USING THE MC68000 AND THE MC6845 FOR A COLOR GRAPHICS SYSTEM

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Probably the slowest link in most computerized control systems is the display of information for human interpretation. The commonly used black and white monitor can display an adequate amount of information in most cases.

In applications where a large amount of information must be displayed in the same screen area, a color graphics system can easily provide this information by using a wide range of contrasting colors. Until recently the high cost of sophisticated components and color monitors required to generate and display color information has probably been the main prohibitive factor in development of these systems.

Recently the cost of components and color monitors has moderated to the point that using a color graphics system offers a viable solution to information display, ranging from the video games market to complex control systems.

A state-of-the-art color graphics system using the MC68000 16-bit microprocessor (MPU) with an economical MC6845 CRT controller (CRTC) is described in this application note. Hardware improvement is evident in data movement occurring in 16-bit words and multiply and divide commands while software compatibilities are greatly enhanced

through the use of a processor that executes instructions which can operate on 8-, 16-, or 32-bit operands.

The general approach to a color graphics system is straightforward and almost identical to a black and white graphics system. A typical black and white graphics system is shown in Figure 1. The MPU has two responsibilities to the graphics system: first, to initially program the CRTC, and second, to transfer data to the display RAM.

Once the clock circuitry is running, the CRTC is initialized and the address lines to the dislay RAM begin incrementing sequentially. As this occurs, the appropriate data from the display RAM is loaded into the shift register and then gated out serially by the dot clock input to the shift register. The display monitor then interprets the data as either turning a particular pixel on or off.

A color graphics system (Figure 2) uses the same principle as the black and white system except that it has to control three color guns (red, green, and blue) instead of just one. Therefore, there is an increase in the amount of hardware involved, but not in complexity. The software becomes more
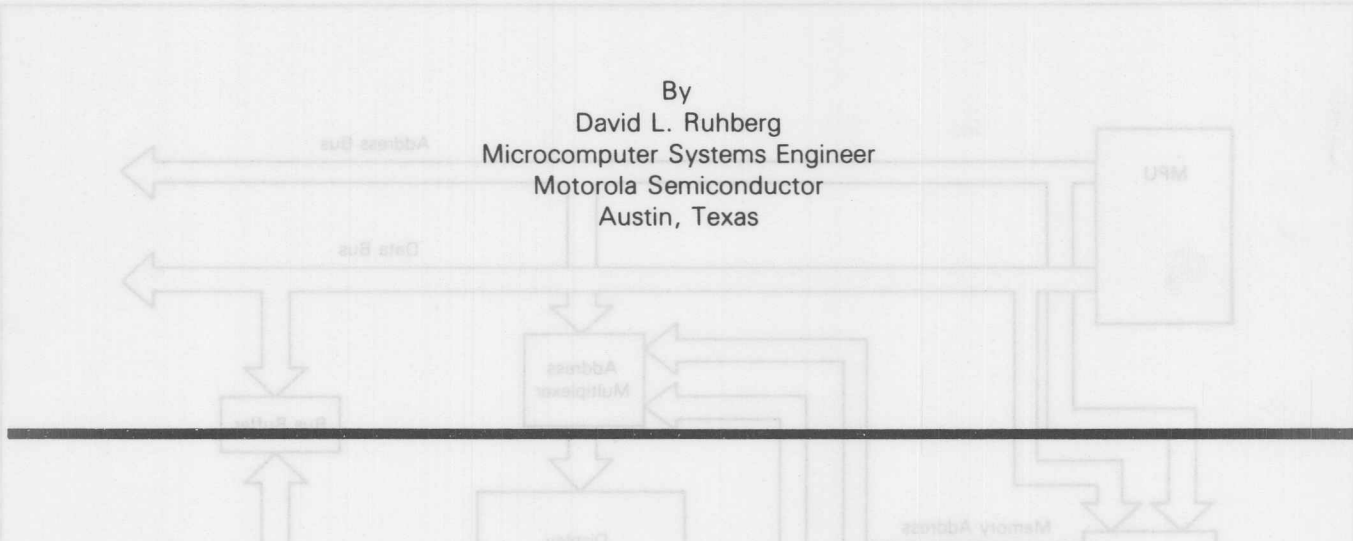
involved due to the fact that more information is being handled and displayed. The basic display system works on the principle that three bits (one for each color) controls each pixel instead of just one as in a black and white system. If two guns are on, the resulting color is a combination of the two. If all guns are on, white is the result. With this configuration a total of eight colors, including black and white, are available. Since the three bits needed to control a pixel do not fit into an eight-bit byte evenly, the unused bits could be used to obtain more colors or some other function. In addition, color systems usually require a separate sync input.

The versatility of the internal architecture of the MC68000 (Figure 3) enhances the effectiveness of the color graphics system. Besides containing a 32-bit program counter yielding 16 megabytes of direct addressing range, the MC68000 also contains eight 32-bit data registers (D0-D7) and seven 32-bit address registers (A0-A6). The eight data registers are used for byte (8-bit), word (16-bit), and long word (32-bit) data operations. The seven address registers and the stack pointer may be used for word and long word address operations. In addition, all address and data registers may be used as index registers.
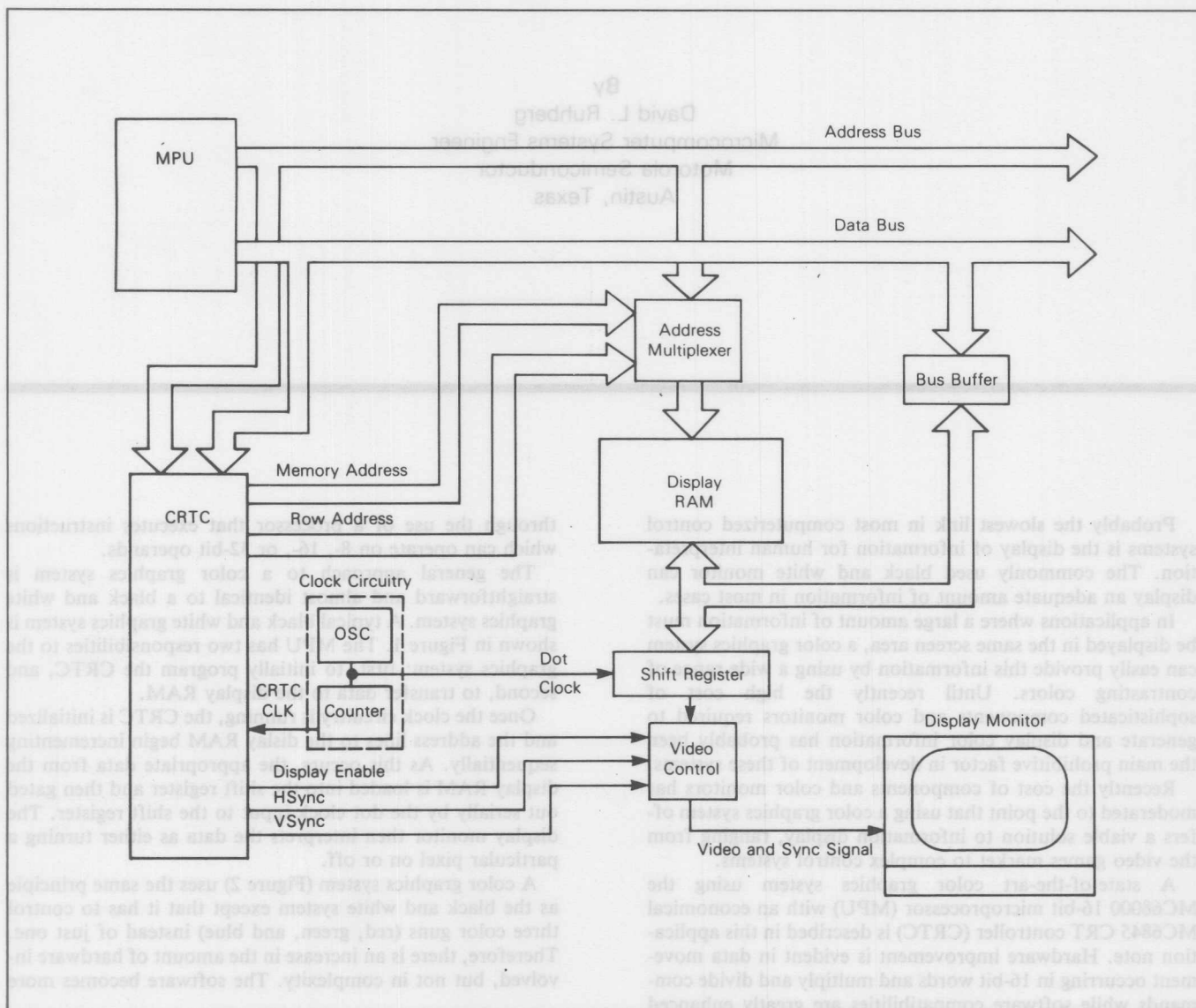
Figure 1. Black and White Graphics System — Block Diagram

