (the carrier was activated in step 13 when terminal B activated the 'request to send' line) and activates the 'received line signal detector' line 7 to terminal A.
16. Modem A and terminal A are now ready to receive the response from terminal B. Remember, the response was not transmitted until after the request-to-send to clear-to-send delay at modem B (step 14).


Terminal A
Communications Adapter
Modem A
Communications Line
Modem B
Terminal B
Communications Adapter
Storage
Control
Power Supply
Carrier Generate
Delay
Transmit Circuits
Modulator
Modem Clock
Echo Delay
Receive Circuits
Demodulator
Serdes
Data Terminal Ready
Data Set Ready
Request to Send
Clear to Send
Transmitter Signal Element Timing
Transmitted Data
Received Line Signal Detector
Receiver Signal Element Timing
Received Data
Modulator
Receive Circuits
Received Line Signal Detector
Receiver Signal Element Timing
Received Data
Request to Send
Clear to Send
Transmitter Signal Element Timing
Transmitted Data

Establishing a Link on a Nonswitched Multipoint Line

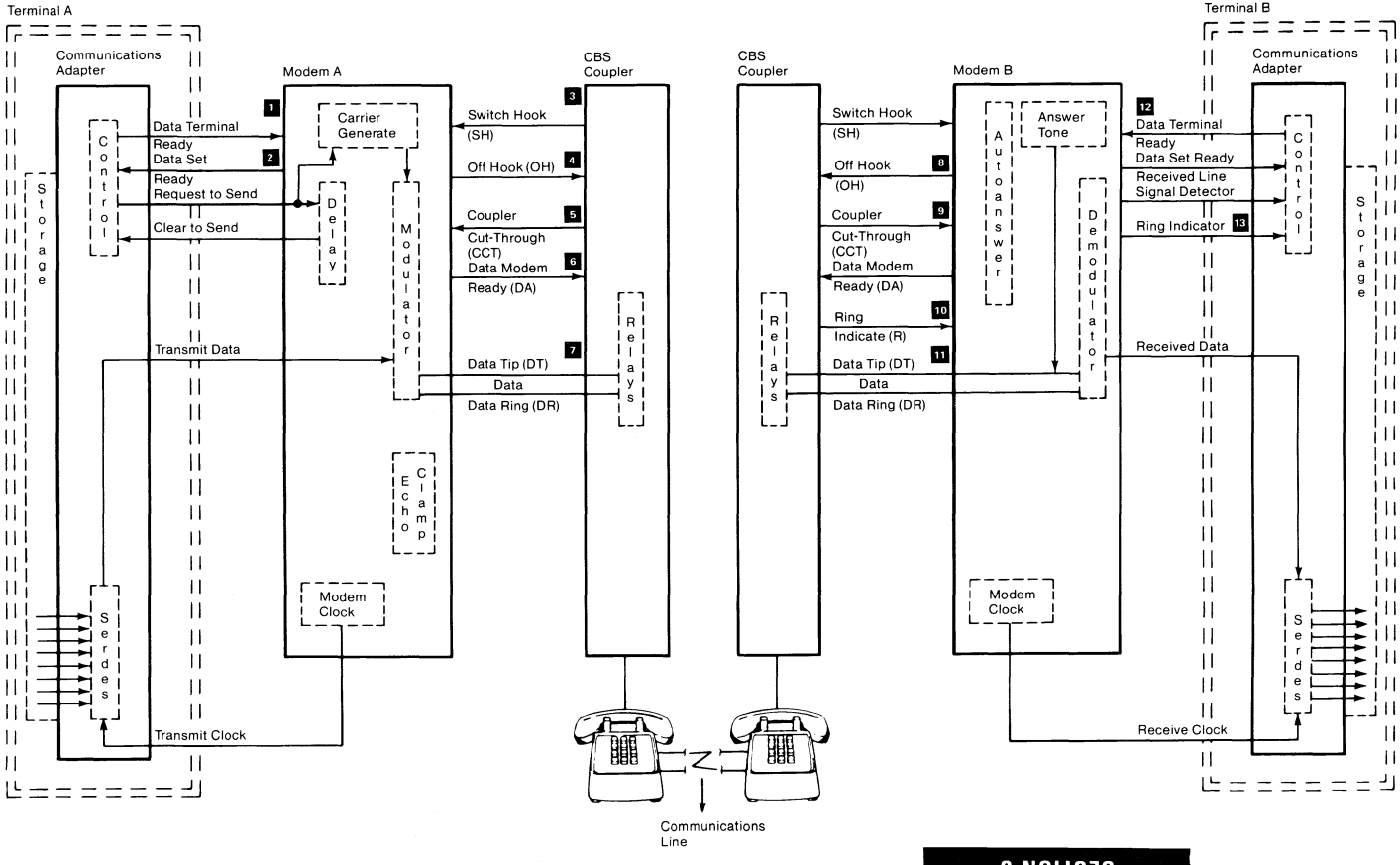
1. The control station serializes the address for the tributary or secondary station (AA) and sends its address to the modem on the 'transmitted data' line 2 .
2. Since the 'request to send' line and, therefore, the modem carrier, is active continuously 1 , the modem immediately modulates the carrier with the address, and, thus, the address is transmitted to all modems on the line.
3. All tributary modems, including the modem for station A, demodulate the address and send it to their terminals on the 'received data' line 5 .
4. Only station A responds to the address; the other stations ignore the address and continue monitoring their 'received data' line. To respond to the poll, station A activates its 'request to send' line 6 which causes the modem to begin transmitting a carrier signal.
5. The control station's modem receives the carrier and activates the 'received line signal detector' line 3 and the 'receiver signal element timing' line 4 (to send clock signals to the control station). Some modems activate the clock signals as soon as they are powered on.
6. After a short delay to allow the control station modem to receive the carrier, the tributary modem activates the 'clear to send' line 7 .
7. When station A detects the active 'clear to send' line, it transmits its response. (For this example, assume that station A has no data to send; therefore, it transmits an EOT 8 .)
8. After transmitting the EOT, station A deactivates the 'request to send' line 6 . This causes the modem to deactivate the carrier and the 'clear to send' line 7 .
9. When the modem at the control station (host) detects the absence of the carrier, it deactivates the 'received line signal detector' line 3 .
10. Tributary station A is now in receive mode waiting for the next poll or select transmission from the control station.


Host
Communications Adapter
Storage
Control
Data Terminal Ready¹
Data Set Ready¹
Request to Send¹ 1
Clear to Send¹
Transmitter Signal Element Timing¹
2 AA
Transmitted Data
3
Received Line Signal Detector
4
Receiver Signal Element Timing¹
AA
Serdes
Received Data
Host Modem
Power On
Carrier Generate
Delay
Transmit
Modulator
Modem Clock
Receiver
Demodulator
Communications Line
AA
Tributary or Secondary Station A
Modem
Power On
Data Terminal Ready¹
Data Set Ready¹
Received Line Signal Detector¹
Receiver Signal Element Timing¹
Modem Clock
5
Received Data
Demodulator
6
Request to Send
Carrier Generate
7
Clear to Send
Delay
Transmit
Transmitter Signal Element Timing
Modem Clock
Modulator
EOT
8
Transmitted Data
Terminal
Communications Adapter
Control
Storage
Serdes
AA
¹These lines are active continuously.

Establishing a Link on a Switched Point-to-Point Line

1. Terminal A is in communications mode; therefore, the 'data terminal ready' line 1 is active. Terminal B is in communication mode waiting for a call from terminal A.
2. When the terminal A operator lifts the telephone handset, the 'switch hook' line from the coupler is activated 3 .
3. Modem A detects the 'switch hook' line and activates the 'off hook' line 4 , which causes the coupler to connect the telephone set to the line and activate the 'coupler cut-through' line 5 to the modem.
4. Modem A activates the 'data modem ready' line 6 to the coupler (the 'data modem ready' line is on continuously in some modems).
5. The terminal A operator sets the exclusion key or talk/data switch to the talk position to connect the handset to the communications line. The operator then dials the terminal B number.
6. When the telephone at terminal B rings, the coupler activates the 'ring indicate' line to modem B 10 . Modem B indicates that the 'ring indicate' line was activated by activating the 'ring indicator' line 13 to terminal B.
7. Terminal B activates the 'data terminal ready' line to modem B 12 , which activates the autoanswer circuits in modem B. (The 'data terminal ready' line might already be active in some terminals.)
8. The autoanswer circuits in modem B activate the 'off hook' line to the coupler 8 .
9. The coupler connects modem B to the communications line through the 'data tip' and 'data ring' lines 11 and activates the 'coupler cut-through' line 9 to the modem. Modem B then transmits an answer tone to terminal A.
10. The terminal A operator hears the tone and sets the exclusion key or talk/data switch to the data position (or performs an equivalent operation) to connect modem A to the communications line through the 'data tip' and 'data ring' lines 7 .
11. The coupler at terminal A deactivates the 'switch hook' line 3 . This causes modem A to activate the 'data set ready' line 2 indicating to terminal A that the modem is connected to the communications line.

    The sequence of the remaining steps to establish the data link is the same as the sequence required on a nonswitched point-to-point line. When the terminals have completed their transmission, they both deactivate the 'data terminal ready' line to disconnect the modems from the line.