MPU

Address Bus

Data Bus

CRTC

Memory Address

Row Address

Address Multiplexer

Bus Buffer

Bus Buffer

Bus Buffer

Clock Circuitry

OSC

Dot Clock

CRTC CLK

Counter

Blue

Green

Red

Display RAM

Display Enable

HSync

VSync

Color Display Monitor

Red   Green   Blue
Shift Register

Video Control

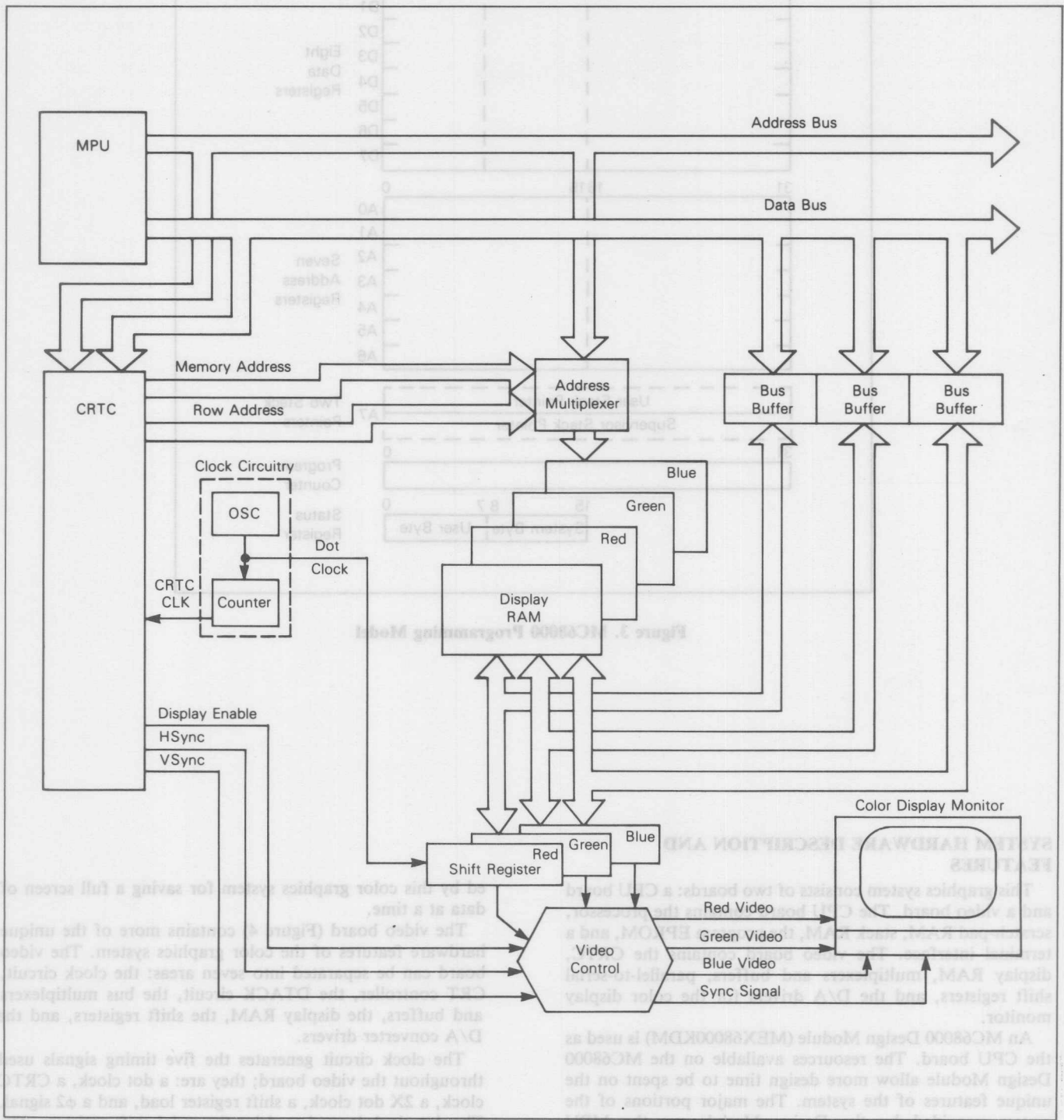Red Video

Green Video

Blue Video

Sync Signal

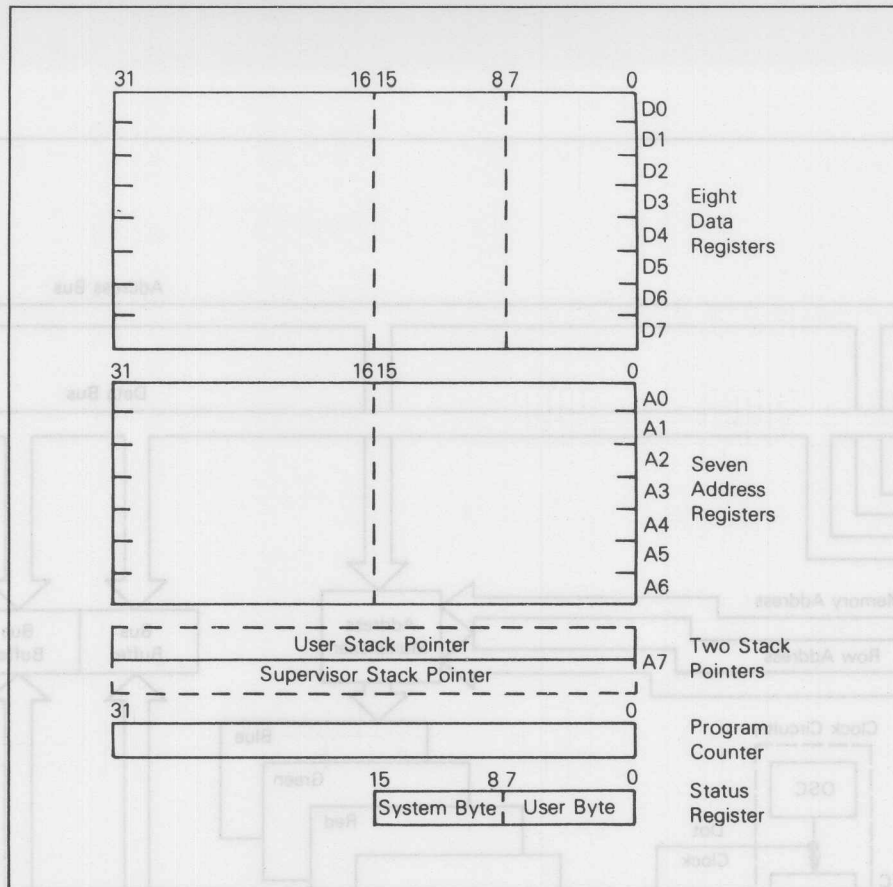**Figure 2. Color Graphics System — Block Diagram**

Figure 3. MC68000 Programming Model

SYSTEM HARDWARE DESCRIPTION AND FEATURES

This graphics system consists of two boards: a CPU board and a video board. The CPU board contains the processor, scratch-pad RAM, stack RAM, the program EPROM, and a terminal interface. The video board contains the CRTC, display RAM, multiplexers and buffers, parallel-to-serial shift registers, and the D/A drivers for the color display monitor.

An MC68000 Design Module (MEX68000KDM) is used as the CPU board. The resources available on the MC68000 Design Module allow more design time to be spent on the unique features of the system. The major portions of the system provided by the Design Module are the MPU (MC68000), the address decoding for the EPROM, a terminal interface, and all the software functions provided by the resident monitor (MACSbug). Included in the MACSbug is a transparent down-load feature which allows the system to communicate through the terminal to another system. The other system can provide the access to the floppy disks need-ed by this color graphics system for saving a full screen of data at a time.

The video board (Figure 4) contains more of the unique hardware features of the color graphics system. The video board can be separated into seven areas: the clock circuit, CRT controller, the DTACK circuit, the bus multiplexers and buffers, the display RAM, the shift registers, and the D/A converter drivers.