Terminal A
Communications Adapter
Storage
Control
Modem A
Carrier Generate
Delay
Modulator
Echo Clamp
Modem Clock
Serdes
CBS Coupler
Relays
Data Terminal Ready
Data Set Ready
Request to Send
Clear to Send
Transmit Data
Transmit Clock
Switch Hook (SH)
Off Hook (OH)
Coupler Cut-Through (CCT)
Data Modem Ready (DA)
Data Tip (DT)
Data
Data Ring (DR)
1
2
3
4
5
6
7
CBS Coupler
Relays
Switch Hook (SH)
Off Hook (OH)
Coupler Cut-Through (CCT)
Data Modem Ready (DA)
Ring Indicate (R)
Data Tip (DT)
Data
Data Ring (DR)
8
9
10
11
Modem B
Autoanswer
Answer Tone
Demodulator
Modem Clock
Terminal B
Communications Adapter
Control
Storage
Serdes
Data Terminal Ready
Data Set Ready
Received Line Signal Detector
Ring Indicator
Received Data
Receive Clock
12
13
Communications Line

Notes:

SECTION 9. IBM PERSONAL COMPUTER COMPATIBILITY

Contents

Notes:

This section describes the differences among the members of the IBM Personal Computer family. It also contains information necessary to design hardware and programs that will be compatible with all members of the IBM Personal Computer family.

Hardware Considerations

To design compatible hardware or programs, you must consider hardware differences among the IBM Personal Computers. The following are hardware features of the IBM Personal Computer AT that are not supported by all of the IBM Personal Computer family.

System Board

The IBM Personal Computer AT system board uses an Intel 80286 Microprocessor. This microprocessor is compatible with the 80287 Math Coprocessor used in the Personal Computer AT, and is generally compatible with the Intel 8088 Microprocessor used in other IBM Personal Computers.

The following table identifies the microprocessor and describes the I/O channel used with each type of IBM Personal Computer.

System Name	System Unit Microprocessor	I/O Channel Description
Personal Computer	8088	5 62-Pin
PCjr	8088	Not Compatible
Personal Computer XT	8088	8 62-Pin
Portable Personal Computer	8088	8 62-Pin
Personal Computer AT	80286	2 62-pin 6 98-Pin (62 Pin + 36 Pin)

System Hardware Identification Chart

The faster processing capability of the 80286, compared to the 8088, creates special programming considerations, which are discussed later in this section under "Application Guidelines."

Some adapters use a 36-pin connector in addition to the 62-pin connector. Adapters designed to use the 36-pin connectors are not compatible with all members of the IBM Personal Computer family. Refer to the "System to Adapter Compatibility Chart" in the *Technical Reference Options and Adapters* manual, Volume 1, to identify the adapters supported by each system. The IBM Personal Computer AT does not support an expansion unit.

On the I/O channel:

- The system clock signal should be used only for synchronization and not for applications requiring a fixed frequency.
- The 14.31818-MHz oscillator is not synchronous with the system clock.
- The ALE signal is activated during DMA cycles.
- The -IOW signal is not active during refresh cycles.
- Pin B04 supports IRQ 9.

Fixed Disk Drive

Reading from and writing to this drive is initiated in the same way as with other IBM Personal Computers; however, the Fixed Disk and Diskette Drive Adapter may be addressed from different BIOS locations.

Diskette Drive Compatibility

The following chart shows the read, write, and format capabilities for each of the diskette drives used by IBM Personal Computers.

Diskette Drive Name	160/180K Mode	320/360K Mode	1.2M Mode
5-1/4 In. Diskette Drive:			
Type 1	R W F	---	---
Type 2	R W F	R W F	---
Type 3	R W F	R W F	---
Slimline Diskette Drive	R W F	R W F	---
Double Sided Diskette Drive	R W F	R W F	---
High Capacity Diskette Drive	R W*	R W*	R W F
R-Read W-Write F-Format W*-If a diskette is formatted in either 160/180K mode or 320/360K mode and written on by a High Capacity Drive, that diskette may be read by only a High Capacity Drive.			

Diskette Drive Compatibility Chart

Note: Diskettes designed for the 1.2M mode may not be used in either a 160/180K or a 320/360K diskette drive.

Copy Protection

The following methods of copy protection may not work on systems using the High Capacity Diskette Drive:

- Bypassing BIOS

- Diskette drive controls
- Write current control

Bypassing BIOS

Copy protection that tries to bypass the following BIOS routines will not work on the High Capacity Diskette Drive:

Track Density: The High Capacity Diskette Drive records tracks at a density of 96 TPI (tracks per inch). This drive has to double-step in the 48 TPI mode, which is performed by BIOS.

Data Transfer Rate: BIOS selects the proper data transfer rate for the media being used.

Disk_Base: Copy protection, which creates its own disk_base will not work on the High Capacity Diskette Drive.

Diskette Drive Controls

Copy protection that uses the following will not work on the High Capacity Diskette Drive:

Rotational Speed: The time between two events on a diskette is controlled by the Fixed Disk and Diskette Drive Adapter.

Access Time: Diskette BIOS routines must set the track-to-track access time for the different types of media used on the IBM Personal Computer AT.

Head Geometry: See "Diskette Drive Compatibility" on page 9-5

Diskette Change Signal: Copy protection may not be able to reset this signal.

Write Current Control

Copy protection that uses write current control will not work because the Fixed Disk and Diskette Drive Adapter selects the proper write current for the media being used.

Application Guidelines

The following information should be used to develop application programs for the IBM Personal Computer family.

High-Level Language Considerations

The IBM-supported languages of BASIC, FORTRAN, COBOL, Pascal, and APL are the best choices for writing compatible programs.

If a program uses specific features of the hardware, that program may not be compatible with all IBM Personal Computers. Specifically, the use of assembler language subroutines or hardware-specific commands (In, Out, Peek, Poke, ...) must follow the assembler language rules (see "Assembler Language Programming Considerations" on page 9-8).

Any program that requires precise timing information should obtain it through a DOS or language interface; for example, TIME$ in BASIC. If greater precision is required, the assembler techniques in "Assembler Language Programming Considerations" are available. The use of programming loops may prevent a program from being compatible with other IBM Personal Computers.

Assembler Language Programming Considerations

The following OP codes work differently on systems using the 80286 microprocessor than they do on systems using the 8088 microprocessor.

- If the system microprocessor executes a POPF instruction in either the real or the virtual address mode with CPL≤IOPL, then a pending maskable interrupt (the INTR pin active) may be improperly recognized after executing the POPF instruction even if maskable interrupts were disabled before the POPF instruction and the value popped had IF=0. If the interrupt is improperly recognized, the interrupt is still correctly executed. This errata has no effect when interrupts are enabled in either real or virtual address mode. This errata has no effect in the virtual address mode when CPL>IOPL.

  The POPF instruction may be simulated with the following code macro:

```
POPFF       Macro       ; use POPFF instead of POPF
                        ; simulate popping flags
                        ; using IRET
EB 01       JMP $+3     ; jump around IRET
CF          IRET        ; POP CS, IP, flags
0E          PUSH CS
E8 FB FF    CALL $-2    ; CALL within segment
                        ; program will continue here
```

- PUSH SP

  80286 microprocessor pushes the current stack pointer.

  8088 microprocessor pushes the new stack pointer.

- Single step interrupt (when TF=1) on the interrupt instruction (OP code hex CC,CD):

  80286 microprocessor does **not** interrupt on the INT instruction.

8088 microprocessor does interrupt on the INT instruction.

- The divide error exception (interrupt 0):

  80286 microprocessor pushes the CS:IP of the instruction, causing the exception.

  8088 microprocessor pushes the CS:IP **following** the instruction, causing the exception.

- Shift counts are masked to five bits. Shift counts greater than 31 are treated mod 32. For example, a shift count of 36, shifts the operand four places.

The following describes anomalies which may occur in systems which contain 80286 processors with 1983 and 1984 date codes (S40172, S54036, S40093, S54012).

In protected mode, the contents of the CX register may be unexpectedly altered under the following conditions:

Note: The value in parenthesis indicates the type of error code pushed onto the exception handler's stack.

Exception #NP() = Exception #11 = Not-present Fault
Exception #SS() = Exception #12 = Stack Fault
Exception #GP() = Exception #13 = General Protection Fault

- Exception #GP(0) from attempted access to data segment or extra segment when the corresponding segment register holds a null selector.

- Exception #GP(0) from attempted data read from code segment when code segment has the "execute only" attribute.

- Exception #GP(0) from attempted write to code segment (code segments are not writable in protected mode), or to data segment of extra segment if the data or extra segment has the read only attribute.

- Exception #GP(0) from attempted load of a selector referencing the local descriptor table into CS, DS, ES or SS, when the LDT is not present.

- Exception #GP(0) from attempted input or output instruction when CPL > IOPL.

- Exception #GP(selector) from attempted access to a descriptor is GDT, LDT, or IDT, beyond the defined limit of the descriptor table.

- Exception #GP(0) from attempted read or write (except for "PUSH" onto stack) beyond the defined limit of segment.

- Exception #SS(0) from attempted "PUSH" below the defined limit of the stack segment.