The clock circuit generates the five timing signals used throughout the video board; they are: a dot clock, a CRTC clock, a 2X dot clock, a shift register load, and a $\phi2$ signal. The dot clock is used to drive the serial shift registers. The CRTC clock is used to drive the CRTC. The 2X dot clock and the shift register load are gated together to generate the parallel load (PLOAD) and chip select (PCS) signals for the shift registers and display RAM, respectively. The $\phi2$ signal is also used to control accesses to the display RAM. A timing diagram of these signals is shown in Figure 5.
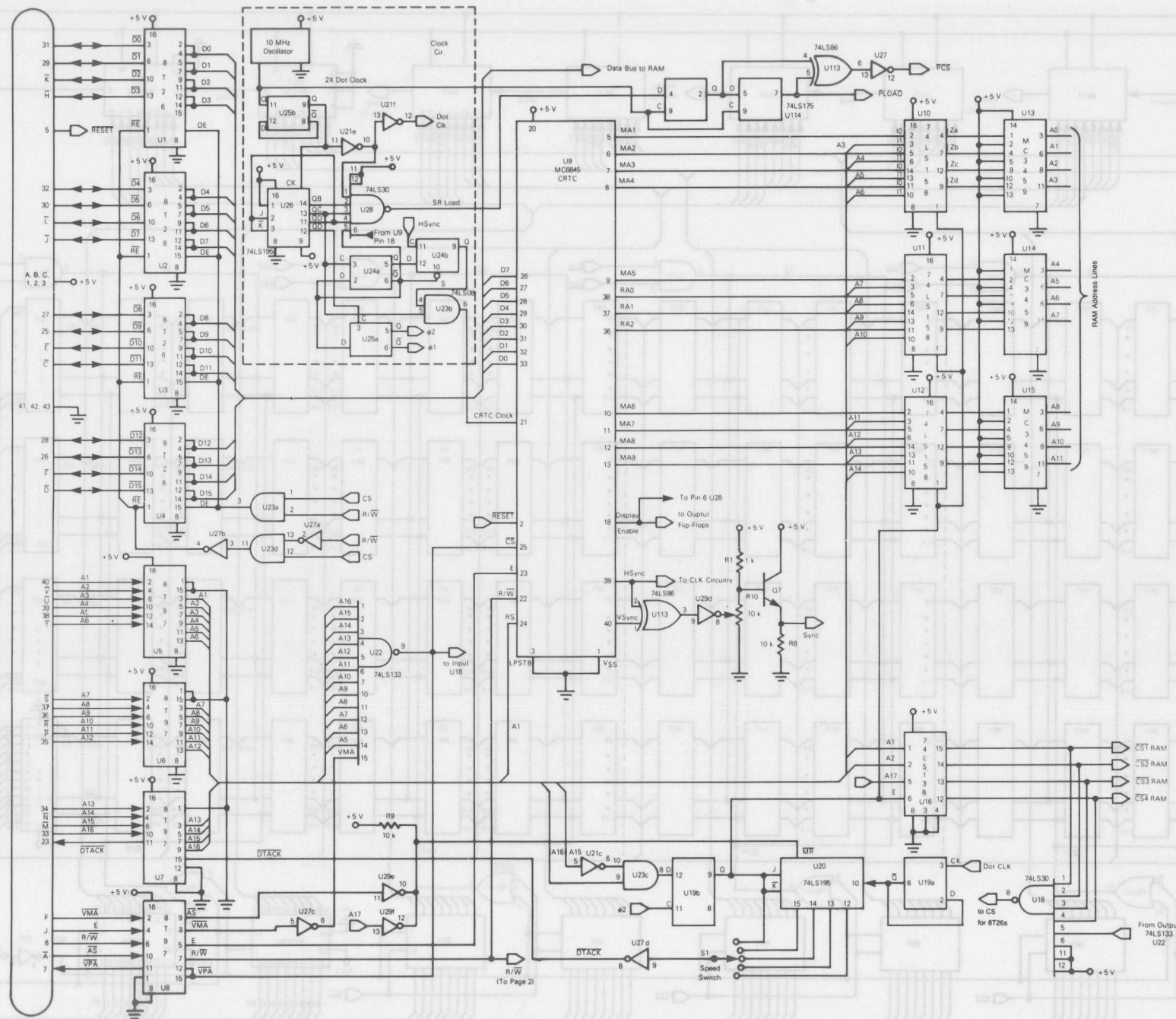
Figure 4. Color Graphics System Schematic (Sheet 1 of 3)
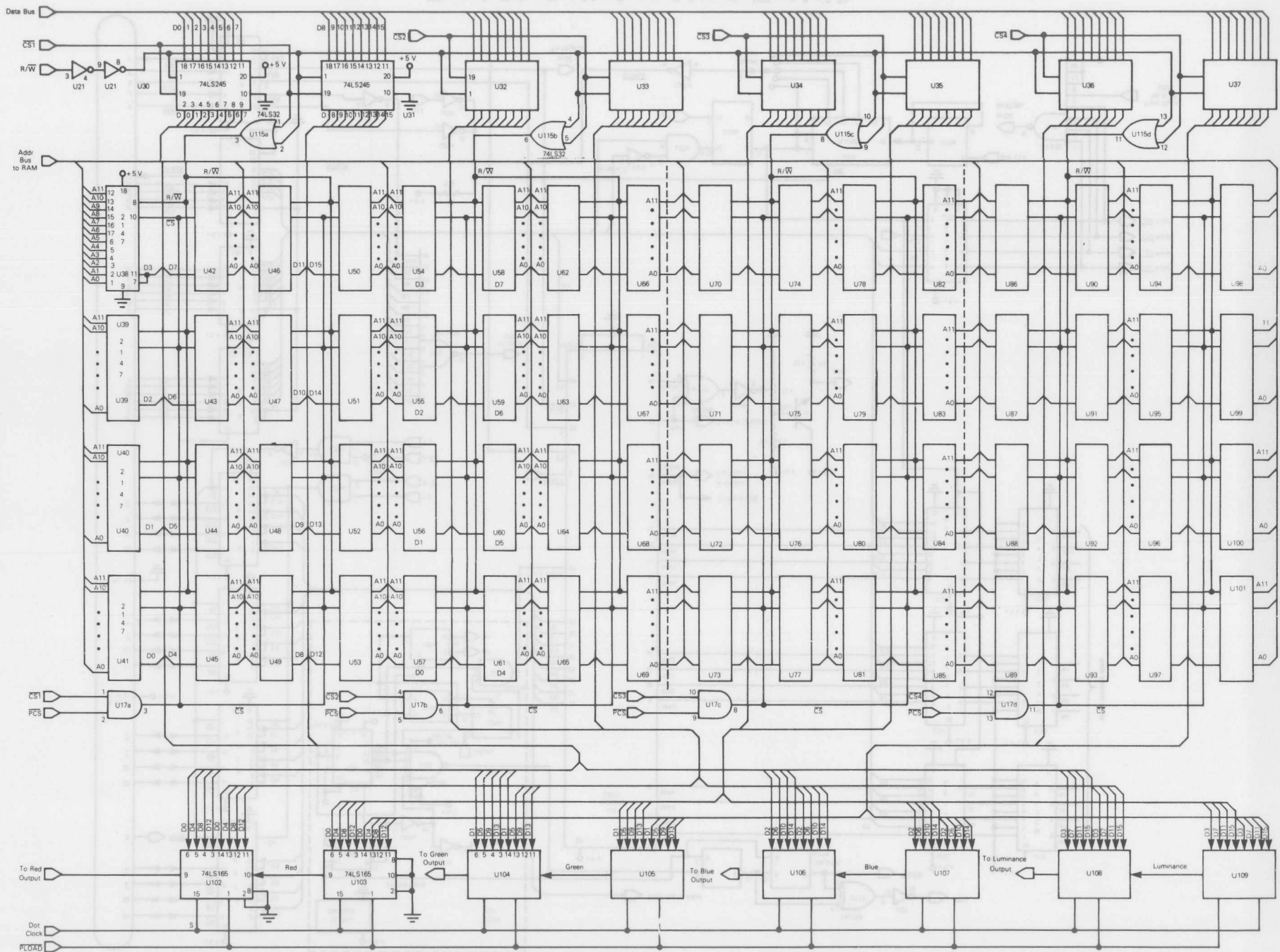
Figure 4. Color Graphics System Schematic (Sheet 2 of 3)
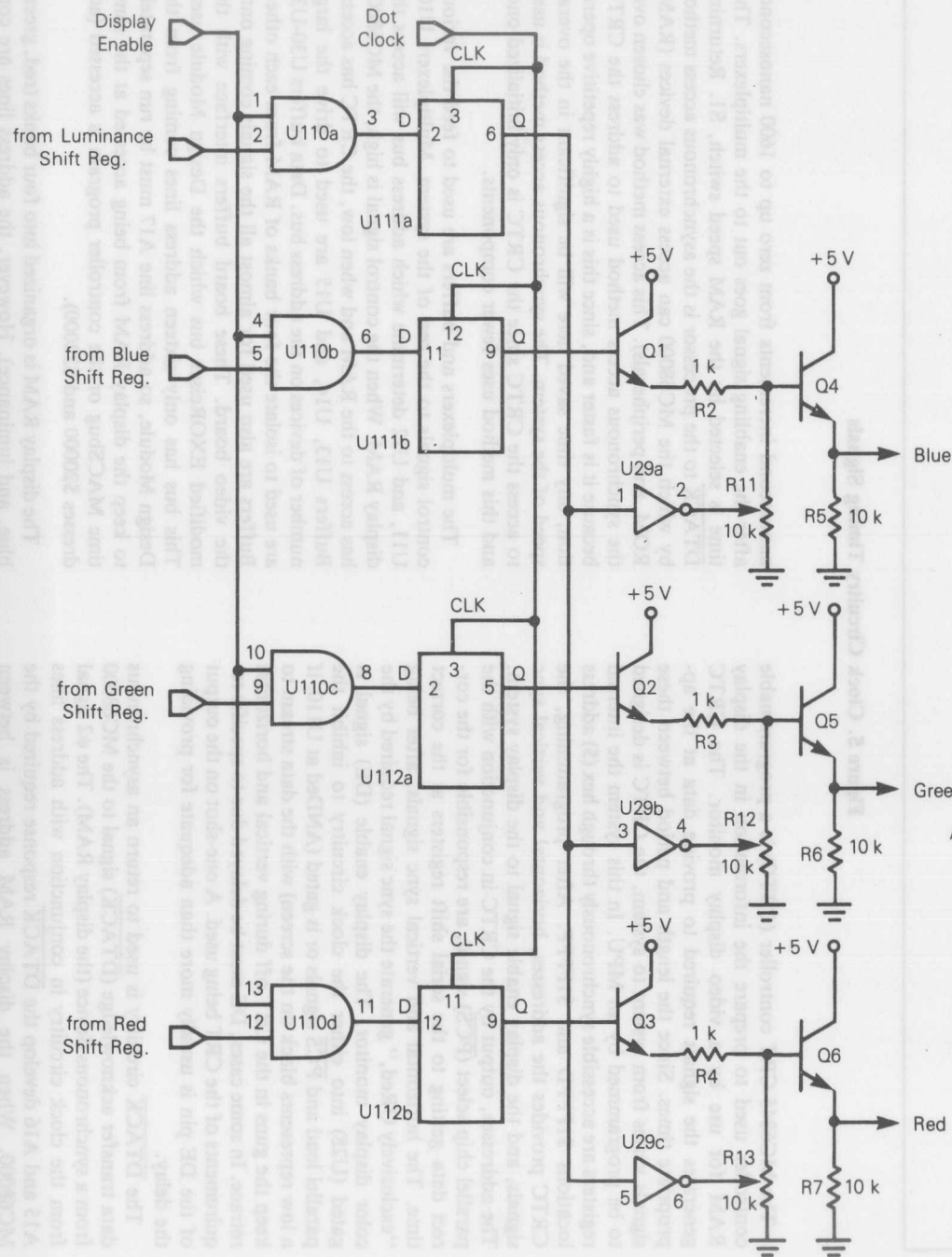
Parts List

U1-4	MC6880A/MC8T26A		
U5-8	MC6887/MC8T97		
U9	MC6845		
U10-U12	SN74LS158		
U13-15	MC3459		
U16	SN74LS138		
U17, 23, 110	SN74LS08		
U18, 28	SN74LS30		
U19, 24, 25, 111, 112	SN74LS74		
U20	SN74LS195		
U21, 27	SN74LS04		
U22	SN74LS133		
U23	SN74LS08		
U24, 25	SN74LS74		
U26	SN74LS195		
U27	SN74LS04		
U28	SN74LS30		
U29	SN74LS05		
U30-U37	SN74LS245	10 MHz Oscillator	
U38-U101	MCM2147	Q1-Q3	2N3904
U102-U109	SN74LS165	Q4-Q7	2N5336
U110	SN74LS08	R1-R4	1 kΩ
U111, U112	SN74LS74	R5-R9	10 kΩ
U113	SN74LS86	R10-R13 (Variable)	10 kΩ
U114	SN74LS175		
U115	SN74LS32	S1 5-Position Switch	

All D Flip-Flops Configured for Power-Up Reset as Shown
(Where Possible)

Figure 4. Color Graphics System Schematic (Sheet 3 of 3)

Figure 5. Clock Circuitry Timing Signals

The MC6845 CRT controller (CRTC) is a programmable controller used to prepare the information in the display RAM for use by a video display monitor. The CRTC generates the signals required to provide data at the appropriate times. Since the length and period between these signals varies from syste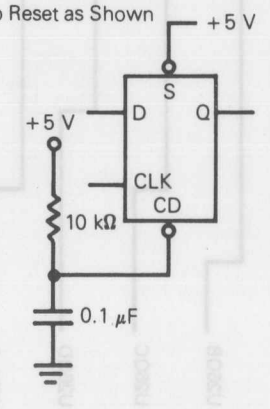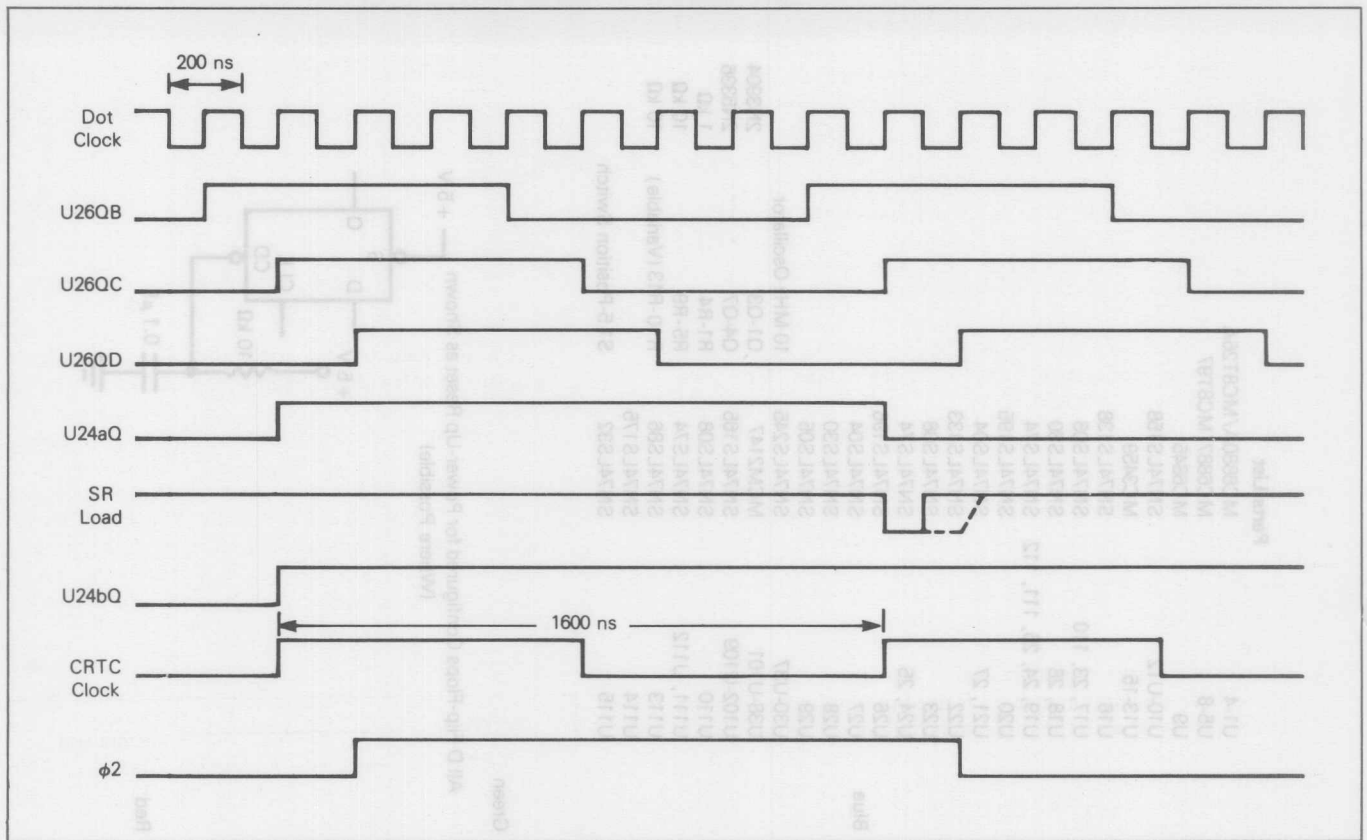m to system, the CRTC is designed to be programmed by an MPU. In this system the internal registers are accessible synchronously through hex ($) address locations $1FFFD and $1FFFF. After programming, the CRTC provides the addresses, horizontal and vertical sync signals, and the display enable signal to the display system. The addresses, output by the CRTC in conjunction with the parallel chip select ($\overline{PCS}$) signal, are responsible for the correct data getting to the serial shift registers at the correct time. The horizontal and vertical sync signals, after being "exclusively ORed," generate the sync signal required by the color display monitor. The display enable (DE) signal is gated (U28) into either the clock circuitry to inhibit the parallel load and $\overline{PCS}$ signals or is gated (ANDed at U110, if a low represents black on the screen) with the data stream to keep the guns in the CRT off during vertical and horizontal retrace. In some cases, DE must be delayed due to specific requirements of the CRT being used. A one-shot on the output of the DE pin is usually more than adequate for providing the delay.

The $\overline{DTACK}$ circuitry is used to return an asynchronous data transfer acknowledge ($\overline{DTACK}$) signal to the MC68000 from a synchronous device (the display RAM). The $\phi2$ signal from the clock circuitry in conjunction with address lines A15 and A16 develop the $\overline{DTACK}$ response required by the MC68000. When the display RAM address is between $10000-$17FFF, the $\overline{DTACK}$ signal is returned in 400

nanosecond increments from zero up to 1600 nanoseconds after the enabling signal goes out to the multiplexers. This time is selected by the RAM speed switch, S1. Returning $\overline{DTACK}$ to the processor is the asynchronous access method by which the MC68000 can access external devices (RAM, ROM, and peripherals). This access method was chosen over the synchronous access method used to address the CRTC because it is faster and, since this is a highly repetitive operation, any time saved here will be significant in the overall speed of the system. The synchronous access method is used to access the CRTC since the CRTC is only initialized once and this method uses fewer components.

The multiplexers and buffers are used to feed the various control signals to the rest of the system. Multiplexers U10, U11, and U12 determine which address bus will access the display RAM. When the control signal is high, the MC68000 has access to the RAM and when low, the CRTC has access. Buffers U13, U14, and U15 are used to drive the large number of devices on the address bus. Data buffers U30-U37 are used to isolate the four banks of RAM from each other. Buffers are also used for almost all the signals coming onto the video board. These board buffers interface with the modified EXORciser bus which the Design Module uses. This bus has only sixteen address lines coming from the Design Module, so address line A17 must be run separately to keep the display RAM from being accessed at the same time MACSbug or the controller program is accessed (addresses $20000 and $22000).

The display RAM is organized into four banks (red, green, blue, and luminance). However, the address lines are configured so that consecutive words are located in consecutive

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banks of RAM. This was done to allow the programmer to visualize accessing one 16-bit wide bank at a time instead of accessing red, green, blue, and luminance banks all at the same time. The memories used are 4K × 1 static RAMs (MCM2147) which simplify some of the chip select circuitry. Dynamic RAMs could be used and should definitely be considered in a production system since they lower the hardware cost as well as power consumption. They were omitted in this application to simplify the system configuration. It should be noted that the CRTC keeps incrementing its address lines during horizontal and vertical retrace to keep the dynamic RAM refreshed. The speed of the static memories is not critical due to the presence of the speed selection switch explained earlier. As far as the CRTC and the serial shift registers are concerned, the memory looks like one 4K × 64-bit bank of RAM.

Shift registers U102-U109 consist of eight 8-bit, parallel-load, serial shift registers. They are configured to look like four 16-bit shift registers, one for each of the color guns and one for luminance. With the RAM and shift registers configured in this fashion, the RAM is accessed only 25 percent of the time. This means that the RAM has four times the amount of setup time and slower RAM can be used. The dot clock then clocks the data out to be gated with display enable.

Conversion from digital to analog voltages in this system is needed because a luminance bit is used to obtain more colors than are possible with the three guns digitally. The luminance bit is used to indicate half luminance when set and full luminance when clear. When all guns are off, the screen is black and the state of the luminance bit has no effect. Since the color display monitor uses an analog input on each gun, any number of colors may be obtained if the supporting hardware is provided. The D/A conversion used in this system was done to save space. A cleaner method would be to use special D/A converters and special line drivers for this function.