Restarting applications which generate the above exceptions may result in errors.

In the protected mode, when any of the null selector values (0000H, 0001H, 0002H, 0003H) are loaded into the DS or ES registers via a MOV or POP instruction or a task switch, the 80286 always loads the null selector 0000H into the corresponding register.

If a coprocessor (80287) operand is read from an "executable and readable" and conforming (ERC) code segment, and the coprocessor operand is sufficiently near the segment's limit that the second or subsequent byte lies outside the limit, no protection exception #9 will be generated.

The following correctly describes the operation of all 80286 parts:

- Instructions longer than 10 bytes (instructions using multiple redundant prefixes) generate exception #13 (General Purpose Exception) in both the real and protected modes.

- If the second operand of an ARPL instruction is a null selector, the instruction generates an exception #13.

Assembler language programs should perform all I/O operations through ROM BIOS or DOS function calls.

- Program interrupts are used for access to these functions. This practice removes the absolute addressing from the program. Only the interrupt number is required.

- The coprocessor detects six different exception conditions that can occur during instruction execution. If the appropriate exception mask within the coprocessor is not set, the coprocessor sets its error signal. This error signal generates a hardware interrupt (interrupt 13) and causes the 'busy' signal to the coprocessor to be held in the busy state. The 'busy' signal may be cleared by an 8-bit I/O Write command to address hex F0 with D0 through D7 equal to 0.

  The power-on-self-test code in the system ROM enables hardware IRQ 13 and sets up its vector to point to a routine in ROM. The ROM routine clears the 'busy' signal latch and then transfers control to the address pointed to by the NMI interrupt vector. This allows code written for any IBM Personal Computer to work on an IBM Personal Computer AT. The NMI interrupt handler should read the coprocessor's status to determine if the NMI was caused by the coprocessor. If the interrupt was not generated by the coprocessor, control should be passed to the original NMI interrupt handler.

- Back to back I/O commands to the same I/O ports will not permit enough recovery time for I/O chips. To ensure enough time, a JMP SHORT $+2 must be inserted between IN/OUT instructions to the same I/O chip.

  Note: MOV AL,AH type instruction does not allow enough recovery time. An example of the correct procedure follows:

```
OUT  IO_ADD,AL
JMP  SHORT $+2
MOV  AL,AH
OUT  IO_ADD,AL
```

- In systems using the 80286 microprocessor, IRQ 9 is redirected to INT hex 0A (hardware IRQ 2). This insures

that hardware designed to use IRQ 2 will operate in the IBM Personal Computer AT.

- The system can mask hardware sensitivity. New devices can change the ROM BIOS to accept the same programming interface on the new device.

- In cases where BIOS provides parameter tables, such as for video or diskette, a program may substitute new parameter values by building a new copy of the table and changing the vector to point to that table. However, the program should copy the current table, using the current vector, and then modify those locations in the table that need to be changed. In this way, the program will not inadvertently change any values that should be left the same.

- Disk_Base consists of 11 parameters required for diskette operation. They are pointed at by the data variable, Disk_Pointer, at absolute address 0:78. It is strongly recommended that the values supplied in ROM be used. If it becomes necessary to modify any of the parameters, build another parameter block and modify the address in Disk_Pointer to point to the new block.

  The parameters were established to operate both the High Capacity Diskette Drive and the Double Sided Diskette Drive. Three of the parameters in this table are under control of BIOS in the following situations.

  The Gap Length Parameter is no longer retrieved from the parameter block.

  The gap length used during diskette read, write, and verify operations is derived from within diskette BIOS.

  The gap length for format operations is still obtained from the parameter block.

  Special considerations are required for formatting operations. See the prolog of Diskette BIOS for the required details. If a parameter block contains a head settle time parameter value of 0 milliseconds, and a write operation is being performed, at least 15 milliseconds of head settle time will be enforced

for a High Capacity Diskette Drive and 20 milliseconds will be enforced for a Double Sided Diskette Drive. If a parameter block contains a motor start wait parameter of less than 1 second for a write or format operation of 625 milliseconds for a read or verify operation, Diskette BIOS will enforce those times listed above.

- The following procedure is used to determine the type of media inserted in the High Capacity Diskette Drive:

  1. Read Track 0, Head 0, Sector 1 to allow diskette BIOS to establish the media/drive combination. If this is successful, continue with the next step.

  2. Read Track 0, Sector 15. If an error occurs, a double sided diskette is in the drive.

     Note: Refer to the *DOS Technical Reference* manual for the File Allocation Table (FAT) parameters for single- and double-sided diskettes.

     If a successful read occurs, a high capacity diskette is in the drive.

  3. If Step 1 fails, issue the reset function (AH=0) to diskette BIOS and retry. If a successful read cannot be done, the media needs to be formatted or is defective.

ROM BIOS and DOS do not provide for all functions. The following are the allowable I/O operations with which IBM will maintain compatibility in future systems.

- Control of the sound, using port hex 61, and the sound channel of the timer/counter. A program can control timer/counter channels 0 and 2, ports hex 40, 42, and 43. A program must not change the value in port hex 41, because this port controls the dynamic-memory refresh. Channel 0 provides the time-of-day interrupt, and can also be used for timing short intervals. Channel 2 of the timer/counter is the output for the speaker and cassette ports. This channel may also be used for timing short intervals, although it cannot interrupt at the end of the period.

- Control of the Game Control Adapter, port hex 201

  Note: Programs should use the timer for delay on the paddle input rather than a program loop.

- Interrupt Mask Register (IMR), port hex 21, can be used to selectively mask and unmask the hardware features.

The following information pertains to absolute memory locations.

- Interrupt Vectors Segment (hex 0)--A program may change these to point at different processing routines. When an interrupt vector is modified, the original value should be retained. If the interrupt, either hardware or program, is not directed toward this device handler, the request should be passed to the next item in the list.

- Video Display Buffers (hex B0000 and B8000)-- For each mode of operation defined in the video display BIOS, the memory map will remain the same. For example, the bit map for the 320 x 200 medium-resolution graphics mode of the Color/Graphics Monitor adapter will be retained on any future adapter that supports that mode. If the bit map is modified, a different mode number will be used.

- ROM BIOS Data Area (hex 40:0)--Any variables in this area will retain their current definition, whenever it is reasonable to do so. IBM may use these data areas for other purposes when the variable no longer has meaning in the system. In general, ROM BIOS data variables should be read or modified through BIOS calls whenever possible, and not with direct access to the variable.

A program that requires timing information should use either the time-of-day clock or the timing channels of the timer/counter. The input frequency to the timer will be maintained at 1.19 MHz, providing a constant time reference. Program loops should be avoided.

Programs that use copy protection schemes should use the ROM BIOS diskette calls to read and verify the diskette and should not be timer dependent. Any method can be used to create the diskette, although manufacturing capability should be considered.

The verifying program can look at the diskette controller's status bytes in the ROM BIOS data area for additional information about embedded errors. More information about copy protection may be found on page 9-5 under "Copy Protection".

Any DOS program must be relocatable and insensitive to the size of DOS or its own load addresses. A program's memory requirement should be identified and contiguous with the load module. A program should not assume that all of memory is available to it.

There are several 80286 instructions that, when executed, lock out external bus signals. DMA requests are not honored during the execution of these instructions. Consecutive instructions of this type prevent DMA activity from the start of the first instruction to the end of the last instruction. To allow for necessary DMA cycles, as required by the diskette controller in a multitasking system, multiple lock-out instructions must be seperated by JMP SHORT $+2.

Multitasking Provisions

The IBM Personal Computer AT BIOS contains a feature to assist multitasking implementation. "Hooks" are provided for a multitasking dispatcher. Whenever a busy (wait) loop occurs in the BIOS, a hook is provided for the program to break out of the loop. Also, whenever BIOS services an interrupt, a corresponding wait loop is exited, and another hook is provided. Thus a program may be written that employs the bulk of the device driver code. The following is valid only in the microprocessor's real address mode and must be taken by the code to allow this support.

The program is responsible for the serialization of access to the device driver. The BIOS code is not reentrant.

The program is responsible for matching corresponding wait and post calls.

Interfaces

There are four interfaces to be used by the multitasking dispatcher:

Startup

First, the startup code hooks interrupt hex 15. The dispatcher is responsible to check for function codes of AH= hex 90 or 91. The "Wait" and "Post" sections describe these codes. The dispatcher must pass all other functions to the previous user of interrupt hex 15. This can be done by a JMP or a CALL. If the function code is hex 90 or 91, the dispatcher should do the appropriate processing and return by the IRET instruction.

Serialization

It is up to the multitasking system to ensure that the device driver code is used serially. Multiple entries into the code can result in serious errors.

Wait (Busy)

Whenever the BIOS is about to enter a busy loop, it first issues an interrupt hex 15 with a function code of hex 90 in AH. This signals a wait condition. At this point, the dispatcher should save the task status and dispatch another task. This allows overlapped execution of tasks when the hardware is busy. The following is an outline of the code that has been added to the BIOS to perform this function.

```
MOV AX, 90XXH          ; wait code in AH and
                       ; type code in AL
INT 15H                ; issue call
JC  TIMEOUT            ; optional: for time-out or
                       ; if carry is set, time-out
                       ; occurred
NORMAL TIMEOUT LOGIC ; normal time-out
```


Post (Interrupt)

Whenever the BIOS has set an interrupt flag for a corresponding busy loop, an interrupt 15 occurs with a function code of hex 91 in AH. This signals a post condition. At this point, the dispatcher should set the task status to "ready to run" and return to the interrupt routine. The following is an outline of the code added to BIOS that performs this function.

```
MOV AX, 91XXH          ; post code AH and
                       ; type code AL
INT 15H                ; issue call
```

Classes

The following types of wait loops are supported:

- The class for hex 0 to 7F is serially reusable. This means that for the devices that use these codes, access to the BIOS must be restricted to only one task at a time.

- The class for hex 80 to BF is reentrant. There is no restriction on the number of tasks that may access the device.

- The class for hex C0 to FF is non-interrupt. There is no corresponding interrupt for the wait loop. Therefore, it is the responsibility of the dispatcher to determine what satisfies this condition to exit the loop.

Function Code Classes

Type Code (AL)	Description
00H->7FH	Serially reusable devices; operating system must serialize access
80H->0BFH	Reentrant devices; ES:BX is used to distinguish different calls (multiple I/O calls are allowed simultaneously)
0C0H->0FH	Wait only calls; there is no complementary POST for these waits--these are time-out only. Times are function-number dependent.

Function Code Assignments

The following are specific assignments for the IBM Personal Computer AT BIOS. Times are approximate. They are grouped according to the classes described under "Function Code Classes".

Type Code (AL)	Time-out	Description
00H	yes (6 second)	fixed disk
01H	yes (2 second)	diskette
02H	no	keyboard
0FDH	yes (1 second-write)	diskette motor start

--	(625 ms-read)	--
0FEH	yes (18 second)	printer

The asynchronous support has been omitted. The Serial/Parallel Adapter will generate interrupts, but BIOS does not support it in the interrupt mode. Therefore, the support should be included in the multitasking system code if that device is to be supported.

Time-Outs

To support time-outs properly, the multitasking dispatcher must be aware of time. If a device enters a busy loop, it generally should remain there for a specific amount of time before indicating an error. The dispatcher should return to the BIOS wait loop with the carry bit set if a time-out occurrs.

Machine-Sensitive Code

Programs may select machine specific features, but they must test for specific machine type. Location of the specific machine identification codes can be found through interrupt 15 function code AH (See 'Configuration Parameters' in BIOS Listing). The code is two bytes. The first byte shows the machine type and the second byte shows the series type. They are as follows:

First Byte	Second Byte	Machine Identification
FF	00	IBM Personal Computer
FE	00	IBM Personal Computer XT
FE	00	IBM Portable Personal Computer
FD	00	IBM PCjr
FC	00	IBM Personal Computer AT

Machine Identification Code

IBM will define methods for uniquely determining the specific machine type or I/O feature for any new device.

Notes:

Glossary

This glossary includes definitions developed by the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO). This material is reproduced from the *American National Dictionary for Information Processing*, copyright 1977 by the Computer and Business Equipment Manufacturers Association, copies of which may be purchased from the American National Standards Institute, 1430 Broadway, New York, New York 10018.

μ. Prefix micro; 0.000 001.

μs. Microsecond; 0.000 001 second.

A. Ampere.

ac. Alternating current.

accumulator. A register in which the result of an operation is formed.

active high. Designates a signal that has to go high to produce an effect. Synonymous with positive true.

active low. Designates a signal that has to go low to produce an effect. Synonymous with negative true.

adapter. An auxiliary device or unit used to extend the operation of another system.

address bus. One or more conductors used to carry the binary-coded address from the processor throughout the rest of the system.

algorithm. A finite set of well-defined rules for the solution of a problem in a finite number of steps.

all points addressable (APA). A mode in which all points of a displayable image can be controlled by the user.

alphameric. Synonym for alphanumeric.

alphanumeric (A/N). Pertaining to a character set that contains letters, digits, and usually other characters, such as punctuation marks. Synonymous with alphameric.

alternating current (ac). A current that periodically reverses its direction of flow.

American National Standard Code for Information Interchange (ASCII). The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity check), used for information exchange between data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

ampere (A). The basic unit of electric current.

A/N. Alphanumeric

analog. (1) Pertaining to data in the form of continuously variable physical quantities. (2) Contrast with digital.

AND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the AND of P, Q, R,...is true if all statements are true, false if any statement is false.

AND gate. A logic gate in which the output is 1 only if all inputs are 1.

AND operation. The boolean operation whose result has the boolean value 1, if and only if, each operand has the boolean value 1. Synonymous with conjunction.

APA. All points addressable.

ASCII. American National Standard Code for Information Interchange.

assemble. To translate a program expressed in an assembler language into a computer language.

assembler. A computer program used to assemble.

assembler language. A computer-oriented language whose instructions are usually in one-to-one correspondence with computer instructions.

asynchronous transmission. (1) Transmission in which the time of occurrence of the start of each character, or block of characters, is arbitrary; once started, the time of occurrence of each signal representing a bit within a character, or block, has the same relationship to significant instants of a fixed time frame. (2) Transmission in which each information character is individually transmitted (usually timed by the use of start elements and stop elements).

audio frequencies. Frequencies that can be heard by the human ear (approximately 15 hertz to 20,000 hertz).

auxiliary storage. (1) A storage device that is not main storage. (2) Data storage other than main storage; for example, storage on magnetic disk. (3) Contrast with main storage.

BASIC. Beginner's all-purpose symbolic instruction code.

basic input/output system (BIOS). The feature of the IBM Personal Computer that provides the level control of the major I/O devices, and relieves the programmer from concern about hardware device characteristics.

baud. (1) A unit of signaling speed equal to the number of discrete conditions or signal events per second. For example, one baud equals one bit per second in a train of binary signals, one-half dot cycle per second in Morse code, and one 3-bit value per second in a train of signals each of which can assume one of eight different states. (2) In asynchronous transmission, the unit of modulation rate corresponding to one unit of interval per second; that is, if the duration of the unit interval is 20 milliseconds, the modulation rate is 50 baud.

BCC. Block-check character.

beginner's all-purpose symbolic instruction code (BASIC). A programming language with a small repertoire of commands and a simple syntax, primarily designed for numeric applications.

binary. (1) Pertaining to a selection, choice, or condition that has two possible values or states. (2) Pertaining to a fixed radix numeration system having a radix of 2.

binary digit. (1) In binary notation, either of the characters 0 or 1. (2) Synonymous with bit.

binary notation. Any notation that uses two different characters, usually the binary digits 0 and 1.

binary synchronous communications (BSC). A uniform procedure, using a standardized set of control characters and control character sequences for synchronous transmission of binary–coded data between stations.

BIOS. Basic input/output system.

bit. Synonym for binary digit

bits per second (bps). A unit of measurement representing the number of discrete binary digits transmitted by a device in one second.

block. (1) A string of records, a string of words, or a character string formed for technical or logic reasons to be treated as an entity. (2) A set of things, such as words, characters, or digits, treated as a unit.

block-check character (BCC). In cyclic redundancy checking, a character that is transmitted by the sender after each message block and is compared with a block-check character computed by the receiver to determine if the transmission was successful.

boolean operation. (1) Any operation in which each of the operands and the result take one of two values. (2) An operation that follows the rules of boolean algebra.

bootstrap. A technique or device designed to bring itself into a desired state by means of its own action; for example, a machine routine whose first few instructions are sufficient to bring the rest of itself into the computer from an input device.

bps. Bits per second.

BSC. Binary synchronous communications.

buffer. (1) An area of storage that is temporarily reserved for use in performing an input/output operation, into which data is read or from which data is written. Synonymous with I/O area. (2) A portion of storage for temporarily holding input or output data.

bus. One or more conductors used for transmitting signals or power.

byte. (1) A sequence of eight adjacent binary digits that are operated upon as a unit. (2) A binary character operated upon as a unit. (3) The representation of a character.

C. Celsius.

capacitor. An electronic circuit component that stores an electric charge.

CAS. Column address strobe.

cathode ray tube (CRT). A vacuum tube in which a stream of electrons is projected onto a fluorescent screen producing a luminous spot. The location of the spot can be controlled.

cathode ray tube display (CRT display). (1) A CRT used for displaying data. For example, the electron beam can be controlled to form alphanumeric data by use of a dot matrix.
(2) Synonymous with monitor.

CCITT. International Telegraph and Telephone Consultative Committee.

Celsius (C). A temperature scale. Contrast with Fahrenheit (F).

central processing unit (CPU). Term for processing unit.

channel. A path along which signals can be sent; for example, data channel, output channel.

character generator. (1) In computer graphics, a functional unit that converts the coded representation of a graphic character into the shape of the character for display. (2) In word processing, the means within equipment for generating visual characters or symbols from coded data.

character set. (1) A finite set of different characters upon which agreement has been reached and that is considered complete for some purpose. (2) A set of unique representations called characters. (3) A defined collection of characters.

characters per second (cps). A standard unit of measurement for the speed at which a printer prints.

check key. A group of characters, derived from and appended to a data item, that can be used to detect errors in the data item during processing.

clipping. In computer graphics, removing parts of a display image that lie outside a window.

closed circuit. A continuous unbroken circuit; that is, one in which current can flow. Contrast with open circuit.