SOFTWARE DESCRIPTION AND CONSIDERATIONS

The software included to exercise this system consists of five basic commands:

CM — Clear Memory
BX — Box Draw
Q8 — Random Line
ED — Edit
BA } Provides the capability of saving (BA) a screen on
SH } floppy disk and calling (SH) it back.

The clear memory (CM) command clears the screen. The box drawing (BX) command draws continuously concentric boxes which close in on each other. This gives the effect of running up a hallway. The random line (Q8) drawing command picks random points and connects them together until they form a multisided polygon and then it continues to repeat that shape, all the while collapsing in on itself and changing colors. A scaling function has been implemented to keep the figure occupying a major portion of the screen. The edit (ED) command allows the user to draw figures on the screen using the cursor controls on the terminal and allows a choice of colors. The BA command is used to store a screen full of data on floppy disk while the SH command is used to call it from the floppy disk and display it on the screen.

Each of the routines which write to the display RAM use the basic data layout for every pixel on the screen. Each pixel is controlled by four bits. Each bit corresponds to either luminance, blue, green, or red, as shown in Figure 6.
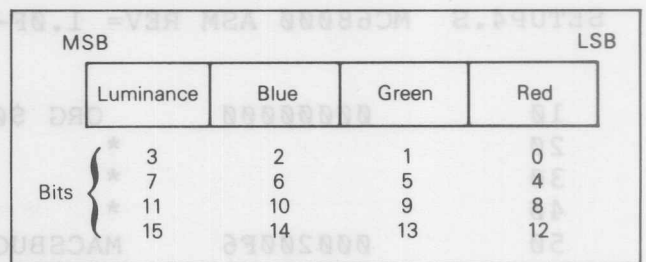
Figure 6. Pixel Control Bit — Layout

A memory map for this application is given in Figure 7. A listing of the software is given at the end of this application note.

The resolution of the display in this application is 256 × 256 pixels. The density could be doubled in both directions to 512 × 512 by quadrupling the memory. This can be easily done if dynamic RAM is used since 4K × 1 and 16K × 1 dynamic RAM can be arranged in the same basic configurations. As space was one of the design criteria in this application, some of the more straightforward approaches were not taken.
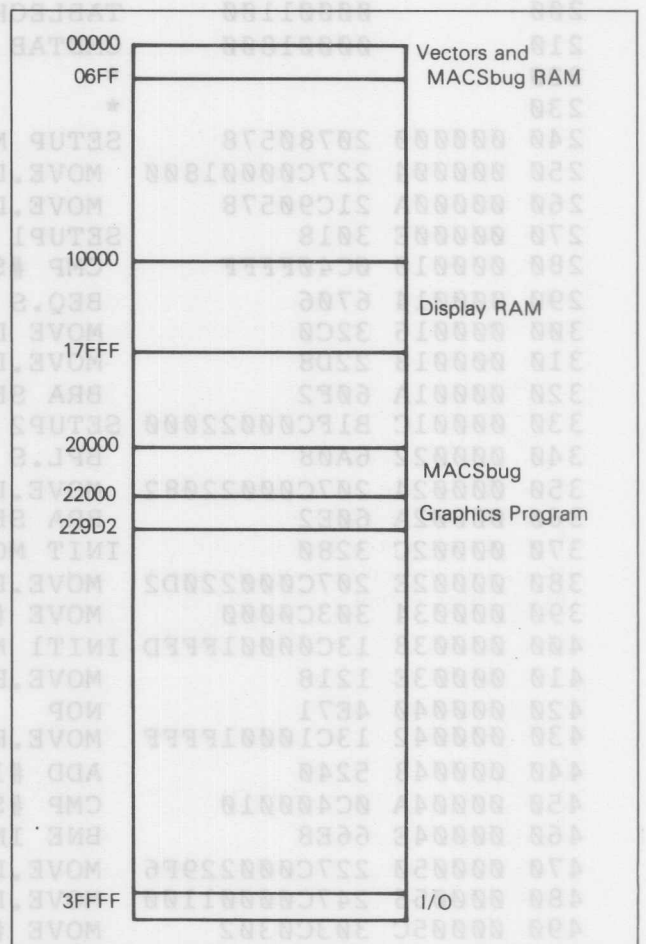
Figure 7. Memory Map

Thanks to Don Voss of Motorola Microsystems for his suggestions on the hardware and his splendid job on the software.

```
 10              00000000          ORG $0000
 20                                *
 30                                *
 40                                *
 50              000200F6          MACSBUG EQU $200F6
 60              00021BC2          OUTPUT2 EQU $21BC2
 70              00021F18          FIXBUF EQU $21F18
 80              000200EE          MSG EQU $200EE
 90              00001000          X1 EQU $1000
100              00001001          Y1 EQU $1001
110              00001002          X2 EQU $1002
120              00001003          Y2 EQU $1003
130              00001010          COLOR EQU $1010
140              00001011          NCOLOR EQU $1011
150              00001012          OCOLOR EQU $1012
160              00001014          NUMPT EQU $1014
170              00001016          SCALE EQU $1016
180              00001018          RANADD EQU $1018
190              00001080          ARRAY EQU $1080
200              00001100          TABLECH EQU $1100
210              00001800          CMDTAB EQU $1800
220                                *
230                                *
240  000000      20780578          SETUP MOVE.L $578,A0
250  000004      227C00001800       MOVE.L #CMDTAB,A1
260  00000A      21C90578           MOVE.L A1,$578
270  00000E      3018              SETUP1 MOVE (A0)+,D0
280  000010      0C40FFFF           CMP #$FFFF,D0
290  000014      6706               BEQ.S SETUP2
300  000016      32C0               MOVE D0,(A1)+
310  000018      22D8               MOVE.L (A0)+,(A1)+
320  00001A      60F2               BRA SETUP1
330  00001C      B1FC00022000      SETUP2 CMP.L #$22000,A0
340  000022      6A08               BPL.S INIT
350  000024      207C00022082       MOVE.L #$22082,A0
360  00002A      60E2               BRA SETUP1
370  00002C      3280              INIT MOVE D0,(A1)
380  00002E      207C000220D2       MOVE.L #$220D2,A0
390  000034      303C0000           MOVE #$0000,D0
400  000038      13C00001FFFD      INIT1 MOVE.B D0,$1FFFD
410  00003E      1218               MOVE.B (A0)+,D1
420  000040      4E71               NOP
430  000042      13C10001FFFF       MOVE.B D1,$1FFFF
440  000048      5240               ADD #1,D0
450  00004A      0C400010           CMP #$0010,D0
460  00004E      66E8               BNE INIT1
470  000050      227C000229F6       MOVE.L #$229F6,A1
480  000056      247C00001100       MOVE.L #TABLECH,A2
490  00005C      303C0302           MOVE #770,D0
500  000060      14D9              SETUP21 MOVE.B (A1)+,(A2)+
  0  000062      5340               SUB #1,D0
  0  000064      66FA               BNE  SETUP21
520  000066      6014               BRA.S RETURN
530  000068      207C00010000      CM MOVE.L #$10000,A0
540  00006E      323C2000           MOVE #$2000,D1
```

```
 550 000072 4280             CLR.L D0
 560 000074 20C0        CLRM MOVE.L D0,(A0)+
   0 000076 5341             SUB #1,D1
   0 000078 66FA             BNE  CLRM
   0 00007A 4E71             NOP
 580 00007C 4EF9000200F6 RETURN JMP MACSBUG
 590 000082 43          NTABLE DC.W 'CM'
 600 000084 00022068          DC.L $22068
 610 000088 53               DC.W 'SH'
 620 00008A 000220E2          DC.L $220E2
 630 00008E 42               DC.W 'BX'
 640 000090 0002218A          DC.L $2218A
 650 000094 45               DC.W 'ED'
 660 000096 000221E8          DC.L $221E8
 670 00009A 42               DC.W 'BA'
 680 00009C 00022454          DC.L $22454
 690 0000A0 51               DC.W 'Q1'
 700 0000A2 00022498          DC.L $22498
 710 0000A6 51               DC.W 'Q2'
 720 0000A8 000224A4          DC.L $224A4
 730 0000AC 51               DC.W 'Q3'
 740 0000AE 000224B0          DC.L $224B0
 750 0000B2 51               DC.W 'Q4'
 760 0000B4 000224BC          DC.L $224BC
 770 0000B8 51               DC.W 'Q5'
 780 0000BA 000224C8          DC.L $224C8
 790 0000BE 51               DC.W 'Q9'
 800 0000C0 00022606          DC.L $22606
 810 0000C4 48               DC.W 'HP'
 820 0000C6 000226AC          DC.L $226AC
 830 0000CA 51               DC.W 'Q8'
 840 0000CC 00022818          DC.L $22818
 850 0000D0 FFFF             DC.W $FFFF
 860                    *
 870                    *
 880                    *
 890                    *
 900 0000D2 27          CRTC DC.B $27
 910 0000D3 20               DC.B $20
 920 0000D4 22               DC.B $22
 930 0000D5 A3               DC.B $A3
 940 0000D6 20               DC.B $20
 950 0000D7 06               DC.B $06
 960 0000D8 1F               DC.B $1F
 970 0000D9 1F               DC.B $1F
 980 0000DA 10               DC.B $10
 990 0000DB 07               DC.B 7
1000 0000DC 00000000         DC.L 0
1010 0000E0 0000             DC.W 0
1020                    *
1030                    *
1040 0000E2 61000004    SH BSR SHQ
1050 0000E6 6094           BRA RETURN
1060 0000E8 4EB900021BC2 SHQ JSR OUTPUT2
1070 0000EE 227C0003FF21    MOVE.L #$3FF21,A1
```

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```
1080 0000F4 61000078        SH1 BSR INPUT
1090 0000F8 0C00000D            CMP.B #$0D,D0
1100 0000FC 6708               BEQ.S SH2
1110 0000FE 0C0000FF           CMP.B #$FF,D0
1120 000102 66F0               BNE SH1
1130 000104 6040               BRA.S SH3
1140 000106 61000066        SH2 BSR INPUT
1150 00010A 0C00000A            CMP.B #$0A,D0
1160 00010E 67F6               BEQ SH2
1170 000110 0C000000           CMP.B #0,D0
1180 000114 67F0               BEQ SH2
1190 000116 0C0000FF           CMP.B #$FF,D0
1200 00011A 672A               BEQ.S SH3
1210 00011C 4EB900021F18       JSR FIXBUF
1220 000122 2CFC4552524F       MOVE.L #'ERRO',(A6)+
1230 000128 2CFC52203B43       MOVE.L #'R ;C',(A6)+
1240 00012E 2CFC4845434B       MOVE.L #'HECK',(A6)+
1250 000134 2CFC2046494C       MOVE.L #' FIL',(A6)+
1260 00013A 2CFC45202020       MOVE.L #'E   ',(A6)+
1270 000140 4EF9000200EE       JMP MSG
1280 000146 207C00010000    SH3 MOVE.L #$10000,A0
1290 00014C 103C0055            MOVE.B #$55,D0
1300 000150 6100002A            BSR OUTPUT
1310 000154 61000018        SH4 BSR INPUT
1320 000158 1200               MOVE.B D0,D1
1330 00015A 61000012            BSR INPUT
1340 00015E E140               ASL 8,D0
1350 000160 1001               MOVE.B D1,D0
1360 000162 30C0               MOVE.W D0,(A0)+
1370 000164 B1FC00017F80        CMP.L #$17F80,A0
1380 00016A 66E8               BNE SH4
1390 00016C 4E75               RTS
1400 00016E 1011            INPUT MOVE.B (A1),D0
1410 000170 02000001           AND.B #1,D0
1420 000174 67F8               BEQ INPUT
1430 000176 10290002           MOVE.B 2(A1),D0
1440 00017A 4E75               RTS
1450 00017C 1E11            OUTPUT MOVE.B (A1),D7
1460 00017E 02070002           AND.B #2,D7
1470 000182 67F8               BEQ OUTPUT
1480 000184 13400002           MOVE.B D0,2(A1)
1490 000188 4E75               RTS
1500 00018A 4240            BX CLR D0
1510 00018C 3200               MOVE D0,D1
1520 00018E 3400               MOVE D0,D2
1530 000190 363C003F        BX3 MOVE #$3F,D3
1540 000194 207C00010000       MOVE.L #$10000,A0
1550 00019A 61000016        BX1 BSR SHOW
1560 00019E 5543               SUB #2,D3
1570 0001A0 6A02               BPL.S BX2
1580 0001A2 60EC               BRA BX3
1590 0001A4 5240            BX2 ADD #1,D0
1600 0001A6 5241               ADD #1,D1
1610 0001A8 5242               ADD #1,D2
1620 0001AA D1FC00000202       ADD.L #514,A0
```

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```
1630 0001B0 60E8                  BRA BX1
1640 0001B2 3803             SHOW MOVE D3,D4
1650 0001B4 30C0             BX11 MOVE D0,(A0)+
   0 0001B6 5344                  SUB #1,D4
   0 0001B8 66FA                  BNE  BX11
1670 0001BA 3080                  MOVE D0,(A0)
1680 0001BC 3803                  MOVE D3,D4
1690 0001BE E544                  ASL 2,D4
1700 0001C0 D1FC00000080     BX22 ADD.L #128,A0
1710 0001C6 3081                  MOVE D1,(A0)
   0 0001C8 5344                  SUB #1,D4
   0 0001CA 66F4                  BNE  BX22
1730 0001CC 3803                  MOVE D3,D4
1740 0001CE 3080                  MOVE D0,(A0)
1750 0001D0 3100             BX33 MOVE D0,-(A0)
   0 0001D2 5344                  SUB  #1,D4
   0 0001D4 66FA                  BNE  BX33
1770 0001D6 3803                  MOVE D3,D4
1780 0001D8 E544                  ASL 2,D4
1790 0001DA 91FC00000080     BX44 SUB.L #128,A0
1800 0001E0 3082                  MOVE D2,(A0)
   0 0001E2 5344                  SUB  #1,D4
   0 0001E4 66F4                  BNE  BX44
1820 0001E6 4E75                  RTS
1830                         *
1840                         *
1850                         *
1860 0001E8 11FC00801000     ED MOVE.B #$80,X1
1870 0001EE 11FC00801001        MOVE.B #$80,Y1
1880 0001F4 11FC00001011        MOVE.B #0,NCOLOR
1890 0001FA 6100014E         ED1 BSR BLINK
1900 0001FE 61000004             BSR CMD
1910 000202 60F6                 BRA ED1
1920 000204 61000230         CMD BSR READK
1930 000208 0C010020             CMP.B #$20,D1
1940 00020C 6A48                 BPL.S RTS
1950 00020E 0C01000B             CMP.B #$B,D1
1960 000212 673C                 BEQ.S UPARROW
1970 000214 0C01000A             CMP.B #$A,D1
1980 000218 673E                 BEQ.S DWARROW
1990 00021A 0C01000C             CMP.B #$C,D1
2000 00021E 673E                 BEQ.S RTARROW
2010 000220 0C010008             CMP.B #$8,D1
2020 000224 673E                 BEQ.S LTARROW
2030 000226 0C010001             CMP.B #$1,D1
2040 00022A 673E                 BEQ.S CMD1   CHARMODE
2050 00022C 0C010003             CMP.B #$3,D1
2060 000230 6756                 BEQ.S CMD2   NCOLOR
2070 000232 0C010004             CMP.B #$4,D1
2080 000236 6738                 BEQ.S CMD3
2090 000238 0C01000D             CMP.B #$0D,D1
2100 00023C 673E                 BEQ.S CR
2110 00023E 0C010005             CMP.B #$5,D1
2120 000242 6732                 BEQ.S CMD4
2130 000244 0C010011             CMP.B #$11,D1
```