CMOS. Complementary metal oxide semiconductor.

code. (1) A set of unambiguous rules specifying the manner in which data may be represented in a discrete form. Synonymous with coding scheme. (2) A set of items, such as abbreviations, representing the members of another set. (3) To represent data or a computer program in a symbolic form that can be accepted by a data processor. (4) Loosely, one or more computer programs, or part of a computer program.

coding scheme. Synonym for code.

collector. An element in a transistor toward which current flows.

color cone. An arrangement of the visible colors on the surface of a double-ended cone where lightness varies along the axis of the cone, and hue varies around the circumference. Lightness includes both the intensity and saturation of color.

column address strobe (CAS). A signal that latches the column addresses in a memory chip.

compile. (1) To translate a computer program expressed in a problem-oriented language into a computer-oriented language. (2) To prepare a machine-language program from a computer program written in another programming language by making use of the overall logic structure of the program, or generating more

than one computer instruction for each symbolic statement, or both, as well as performing the function of an assembler.

complement. A number that can be derived from a specified number by subtracting it from a second specified number.

complementary metal oxide semiconductor (CMOS). A logic circuit family that uses very little power. It works with a wide range of power supply voltages.

computer. A functional unit that can perform substantial computation, including numerous arithmetic operations or logic operations, without human intervention during a run.

computer instruction code. A code used to represent the instructions in an instruction set. Synonymous with machine code.

computer program. A sequence of instructions suitable for processing by a computer.

computer word. A word stored in one computer location and capable of being treated as a unit.

configuration. (1) The arrangement of a computer system or network as defined by the nature, number, and the chief characteristics of its functional units. More specifically, the term configuration may refer to a hardware configuration or a software configuration. (2) The devices and programs that make up a system, subsystem, or network.

conjunction. Synonym for AND operation.

contiguous. Touching or joining at the edge or boundary; adjacent.

control character. A character whose occurrence in a particular context initiates, modifies, or stops a control operation.

control operation. An action that affects the recording, processing, transmission, or interpretation of data; for example, starting or stopping a process, carriage return, font change, rewind, and end of transmission.

control storage. A portion of storage that contains microcode.

coordinate space. In computer graphics, a system of Cartesian coordinates in which an object is defined.

cps. Characters per second.

CPU. Central processing unit.

CRC. Cyclic redundancy check.

CRT. Cathode ray tube.

CRT display. Cathode ray tube display.

CTS. Clear to send. Associated with modem control.

cursor. (1) In computer graphics, a movable marker that is used to indicate position on a display. (2) A displayed symbol that acts as a marker to help the user locate a point in text, in a system command, or in storage. (3) A movable spot of light on the screen of a display device, usually indicating where the next character is to be entered, replaced, or deleted.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) A system of error checking performed at both the sending and receiving station after a block-check character has been accumulated.

cylinder. (1) The set of all tracks with the same nominal distance from the axis about which the disk rotates. (2) The tracks of a disk storage device that can be accessed without repositioning the access mechanism.

daisy-chained cable. A type of cable that has two or more connectors attached in series.

data. (1) A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or

processing by human or automatic means. (2) Any representations, such as characters or analog quantities, to which meaning is, or might be assigned.

data base. A collection of data that can be immediately accessed and operated upon by a data processing system for a specific purpose.

data processing system. A system that performs input, processing, storage, output, and control functions to accomplish a sequence of operations on data.

data transmission. Synonym for transmission.

dB. Decibel.

dBa. Adjusted decibels.

dc. Direct current.

debounce. (1) An electronic means of overcoming the make/break bounce of switches to obtain one smooth change of signal level. (2) The elimination of undesired signal variations caused by mechanically generated signals from contacts.

decibel. (1) A unit that expresses the ratio of two power levels on a logarithmic scale. (2) A unit for measuring relative power.

decoupling capacitor. A capacitor that provides a low impedance path to ground to prevent common coupling between circuits.

Deutsche Industrie Norm (DIN). (1) German Industrial Norm. (2) The committee that sets German dimension standards.

digit. (1) A graphic character that represents an integer; for example, one of the characters 0 to 9. (2) A symbol that represents one of the non-negative integers smaller than the radix. For example, in decimal notation, a digit is one of the characters 0 to 9.

digital. (1) Pertaining to data in the form of digits. (2) Contrast with analog.

DIN. Deutsche Industrie Norm.

DIN connector. One of the connectors specified by the DIN committee.

DIP. Dual in-line package.

DIP switch. One of a set of small switches mounted in a dual in-line package.

direct current (dc). A current that always flows in one direction.

direct memory access (DMA). A method of transferring data between main storage and I/O devices that does not require processor intervention.

disable. To stop the operation of a circuit or device.

disabled. Pertaining to a state of a processing unit that prevents the occurrence of certain types of interruptions. Synonymous with masked.

disk. Loosely, a magnetic disk.

diskette. A thin, flexible magnetic disk and a semirigid protective jacket, in which the disk is permanently enclosed. Synonymous with flexible disk.

diskette drive. A device for storing data on and retrieving data from a diskette.

display. (1) A visual presentation of data. (2) A device for visual presentation of information on any temporary character imaging device. (3) To present data visually. (4) See cathode ray tube display.

display attribute. In computer graphics, a particular property that is assigned to all or part of a display; for example, low intensity, green color, blinking status.

display element. In computer graphics, a basic graphic element that can be used to construct a display image; for example, a dot, a line segment, a character.

display group. In computer graphics, a collection of display elements that can be manipulated as a unit and that can be further combined to form larger groups.

display image. In computer graphics, a collection of display elements or display groups that are represented together at any one time in a display space.

display space. In computer graphics, that portion of a display surface available for a display image. The display space may be all or part of a display surface.

display surface. In computer graphics, that medium on which display images may appear; for example, the entire screen of a cathode ray tube.

DMA. Direct memory access.

dot matrix. (1) In computer graphics, a two-dimensional pattern of dots used for constructing a display image. This type of matrix can be used to represent characters by dots. (2) In word processing, a pattern of dots used to form characters. This term normally refers to a small section of a set of addressable points; for example, a representation of characters by dots.

dot printer. Synonym for matrix printer.

dot-matrix character generator. In computer graphics, a character generator that generates character images composed of dots.

drawing primitive. A group of commands that draw defined geometric shapes.

DSR. Data set ready. Associated with modem control.

DTR. In the IBM Personal Computer, data terminal ready. Associated with modem control.

dual in-line package (DIP). A widely used container for an integrated circuit. DIPs have pins in two parallel rows. The pins are spaced 1/10 inch apart. See also DIP switch.

duplex. (1) In data communication, pertaining to a simultaneous two-way independent transmission in both directions. (2) Contrast with half-duplex.

duty cycle. In the operation of a device, the ratio of on time to idle time. Duty cycle is expressed as a decimal or percentage.

dynamic memory. RAM using transistors and capacitors as the memory elements. This memory requires a refresh (recharge) cycle every few milliseconds. Contrast with static memory.

EBCDIC. Extended binary-coded decimal interchange code.

ECC. Error checking and correction.

edge connector. A terminal block with a number of contacts attached to the edge of a printed-circuit board to facilitate plugging into a foundation circuit.

EIA. Electronic Industries Association.

electromagnet. Any device that exhibits magnetism only while an electric current flows through it.

enable. To initiate the operation of a circuit or device.

end of block (EOB). A code that marks the end of a block of data.

end of file (EOF). An internal label, immediately following the last record of a file, signaling the end of that file. It may include control totals for comparison with counts accumulated during processing.

end-of-text (ETX). A transmission control character used to terminate text.

end-of-transmission (EOT). A transmission control character used to indicate the conclusion of a transmission, which may have included one or more texts and any associated message headings.

end-of-transmission-block (ETB). A transmission control character used to indicate the end of a transmission block of data when data is divided into such blocks for transmission purposes.

EOB. End of block.

EOF. End of file.

EOT. End-of-transmission.

EPROM. Erasable programmable read-only memory.

erasable programmable read-only memory (EPROM). A PROM in which the user can erase old information and enter new information.

error checking and correction (ECC). The detection and correction of all single-bit errors, plus the detection of double-bit and some multiple-bit errors.

ESC. The escape character.

escape character (ESC). A code extension character used, in some cases, with one or more succeeding characters to indicate by some convention or agreement that the coded representations following the character or the group of characters are to be

interpreted according to a different code or according to a different coded character set.

ETB. End-of-transmission-block.

ETX. End-of-text.

extended binary-coded decimal interchange code (EBCDIC). A set of 256 characters, each represented by eight bits.

F. Fahrenheit.

Fahrenheit (F). A temperature scale. Contrast with Celsius (C).

falling edge. Synonym for negative-going edge.

FCC. Federal Communications Commission.

fetch. To locate and load a quantity of data from storage.

FF. The form feed character.

field. (1) In a record, a specified area used for a particular category of data. (2) In a data base, the smallest unit of data that can be referred to.

field-programmable logic sequencer (FPLS). An integrated circuit containing a programmable, read-only memory that responds to external inputs and feedback of its own outputs.

FIFO (first-in-first out). A queuing technique in which the next item to be retrieved is the item that has been in the queue for the longest time.

fixed disk drive. In the IBM Personal Computer, a unit consisting of nonremovable magnetic disks, and a device for storing data on and retrieving data from the disks.

flag. (1) Any of various types of indicators used for identification. (2) A character that signals the occurrence of some condition, such as the end of a word. (3) Deprecated term for mark.

flexible disk. Synonym for diskette.

flip-flop. A circuit or device containing active elements, capable of assuming either one of two stable states at a given time.

font. A family or assortment of characters of a given size and style; for example, 10 point Press Roman medium.

foreground. (1) In multiprogramming, the environment in which high-priority programs are executed. (2) On a color display screen, the characters as opposed to the background.

form feed. (1) Paper movement used to bring an assigned part of a form to the printing position. (2) In word processing, a function that advances the typing position to the same character position on a predetermined line of the next form or page.

form feed character. A control character that causes the print or display position to move to the next predetermined first line on the next form, the next page, or the equivalent.

format. The arrangement or layout of data on a data medium.

FPLS. Field-programmable logic sequencer.

frame. (1) In SDLC, the vehicle for every command, every response, and all information that is transmitted using SDLC procedures. Each frame begins and ends with a flag. (2) In data transmission, the sequence of contiguous bits bracketed by and including beginning and ending flag sequences.

g. Gram.

G. (1) Prefix giga; 1,000,000,000. (2) When referring to computer storage capacity, 1,073,741,824. (1,073,741,824 = 2 to the 30th power.)

gate. (1) A combinational logic circuit having one output channel and one or more input channels, such that the output channel state is completely determined by the input channel states. (2) A signal that enables the passage of other signals through a circuit.

Gb. 1,073,741,824 bytes.

general-purpose register. A register, usually explicitly addressable within a set of registers, that can be used for different purposes; for example, as an accumulator, as an index register, or as a special handler of data.

giga (G). Prefix 1,000,000,000.

gram (g). A unit of weight (equivalent to 0.035 ounces).

graphic. A symbol produced by a process such as handwriting, drawing, or printing.

graphic character. A character, other than a control character, that is normally represented by a graphic.

half-duplex. (1) In data communication, pertaining to an alternate, one way at a time, independent transmission. (2) Contrast with duplex.

hardware. (1) Physical equipment used in data processing, as opposed to programs, procedures, rules, and associated documentation. (2) Contrast with software.

head. A device that reads, writes, or erases data on a storage medium; for example, a small electromagnet used to read, write, or erase data on a magnetic disk.

hertz (Hz). A unit of frequency equal to one cycle per second.

hex. Common abbreviation for hexadecimal.

hexadecimal. (1) Pertaining to a selection, choice, or condition that has 16 possible different values or states. These values or states are usually symbolized by the ten digits 0 through 9 and the six letters A through F. (2) Pertaining to a fixed radix numeration system having a radix of 16.

high impedance state. A state in which the output of a device is effectively isolated from the circuit.

highlighting. In computer graphics, emphasizing a given display group by changing its attributes relative to other display groups in the same display field.

high-order position. The leftmost position in a string of characters. See also most-significant digit.

hither plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point and that lies between these two points. Any part of an object between the hither plane and the view point is not seen. See also yon plane.

housekeeping. Operations or routines that do not contribute directly to the solution of the problem but do contribute directly to the operation of the computer.

Hz. Hertz

image. A fully processed unit of operational data that is ready to be transmitted to a remote unit; when loaded into control storage in the remote unit, the image determines the operations of the unit.

immediate instruction. An instruction that contains within itself an operand for the operation specified, rather than an address of the operand.

index register. A register whose contents may be used to modify an operand address during the execution of computer instructions.

indicator. (1) A device that may be set into a prescribed state, usually according to the result of a previous process or on the occurrence of a specified condition in the equipment, and that usually gives a visual or other indication of the existence of the prescribed state, and that may in some cases be used to determine the selection among alternative processes; for example, an overflow indicator. (2) An item of data that may be interrogated to determine whether a particular condition has been satisfied in the execution of a computer program; for example, a switch indicator, an overflow indicator.

inhibited. (1) Pertaining to a state of a processing unit in which certain types of interruptions are not allowed to occur. (2) Pertaining to the state in which a transmission control unit or an audio response unit cannot accept incoming calls on a line.

initialize. To set counters, switches, addresses, or contents of storage to 0 or other starting values at the beginning of, or at prescribed points in, the operation of a computer routine.

input/output (I/O). (1) Pertaining to a device or to a channel that may be involved in an input process, and, at a different time, in an output process. In the English language, "input/output" may be used in place of such terms as "input/output data," "input/output signal," and "input/output terminals," when such usage is clear in a given context. (2) Pertaining to a device whose parts can be performing an input process and an output process at the same time. (3) Pertaining to either input or output, or both.

instruction. In a programming language, a meaningful expression that specifies one operation and identifies its operands, if any.

instruction set. The set of instructions of a computer, of a programming language, or of the programming languages in a programming system.

intensity. In computer graphics, the amount of light emitted at a display point

interface. A device that alters or converts actual electrical signals between distinct devices, programs, or systems.

interleave. To arrange parts of one sequence of things or events so that they alternate with parts of one or more other sequences of the same nature and so that each sequence retains its identity.

interrupt. (1) A suspension of a process, such as the execution of a computer program, caused by an event external to that process, and performed in such a way that the process can be resumed. (2) In a data transmission, to take an action at a receiving station that causes the transmitting station to terminate a transmission. (3) Synonymous with interruption.

I/O. Input/output.

I/O area. Synonym for buffer.

irrecoverable error. An error that makes recovery impossible without the use of recovery techniques external to the computer program or run.

joystick. In computer graphics, a lever that can pivot in all directions and that is used as a locator device.

k. Prefix kilo; 1000.

K. When referring to storage capacity, 1024. (1024 = 2 to the 10th power.)

Kb. 1024 bytes.

key lock. A device that deactivates the keyboard and locks the cover on for security.

kg. Kilogram; 1000 grams.

kHz. Kilohertz; 1000 hertz.

kilo (k). Prefix 1000

kilogram (kg). 1000 grams.

kilohertz (kHz). 1000 hertz

latch. (1) A simple logic-circuit storage element. (2) A feedback loop in sequential digital circuits used to maintain a state.

least-significant digit. The rightmost digit. See also low-order position.

LED. Light-emitting diode.

light-emitting diode (LED). A semiconductor device that gives off visible or infrared light when activated.

load. In programming, to enter data into storage or working registers.

look-up table (LUT). (1) A technique for mapping one set of values into a larger set of values. (2) In computer graphics, a table that assigns a color value (red, green, blue intensities) to a color index.

low power Schottky TTL. A version (LS series) of TTL giving a good compromise between low power and high speed. See also transistor-transistor logic and Schottky TTL.

low-order position. The rightmost position in a string of characters. See also least-significant digit.

luminance. The luminous intensity per unit projected area of a given surface viewed from a given direction.

LUT. Look-up table.

m. (1) Prefix milli; 0.001. (2) Meter.

M. (1) Prefix mega; 1,000,000. (2) When referring to computer storage capacity, 1,048,576. (1,048,576 = 2 to the 20th power.)

mA. Milliampere; 0.001 ampere.

machine code. The machine language used for entering text and program instructions onto the recording medium or into storage and which is subsequently used for processing and printout.

machine language. (1) A language that is used directly by a machine. (2) Deprecated term for computer instruction code.

magnetic disk. (1) A flat circular plate with a magnetizable surface layer on which data can be stored by magnetic recording. (2) See also diskette.

main storage. (1) Program-addressable storage from which instructions and other data can be loaded directly into registers for subsequent execution or processing. (2) Contrast with auxiliary storage.

mark. A symbol or symbols that indicate the beginning or the end of a field, of a word, of an item of data, or of a set of data such as a file, a record, or a block.

mask. (1) A pattern of characters that is used to control the retention or elimination of portions of another pattern of characters. (2) To use a pattern of characters to control the retention or elimination of portions of another pattern of characters.

masked. Synonym for disabled.

matrix. (1) A rectangular array of elements, arranged in rows and columns, that may be manipulated according to the rules of

matrix algebra. (2) In computers, a logic network in the form of an array of input leads and output leads with logic elements connected at some of their intersections.

matrix printer. A printer in which each character is represented by a pattern of dots; for example, a stylus printer, a wire printer. Synonymous with dot printer.

Mb. 1,048,576 bytes.

mega (M). Prefix 1,000,000.

megahertz (MHz). 1,000,000 hertz.

memory. Term for main storage.

meter (m). A unit of length (equivalent to 39.37 inches).

MFM. Modified frequency modulation.