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2140  000248  660A              BNE.S RTS1
2150  00024A  588F              ADD.L #4,A7
2160  00024C  6000FE2E          BRA RETURN
2170  000250  53381001     UPARROW SUB.B #1,Y1
2180  000254  4241         RTS1 CLR D1
2190  000256  4E75         RTS RTS
2200  000258  52381001     DWARROW ADD.B #1,Y1
2210  00025C  60F6              BRA RTS1
2220  00025E  52381000     RTARROW ADD.B #1,X1
2230  000262  60F0              BRA RTS1
2240  000264  53381000     LTARROW SUB.B #1,X1
2250  000268  60EA              BRA RTS1
2260  00026A  588F         CMD1 ADD.L #4,A7
2270  00026C  60000132          BRA CHARED
2280  000270  588F         CMD3 ADD.L #4,A7
2290  000272  600001A8          BRA DOT
2300  000276  588F         CMD4 ADD.L #4,A7
2310  000278  6000FF80          BRA ED1
2320  00027C  5E381001     CR ADD.B #7,Y1
2330  000280  11FC00001000      MOVE.B #0,X1
2340  000286  60CC              BRA RTS1
2350  000288  610001AC     CMD2 BSR READK
2360  00028C  267C00001011      MOVE.L #NCOLOR,A3
2370  000292  0C010052          CMP.B #'R',D1
2380  000296  6758              BEQ.S RED
2390  000298  0C010047          CMP.B #'G',D1
2400  00029C  6758              BEQ.S GREEN
2410  00029E  0C010042          CMP.B #'B',D1
2420  0002A2  6758              BEQ.S BLUE
2430  0002A4  0C010057          CMP.B #'W',D1
2440  0002A8  6758              BEQ.S WHITE
2450  0002AA  0C01005A          CMP.B #'Z',D1
2460  0002AE  6758              BEQ.S BLACK
2470  0002B0  0C010059          CMP.B #'Y',D1
2480  0002B4  6758              BEQ.S YELLOW
2490  0002B6  0C01004D          CMP.B #'M',D1
2500  0002BA  6758              BEQ.S MAG
2510  0002BC  0C010043          CMP.B #'C',D1
2520  0002C0  6758              BEQ.S CYAN
2530  0002C2  0C010054          CMP.B #'T',D1
2540  0002C6  6758              BEQ.S DRED
2550  0002C8  0C010048          CMP.B #'H',D1
2560  0002CC  6758              BEQ.S DGR
2570  0002CE  0C01004E          CMP.B #'N',D1
2580  0002D2  6758              BEQ.S DBLUE
2590  0002D4  0C010045          CMP.B #'E',D1
2600  0002D8  6758              BEQ.S DWH
2610  0002DA  0C010055          CMP.B #'U',D1
2620  0002DE  6758              BEQ.S DYEL
2630  0002E0  0C01002C          CMP.B #',',D1
2640  0002E4  6758              BEQ.S DMAG
2650  0002E6  0C010056          CMP.B #'V',D1
2660  0002EA  6758              BEQ.S DCYAN
2670  0002EC  4241         RTS2 CLR D1
2680  0002EE  4E75              RTS
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2690  0002F0  16BC0009      RED MOVE.B #$9,(A3)
2700  0002F4  60F6            BRA RTS2
2710  0002F6  16BC000A      GREEN MOVE.B #$A,(A3)
2720  0002FA  60F0            BRA RTS2
2730  0002FC  16BC000C      BLUE MOVE.B #$C,(A3)
2740  000300  60EA            BRA RTS2
2750  000302  16BC000F      WHITE MOVE.B #$F,(A3)
2760  000306  60E4            BRA RTS2
2770  000308  16BC0000      BLACK MOVE.B #0,(A3)
2780  00030C  60DE            BRA RTS2
2790  00030E  16BC000B      YELLOW MOVE.B #$B,(A3)
2800  000312  60D8            BRA RTS2
2810  000314  16BC000D      MAG MOVE.B #$D,(A3)
2820  000318  60D2            BRA RTS2
2830  00031A  16BC000E      CYAN MOVE.B #$E,(A3)
2840  00031E  60CC            BRA RTS2
2850  000320  16BC0001      DRED MOVE.B #1,(A3)
2860  000324  60C6            BRA RTS2
2870  000326  16BC0002      DGR MOVE.B #2,(A3)
2880  00032A  60C0            BRA RTS2
2890  00032C  16BC0004      DBLUE MOVE.B #4,(A3)
2900  000330  60BA            BRA RTS2
2910  000332  16BC0007      DWH MOVE.B #7,(A3)
2920  000336  60B4            BRA RTS2
2930  000338  16BC0003      DYEL MOVE.B #3,(A3)
2940  00033C  60AE            BRA RTS2
2950  00033E  16BC0005      DMAG MOVE.B #5,(A3)
2960  000342  60A8            BRA RTS2
2970  000344  16BC0006      DCYAN MOVE.B #6,(A3)
2980  000348  60A2            BRA RTS2
2990                        *
3000  00034A  12381000      BLINK MOVE.B X1,D1
3010  00034E  14381001        MOVE.B Y1,D2
3020  000352  61000226        BSR GETADD
3030  000356  4643          NOT D3
3040  000358  0C03000F      BL2 CMP.B #$F,D3
3050  00035C  6706            BEQ.S BL1
3060  00035E  E84B            LSR 4,D3
3070  000360  E849            LSR 4,D1
3080  000362  60F4            BRA BL2
3090  000364  11C11012      BL1 MOVE.B D1,OCOLOR
3100  000368  103C000F      BL3 MOVE.B #$F,D0
3110  00036C  12381000        MOVE.B X1,D1
3120  000370  14381001        MOVE.B Y1,D2
3130  000374  610001DE        BSR DSP
3140  000378  610000D0        BSR DLY
3150  00037C  4200          CLR.B D0
3160  00037E  610001D4        BSR DSP
3170  000382  610000C6        BSR DLY
3180  000386  10381012        MOVE.B OCOLOR,D0
3190  00038A  610001C8        BSR DSP
3200  00038E  610000BA        BSR DLY
3210  000392  10390003FF01    MOVE.B $3FF01,D0
3220  000398  02000001        AND.B #1,D0
3230  00039C  67CA            BEQ BL3
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3240 00039E 4E75              RTS
3250                          *
3260 0003A0 31F810001002 CHARED MOVE X1,X2
3270 0003A6 61A2              BSR BLINK
3280 0003A8 6100FE5A          BSR CMD
3290 0003AC 4A01              TST.B D1
3300 0003AE 67F0              BEQ CHARED
3310 0003B0 61000004          BSR CHAR
3320 0003B4 60EA              BRA CHARED
3330 0003B6 04010020     CHAR SUB.B #$20,D1
3340 0003BA E741              ASL 3,D1
3350 0003BC 267C00001100      MOVE.L #TABLECH,A3
3360 0003C2 02810000003FF     AND.L #$3FF,D1
3370 0003C8 D7C1              ADD.L D1,A3
3380 0003CA 3C3C0004          MOVE #4,D6
3390 0003CE 4245         CHARED1 CLR D5
3400 0003D0 0B13         CHARED2 BTST D5,(A3)
3410 0003D2 6636              BNE.S SET
3420 0003D4 52381002     CHARED3 ADD.B #1,X2
3430 0003D8 5245              ADD #1,D5
3440 0003DA 0C450010          CMP #16,D5
3450 0003DE 6618              BNE.S CHARED4
3460 0003E0 52381003          ADD.B #1,Y2
3470 0003E4 11F810001002      MOVE.B X1,X2
3480 0003EA D7F80002          ADD.L $2,A3
   0 0003EE 5346              SUB  #1,D6
   0 0003F0 66DC              BNE  CHARED1
3500 0003F2 50381000          ADD.B #8,X1
3510 0003F6 4E75              RTS
3520 0003F8 0C450008     CHARED4 CMP #8,D5
3530 0003FC 66D2              BNE CHARED2
3540 0003FE 52381003          ADD.B #1,Y2
3550 000402 11F810001002      MOVE.B X1,X2
3560 000408 60C6              BRA CHARED2
3570 00040A 10381011     SET MOVE.B NCOLOR,D0
3580 00040E 12381002          MOVE.B X2,D1
3590 000412 14381003          MOVE.B Y2,D2
3600 000416 6100013C          BSR DSP
3610 00041A 60B8              BRA CHARED3
3620                          *
3630 00041C 10381011     DOT MOVE.B NCOLOR,D0
3640 000420 12381000          MOVE.B X1,D1
3650 000424 14381001          MOVE.B Y1,D2
3660 000428 6100012A          BSR DSP
3670 00042C 6100FF1C          BSR BLINK
3680 000430 6100FDD2          BSR CMD
3690 000434 60E6              BRA DOT
3700                          *
3710 000436 12390003FF01 READK MOVE.B $3FF01,D1
3720 00043C 02010001          AND.B #1,D1
3730 000440 67F4              BEQ READK
3740 000442 12390003FF03      MOVE.B $3FF03,D1
3750 000448 4E75              RTS
3760 00044A 3C3C00FF     DLY MOVE #$00FF,D6
3770 00044E 5346         DLY1 SUB #1,D6
```

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3780 000450 66FC              BNE DLY1
3790 000452 4E75              RTS
3800                          *
3810                          *
3820                          *
3830 000454 207C00010000 BA MOVE.L #$10000,A0
3840 00045A 227C0003FF23      MOVE.L #$3FF23,A1
3850 000460 247C0003FF21      MOVE.L #$3FF21,A2
3860 000466 1212          L1 MOVE.B (A2),D1
3870 000468 02010002          AND.B #$2,D1
3880 00046C 67F8              BEQ L1
3890 00046E 103C0065          MOVE.B #$65,D0
3900 000472 1280              MOVE.B D0,(A1)
3910 000474 1212          LOOP MOVE.B (A2),D1
3920 000476 02010002          AND.B #$2,D1
3930 00047A 67F8              BEQ LOOP
3940 00047C 3018              MOVE (A0)+,D0
3950 00047E 1280              MOVE.B D0,(A1)
3960 000480 E048              LSR 8,D0
3970 000482 1212          L2 MOVE.B (A2),D1
3980 000484 02010002          AND.B #$2,D1
3990 000488 67F8              BEQ L2
4000 00048A 1280              MOVE.B D0,(A1)
4010 00048C B1FC00018000      CMP.L #$18000,A0
4020 000492 66E0              BNE LOOP
4030 000494 6000FBE6          BRA RETURN
4040                          *
4050                          *
4060                          *
4070 000498 2C7C000225AC Q1 MOVE.L #$225AC,A6
4080 00049E 3E3C0010          MOVE #$10,D7
4090 0004A2 602E              BRA.S RUN
4100 0004A4 2C7C000225BE Q2 MOVE.L #$225BE,A6
4110 0004AA 3E3C0010          MOVE #$10,D7
4120 0004AE 6022              BRA.S RUN
4130 0004B0 2C7C000225D0 Q3 MOVE.L #$225D0,A6
4140 0004B6 3E3C0010          MOVE #$10,D7
4150 0004BA 6016              BRA.S RUN
4160 0004BC 2C7C000225E2 Q4 MOVE.L #$225E2,A6
4170 0004C2 3E3C0010          MOVE #$10,D7
4180 0004C6 600A              BRA.S RUN
4190 0004C8 2C7C000225F4 Q5 MOVE.L #$225F4,A6
4200 0004CE 3E3C0010          MOVE #$10,D7
4210 0004D2 61000006      RUN BSR RUN1
4220 0004D6 6000FBA4          BRA RETURN
4230                          *