MHz. Megahertz; 1,000,000 hertz.

micro (μ). Prefix 0.000,001.

microcode. (1) One or more microinstructions. (2) A code, representing the instructions of an instruction set, implemented in a part of storage that is not program-addressable.

microinstruction. (1) An instruction of microcode. (2) A basic or elementary machine instruction.

microprocessor. An integrated circuit that accepts coded instructions for execution; the instructions may be entered, integrated, or stored internally.

microsecond (μs). 0.000,001 second.

milli (m). Prefix 0.001.

milliampere (mA). 0.001 ampere.

millisecond (ms). 0.001 second.

mnemonic. A symbol chosen to assist the human memory; for example, an abbreviation such as "mpy" for "multiply."

mode. (1) A method of operation; for example, the binary mode, the interpretive mode, the alphanumeric mode. (2) The most frequent value in the statistical sense.

modeling transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). See also viewing transformation.

modem (modulator-demodulator). A device that converts serial (bit by bit) digital signals from a business machine (or data communication equipment) to analog signals that are suitable for transmission in a telephone network. The inverse function is also performed by the modem on reception of analog signals.

modified frequency modulation (MFM). The process of varying the amplitude and frequency of the 'write' signal. MFM pertains to the number of bytes of storage that can be stored on the recording media. The number of bytes is twice the number contained in the same unit area of recording media at single density.

modulation. The process by which some characteristic of one wave (usually high frequency) is varied in accordance with another wave or signal (usually low frequency). This technique is used in modems to make business-machine signals compatible with communication facilities.

modulation rate. The reciprocal of the measure of the shortest nominal time interval between successive significant instants of the modulated signal. If this measure is expressed in seconds, the modulation rate is expressed in baud.

module. (1) A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading.

(2) A packaged functional hardware unit designed for use with other components.

modulo check. A calculation performed on values entered into a system. This calculation is designed to detect errors.

modulo-N check. A check in which an operand is divided by a number N (the modulus) to generate a remainder (check digit) that is retained with the operand. For example, in a modulo-7 check, the remainder will be 0, 1, 2, 3, 4, 5, or 6. The operand is later checked by again dividing it by the modulus; if the remainder is not equal to the check digit, an error is indicated.

modulus. In a modulo-N check, the number by which the operand is divided.

monitor. Synonym for cathode ray tube display (CRT display).

most-significant digit. The leftmost (non-zero) digit. See also high-order position.

ms. Millisecond; 0.001 second.

multiplexer. A device capable of interleaving the events of two or more activities, or capable of distributing the events of an interleaved sequence to the respective activities.

multiprogramming. (1) Pertaining to the concurrent execution of two or more computer programs by a computer. (2) A mode of operation that provides for the interleaved execution of two or more computer programs by a single processor.

n. Prefix nano; 0.000,000,001.

NAND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NAND of P, Q ,R,... is true if at least one statement is false, false if all statements are true.

NAND gate. A gate in which the output is 0 only if all inputs are 1.

nano (n). Prefix 0.000,000,001.

nanosecond (ns). 0.000,000,001 second.

negative true. Synonym for active low.

negative-going edge. The edge of a pulse or signal changing in a negative direction. Synonymous with falling edge.

non-return-to-zero change-on-ones recording (NRZI). A transmission encoding method in which the data terminal equipment changes the signal to the opposite state to send a binary 1 and leaves it in the same state to send a binary 0.

non-return-to-zero (inverted) recording (NRZI). Deprecated term for non-return-to-zero change-on-ones recording.

NOR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NOR of P, Q, R,... is true if all statements are false, false if at least one statement is true.

NOR gate. A gate in which the output is 0 only if at least one input is 1.

NOT. A logical operator having the property that if P is a statement, then the NOT of P is true if P is false, false if P is true.

NRZI. Non-return-to-zero change-on-ones recording.

ns. Nanosecond; 0.000,000,001 second.

NUL. The null character.

null character (NUL). A control character that is used to accomplish media-fill or time-fill, and that may be inserted into or removed from, a sequence of characters without affecting the meaning of the sequence; however, the control of the equipment or the format may be affected by this character.

odd-even check. Synonym for parity check.

offline. Pertaining to the operation of a functional unit without the continual control of a computer.

one-shot. A circuit that delivers one output pulse of desired duration for each input (trigger) pulse.

open circuit. (1) A discontinuous circuit; that is, one that is broken at one or more points and, consequently, cannot conduct current. Contrast with closed circuit. (2) Pertaining to a no-load condition; for example, the open-circuit voltage of a power supply.

open collector. A switching transistor without an internal connection between its collector and the voltage supply. A connection from the collector to the voltage supply is made through an external (pull-up) resistor.

operand. (1) An entity to which an operation is applied. (2) That which is operated upon. An operand is usually identified by an address part of an instruction.

operating system. Software that controls the execution of programs; an operating system may provide services such as resource allocation, scheduling, input/output control, and data management.

OR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the OR of P, Q, R,...is true if at least one statement is true, false if all statements are false.

OR gate. A gate in which the output is 1 only if at least one input is 1.

output. Pertaining to a device, process, or channel involved in an output process, or to the data or states involved in an output process.

output process. (1) The process that consists of the delivery of data from a data processing system, or from any part of it. (2) The return of information from a data processing system to an end user, including the translation of data from a machine language to a language that the end user can understand.

overcurrent. A current of higher than specified strength.

overflow indicator. (1) An indicator that signifies when the last line on a page has been printed or passed. (2) An indicator that is set on if the result of an arithmetic operation exceeds the capacity of the accumulator.

overrun. Loss of data because a receiving device is unable to accept data at the rate it is transmitted.

overvoltage. A voltage of higher than specified value.

parallel. (1) Pertaining to the concurrent or simultaneous operation of two or more devices, or to the concurrent performance of two or more activities. (2) Pertaining to the concurrent or simultaneous occurrence of two or more related activities in multiple devices or channels. (3) Pertaining to the simultaneity of two or more processes. (4) Pertaining to the simultaneous processing of the individual parts of a whole, such as the bits of a character and the characters of a word, using separate facilities for the various parts. (5) Contrast with serial.

parameter. (1) A variable that is given a constant value for a specified application and that may denote the application. (2) A name in a procedure that is used to refer to an argument passed to that procedure.

parity bit. A binary digit appended to a group of binary digits to make the sum of all the digits either always odd (odd parity) or always even (even parity).

parity check. (1) A redundancy check that uses a parity bit. (2) Synonymous with odd-even check.

PEL. Picture element.

personal computer. A small home or business computer that has a processor and keyboard and that can be connected to a television or some other monitor. An optional printer is usually available.

phototransistor. A transistor whose switching action is controlled by light shining on it.

picture element (PEL). The smallest displayable unit on a display.

polling. (1) Interrogation of devices for purposes such as to avoid contention, to determine operational status, or to determine readiness to send or receive data. (2) The process whereby stations are invited, one at a time, to transmit.

port. An access point for data entry or exit.

positive true. Synonym for active high.

positive-going edge. The edge of a pulse or signal changing in a positive direction. Synonymous with rising edge.

potentiometer. A variable resistor with three terminals, one at each end and one on a slider (wiper).

power supply. A device that produces the power needed to operate electronic equipment.

printed circuit. A pattern of conductors (corresponding to the wiring of an electronic circuit) formed on a board of insulating material.

printed-circuit board. A usually copper-clad plastic board used to make a printed circuit.

priority. A rank assigned to a task that determines its precedence in receiving system resources.

processing program. A program that performs such functions as compiling, assembling, or translating for a particular programming language.

processing unit. A functional unit that consists of one or more processors and all or part of internal storage.

processor. (1) In a computer, a functional unit that interprets and executes instructions. (2) A functional unit, a part of another unit such as a terminal or a processing unit, that interprets and executes instructions. (3) Deprecated term for processing program. (4) See microprocessor.

program. (1) A series of actions designed to achieve a certain result. (2) A series of instructions telling the computer how to handle a problem or task. (3) To design, write, and test computer programs.

programmable read-only memory (PROM). A read-only memory that can be programmed by the user.

programming language. (1) An artificial language established for expressing computer programs. (2) A set of characters and rules with meanings assigned prior to their use, for writing computer programs.

programming system. One or more programming languages and the necessary software for using these languages with particular automatic data-processing equipment.

PROM. Programmable read-only memory.

propagation delay. (1) The time necessary for a signal to travel from one point on a circuit to another. (2) The time delay between a signal change at an input and the corresponding change at an output.

protocol. (1) A specification for the format and relative timing of information exchanged between communicating parties. (2) The set of rules governing the operation of functional units of a communication system that must be followed if communication is to be achieved.

pulse. A variation in the value of a quantity, short in relation to the time schedule of interest, the final value being the same as the initial value.

radio frequency (RF). An ac frequency that is higher than the highest audio frequency. So called because of the application to radio communication.

radix. (1) In a radix numeration system, the positive integer by which the weight of the digit place is multiplied to obtain the weight of the digit place with the next higher weight; for example, in the decimal numeration system the radix of each digit place is 10. (2) Another term for base.

radix numeration system. A positional representation system in which the ratio of the weight of any one digit place to the weight of the digit place with the next lower weight is a positive integer (the radix). The permissible values of the character in any digit place range from 0 to one less than the radix.

RAM. Random access memory. Read/write memory.

random access memory (RAM). Read/write memory.

RAS. In the IBM Personal Computer, row address strobe.

raster. In computer graphics, a predetermined pattern of lines that provides uniform coverage of a display space.

read. To acquire or interpret data from a storage device, from a data medium, or from another source.

read-only memory (ROM). A storage device whose contents cannot be modified. The memory is retained when power is removed.

read/write memory. A storage device whose contents can be modified. Also called RAM.

recoverable error. An error condition that allows continued execution of a program.

red-green-blue-intensity (RGBI). The description of a direct-drive color monitor that accepts input signals of red, green, blue, and intensity.

redundancy check. A check that depends on extra characters attached to data for the detection of errors. See cyclic redundancy check.

register. (1) A storage device, having a specified storage capacity such as a bit, a byte, or a computer word, and usually intended for a special purpose. (2) A storage device in which specific data is stored.

retry. To resend the current block of data (from the last EOB or ETB) a prescribed number of times, or until it is entered correctly or accepted.

reverse video. A form of highlighting a character, field, or cursor by reversing the color of the character, field, or cursor with its background; for example, changing a red character on a black background to a black character on a red background.

RF. Radio frequency.

RF modulator. The device used to convert the composite video signal to the antenna level input of a home TV.

RGBI. Red-green-blue-intensity.

rising edge. Synonym for positive-going edge.

ROM. Read-only memory.

ROM/BIOS. The ROM resident basic input/output system, which provides the level control of the major I/O devices in the computer system.

row address strobe (RAS). A signal that latches the row address in a memory chip.

RS-232C. A standard by the EIA for communication between computers and external equipment.

RTS. Request to send. Associated with modem control.

run. A single continuous performance of a computer program or routine.

saturation. In computer graphics, the purity of a particular hue. A color is said to be saturated when at least one primary color (red, blue, or green) is completely absent.

scaling. In computer graphics, enlarging or reducing all or part of a display image by multiplying the coordinates of the image by a constant value.

schematic. The representation, usually in a drawing or diagram form, of a logical or physical structure.

Schottky TTL. A version (S series) of TTL with faster switching speed, but requiring more power. See also transistor-transistor logic and low power Schottky TTL.

SDLC. Synchronous Data Link Control.

sector. That part of a track or band on a magnetic drum, a magnetic disk, or a disk pack that can be accessed by the magnetic heads in the course of a predetermined rotational displacement of the particular device.

SERDES. Serializer/deserializer.

serial. (1) Pertaining to the sequential performance of two or more activities in a single device. In English, the modifiers serial and parallel usually refer to devices, as opposed to sequential and consecutive, which refer to processes. (2) Pertaining to the sequential or consecutive occurrence of two or more related activities in a single device or channel. (3) Pertaining to the sequential processing of the individual parts of a whole, such as the bits of a character or the characters of a word, using the same facilities for successive parts. (4) Contrast with parallel.

serializer/deserializer (SERDES). A device that serializes output from, and deserializes input to, a business machine.

setup. (1) In a computer that consists of an assembly of individual computing units, the arrangement of interconnections between the units, and the adjustments needed for the computer to operate. (2) The preparation of a computing system to perform a job or job step. Setup is usually performed by an operator and often involves performing routine functions, such as mounting tape reels. (3) The preparation of the system for normal operation.

short circuit. A low-resistance path through which current flows, rather than through a component or circuit.

signal. A variation of a physical quantity, used to convey data.

sink. A device or circuit into which current drains.

software. (1) Computer programs, procedures, and rules concerned with the operation of a data processing system. (2) Contrast with hardware.

source. The origin of a signal or electrical energy.

square wave. An alternating or pulsating current or voltage whose waveshape is square.

square wave generator. A signal generator delivering an output signal having a square waveform.

SS. Start-stop.

start bit. (1) A signal to a receiving mechanism to get ready to receive data or perform a function. (2) In a start-stop system, a signal preceding a character or block that prepares the receiving device for the reception of the code elements.

start-of-text (STX). A transmission control character that precedes a text and may be used to terminate the message heading.

start-stop system. A data transmission system in which each character is preceded by a start bit and is followed by a stop bit.

start-stop (SS) transmission. (1) Asynchronous transmission such that a group of signals representing a character is preceded by a start bit and followed by a stop bit. (2) Asynchronous transmission in which a group of bits is preceded by a start bit that prepares the receiving mechanism for the reception and registration of a character and is followed by at least one stop bit that enables the receiving mechanism to come to an idle condition pending the reception of the next character.

static memory. RAM using flip-flops as the memory elements. Data is retained as long as power is applied to the flip-flops. Contrast with dynamic memory.

stop bit. (1) A signal to a receiving mechanism to wait for the next signal. (2) In a start-stop system, a signal following a character or block that prepares the receiving device for the reception of a subsequent character or block.

storage. (1) A storage device. (2) A device, or part of a device, that can retain data. (3) The retention of data in a storage device. (4) The placement of data into a storage device.

strobe. An instrument that emits adjustable-rate flashes of light. Used to measure the speed of rotating or vibrating objects.

STX. Start-of-text.

symbol. (1) A conventional representation of a concept. (2) A representation of something by reason of relationship, association, or convention.

synchronization. The process of adjusting the corresponding significant instants of two signals to obtain the desired phase relationship between these instants.

Synchronous Data Link Control (SDLC). A protocol for management of data transfer over a data link.

synchronous transmission. (1) Data transmission in which the time of occurrence of each signal representing a bit is related to a fixed time frame. (2) Data transmission in which the sending and receiving devices are operating continuously at substantially the same frequency and are maintained, by means of correction, in a desired phase relationship.

syntax. (1) The relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use. (2) The structure of expressions in a language. (3) The rules governing the structure of a language. (4) The relationships among symbols.

text. In ASCII and data communication, a sequence of characters treated as an entity if preceded and terminated by one STX and one ETX transmission control character, respectively.

time-out. (1) A parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time. A time-out condition can be cancelled by the receipt of an appropriate time-out cancellation signal. (2) A time interval allotted for certain operations to occur; for example, response to polling or addressing before system operation is interrupted and must be restarted.

track. (1) The path or one of the set of paths, parallel to the reference edge on a data medium, associated with a single reading or writing component as the data medium moves past the

component. (2) The portion of a moving data medium such as a drum, or disk, that is accessible to a given reading head position.

transistor-transistor logic (TTL). A popular logic circuit family that uses multiple-emitter transistors.

translate. To transform data from one language to another.

transmission. (1) The sending of data from one place for reception elsewhere. (2) In ASCII and data communication, a series of characters including headings and text. (3) The dispatching of a signal, message, or other form of intelligence by wire, radio, telephone, or other means. (4) One or more blocks or messages. For BSC and start-stop devices, a transmission is terminated by an EOT character. (5) Synonymous with data transmission.

TTL. Transistor-transistor logic.

typematic key. A keyboard key that repeats its function when held pressed.

V. Volt.

vector. In computer graphics, a directed line segment.

video. Computer data or graphics displayed on a cathode ray tube, monitor, or display.

view point. In computer graphics, the origin from which angles and scales are used to map virtual space into display space.

viewing reference point. In computer graphics, a point in the modeling coordinate space that is a defined distance from the view point.

viewing transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the view of the object to be rotated about any axis, translated (moved without

rotating), and/or scaled (changed in size along any or all dimensions). Viewing transformation differs from modeling transformation in that perspective is considered. See also modeling transformation.

viewplane. The visible plane of a CRT display screen that completely contains a defined window.

viewport. In computer graphics, a predefined part of the CRT display space.

volt. The basic practical unit of electric pressure. The potential that causes electrons to flow through a circuit.

W. Watt.

watt. The practical unit of electric power.

window. (1) A predefined part of the virtual space. (2) The visible area of a viewplane.

word. (1) A character string or a bit string considered as an entity. (2) See computer word.

write. To make a permanent or transient recording of data in a storage device or on a data medium.

write precompensation. The varying of the timing of the head current from the outer tracks to the inner tracks of the diskette to keep a constant 'write' signal.

yon plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point, and that lies beyond the viewing reference point. Any part of an object beyond the yon plane is not seen. See also hither plane.

Bibliography

- Microprocessor and Peripheral Handbook
  - INTEL Corporation.*210844.001*
- Introduction to the iAPX 286
  - INTEL Corporation.*210308.001*
- iAPX 286 Operating Systems Writer's Guide
  - INTEL Corporation.*121960.001*
- iAPX 286 Programmer's Reference Manual
  - INTEL Corporation.*210498.001*
- iAPX 286 Hardware Reference Manual
  - INTEL Corporation.*210760.001*
- Numeric Processor Extension Data Sheet
  - INTEL Corporation.*210920*
- 80287 Support Library Reference Manual
  - INTEL Corporation.*122129*
- National Semiconductor Corporation. *NS16450*
- Motorola Microprocessor's Data Manual
  - Motorola Inc. *Series B*

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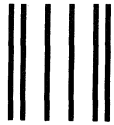

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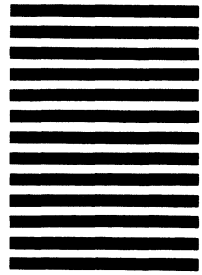

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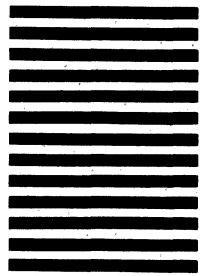

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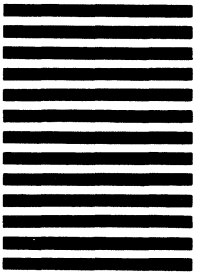

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