4240                          *
4250                          *
4260 0004DA 3C3C0080      RUN1 MOVE #128,D6
4270 0004DE 61000034          BSR RAND
4280 0004E2 4E96          RUN2 JSR (A6)
4290 0004E4 48E76000          MOVEM.L D1/D2,-(A7)
4300 0004E8 0241007F          AND #$7F,D1
4310 0004EC 0242007F          AND #$7F,D2
4320 0004F0 61000068          BSR DSPLY
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4330 0004F4 4401            NEG.B D1
4340 0004F6 61000062        BSR DSPLY
4350 0004FA 4402            NEG.B D2
4360 0004FC 6100005C        BSR DSPLY
4370 000500 4401            NEG.B D1
4380 000502 61000056        BSR DSPLY
4390 000506 4CDF0006        MOVEM.L (A7)+,D1/D2
   0 00050A 5346            SUB  #1,D6
   0 00050C 66D4            BNE  RUN2
   0 00050E 5347            SUB  #1,D7
   0 000510 66C8            BNE  RUN1
4420 000512 4E75            RTS
4430                      *
4440                      * MOVE.B (A2),D1
4450                      *
4460 000514 6100001C        RAND BSR RAND1
4470 000518 3200            MOVE D0,D1
4480 00051A 61000016        BSR RAND1
4490 00051E 3400            MOVE D0,D2
4500 000520 61000010        RAND2 BSR RAND1
4510 000524 0200000F        AND.B #$F,D0
4520 000528 67F6            BEQ RAND2
4530 00052A 0C000008        CMP.B #$08,D0
4540 00052E 67F0            BEQ RAND2
4550 000530 4E75            RTS
4560 000532 10381019        RAND1 MOVE.B RANADD+1,D0
4570 000536 E500            ASL.B 2,D0
4580 000538 D0381018        ADD.B RANADD,D0
4590 00053C E140            ASL 8,D0
4600 00053E 10381019        MOVE.B RANADD+1,D0
4610 000542 E540            ASL 2,D0
4620 000544 D0781018        ADD RANADD,D0
4630 000548 06403619        ADD #$3619,D0
4640 00054C 31C01018        MOVE D0,RANADD
4650 000550 E048            LSR 8,D0
4660 000552 4E75            RTS
4670                      *
4680                      *
4690                      *
4700                      *DSPLY(C,X,Y)
4710                      *  D0=COLOR
4720                      *  D1=X 8-BITS
4730                      *  D2=Y 8-BITS
4740                      *
4750 000554 48E7F080        DSP MOVEM.L D0-D3/A0,-(A7)
4760 000558 600C            BRA.S DSP1
4770                      *
4780 00055A 48E7F080        DSPLY MOVEM.L D0-D3/A0,-(A7)
4790 00055E 06010080        ADD.B #128,D1
4800 000562 06020080        ADD.B #128,D2
4810 000566 0240000F        DSP1 AND #$F,D0
4820 00056A 6100000E        BSR GETADD
4830 00056E C243            AND D3,D1
4840 000570 8041            OR D1,D0
4850 000572 3080            MOVE D0,(A0)
```

```
4860 000574 4CDF010F        MOVEM.L (A7)+,D0-D3/A0
4870 000578 4E75            RTS
4880 00057A 024100FF   GETADD AND #$FF,D1
4890 00057E 363CFFF0        MOVE #$FFF0,D3
4900 000582 E142            ASL 8,D2
4910 000584 D242            ADD D2,D1
4920 000586 02810000FFFF    AND.L #$FFFF,D1
4930 00058C 3401            MOVE D1,D2
4940 00058E E449            LSR 2,D1
4950 000590 E341            ASL 1,D1
4960 000592 207C00010000    MOVE.L #$10000,A0
4970 000598 D1C1            ADD.L D1,A0
4980 00059A 02420003        AND #3,D2
4990 00059E 6708            BEQ.S DSPLY1
5000 0005A0 E940     DSPLY2 ASL 4,D0
5010 0005A2 E95B            ROL 4,D3
   0 0005A4 5342            SUB #1,D2
   0 0005A6 66F8            BNE DSPLY2
5030 0005A8 3210     DSPLY1 MOVE (A0),D1
5040 0005AA 4E75            RTS
5050                        *
5060                        *
5070 0005AC 3601     EQU1 MOVE D1,D3
5080 0005AE 3802            MOVE D2,D4
5090 0005B0 4883            EXT D3
5100 0005B2 4884            EXT D4
5110 0005B4 E64B            LSR 3,D3
5120 0005B6 E64C            LSR 3,D4
5130 0005B8 9403            SUB.B D3,D2
5140 0005BA 9204            SUB.B D4,D1
5150 0005BC 4E75            RTS
5160                        *
5170 0005BE 3602     EQU2 MOVE D2,D3
5180 0005C0 4883            EXT D3
5190 0005C2 E64B            LSR 3,D3
5200 0005C4 9203            SUB.B D3,D1
5210 0005C6 3801            MOVE D1,D4
5220 0005C8 4884            EXT D4
5230 0005CA E64C            LSR 3,D4
5240 0005CC D404            ADD.B D4,D2
5250 0005CE 4E75            RTS
5260                        *
5270                        *
5280 0005D0 3602     EQU3 MOVE D2,D3
5290 0005D2 4883            EXT D3
5300 0005D4 E24B            LSR 1,D3
5310 0005D6 D203            ADD.B D3,D1
5320 0005D8 3801            MOVE D1,D4
5330 0005DA 4884            EXT D4
5340 0005DC E24C            LSR 1,D4
5350 0005DE 9404            SUB.B D4,D2
5360 0005E0 4E75            RTS
5370                        *
5380 0005E2 3602     EQU4 MOVE D2,D3
5390 0005E4 4883            EXT D3
```

```
5400  0005E6  E64B              LSR 3,D3
5410  0005E8  9203              SUB.B D3,D1
5420  0005EA  3801              MOVE D1,D4
5430  0005EC  4884              EXT D4
5440  0005EE  E64C              LSR 3,D4
5450  0005F0  9404              SUB.B D4,D2
5460  0005F2  4E75              RTS
5470                        *
5480  0005F4  3602          EQU5 MOVE D2,D3
5490  0005F6  4883              EXT D3
5500  0005F8  E24B              LSR 1,D3
5510  0005FA  9203              SUB.B D3,D1
5520  0005FC  3801              MOVE D1,D4
5530  0005FE  4884              EXT D4
5540  000600  E44C              LSR 2,D4
5550  000602  D404              ADD.B D4,D2
5560  000604  4E75              RTS
5570  000606  2C7C000225AC  Q9 MOVE.L #$225AC,A6
5580  00060C  3A3C0002      Q91 MOVE #2,D5
5590  000610  61000044      Q92 BSR CMQ
5600  000614  3E3C0020          MOVE #$20,D7
5610  000618  6100FEC0          BSR RUN1
5620  00061C  6100002C          BSR DLYQ
5630  000620  48E70402          MOVEM.L D5/A6,-(A7)
5640  000624  6100008E          BSR HP1
5650  000628  4CDF4020          MOVEM.L (A7)+,D5/A6
5660  00062C  6100001C          BSR DLYQ
   0  000630  5345              SUB  #1,D5
   0  000632  66DC              BNE  Q92
5680  000634  61000034          BSR LOGO
5690  000638  DDFC00000012      ADD.L #$12,A6
5700  00063E  BDFC00022606      CMP.L #$22606,A6
5710  000644  670001D2          BEQ Q8
5720  000648  60C2              BRA Q91
5730  00064A  283C000AFFFF  DLYQ MOVE.L #$000AFFFF,D4
5740  000650  5384          DLYQ1 SUB.L #1,D4
5750  000652  66FC              BNE DLYQ1
5760  000654  4E75              RTS
5770  000656  4280          CMQ CLR.L D0
5780  000658  323C2000          MOVE #$2000,D1
5790  00065C  207C00010000      MOVE.L #$10000,A0
5800  000662  20C0          CMQ1 MOVE.L D0,(A0)+
   0  000664  5341              SUB  #1,D1
   0  000666  66FA              BNE  CMQ1
5820  000668  4E75              RTS
5830  00066A  48E7FFFE      LOGO MOVEM.L D0-D7/A0-A6,-(A7)
5840  00066E  4EB900021F18      JSR FIXBUF
5850  000674  2CFC53482053      MOVE.L #'SH S',(A6)+
5860  00067A  2CFC4C494445      MOVE.L #'LIDE',(A6)+
5870  000680  1CBC0020          MOVE.B #' ',(A6)
5880  000684  6100FA62          BSR SHQ
5890  000688  61C0              BSR DLYQ
5900  00068A  4EB900021F18      JSR FIXBUF
5910  000690  2CFC5348204D      MOVE.L #'SH M',(A6)+
5920  000696  2CFC41534B20      MOVE.L #'ASK ',(A6)+
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5930 00069C 6100FA4A         BSR SHQ
5940 0006A0 4CDF7FFF          MOVEM.L (A7)+,D0-D7/A0-A6
5950 0006A4 283C0010FFFF      MOVE.L #$0010FFFF,D4
5960 0006AA 60A4              BRA DLYQ1
5970                          *
5980 0006AC 61000006     HP   BSR HP1
5990 0006B0 6000F9CA          BRA RETURN
6000 0006B4 267C00001080 HP1  MOVE.L #ARRAY,A3
6010 0006BA 619A              BSR CMQ
6020 0006BC 4241              CLR D1
6030 0006BE 4242              CLR D2
6040 0006C0 363C00FF          MOVE #$FF,D3
6050 0006C4 3803              MOVE D3,D4
6060 0006C6 6100FE6A          BSR RAND1
6070 0006CA 02000007          AND.B #7,D0
6080 0006CE 5A00              ADD.B #5,D0
6090 0006D0 E340              ASL 1,D0
6100 0006D2 11C01014          MOVE.B D0,NUMPT
6110 0006D6 6100FE5A          BSR RAND1
6120 0006DA 0200001F          AND.B #$1F,D0
6130 0006DE 00000005          OR.B #$5,D0
6140 0006E2 11C01016          MOVE.B D0,SCALE
6150 0006E6 4245              CLR D5
6160 0006E8 6100FE48     H6   BSR RAND1
6170 0006EC 024000FF          AND #$FF,D0
6180 0006F0 17805000          MOVE.B D0,0(A3,D5)
6190 0006F4 B240              CMP D0,D1
6200 0006F6 6A02              BPL.S H1
6210 0006F8 1200              MOVE.B D0,D1
6220 0006FA B640         H1   CMP D0,D3
6230 0006FC 6B02              BMI.S H2
6240 0006FE 1600              MOVE.B D0,D3
6250 000700 6100FE30     H2   BSR RAND1
6260 000704 024000FF          AND #$FF,D0
6270 000708 17805001          MOVE.B D0,1(A3,D5)
6280 00070C B440              CMP D0,D2
6290 00070E 6A02              BPL.S H3
6300 000710 1400              MOVE.B D0,D2
6310 000712 B840         H3   CMP D0,D4
6320 000714 6B02              BMI.S H4
6330 000716 1800              MOVE.B D0,D4
6340 000718 BA381014     H4   CMP.B NUMPT,D5
6350 00071C 6704              BEQ.S H5
6360 00071E 5405              ADD.B #2,D5
6370 000720 60C6              BRA H6
6380        00000722     H5   EQU *
6390 000722 9203         H8   SUB.B D3,D1
6400 000724 9404              SUB.B D4,D2
6410 000726 4245              CLR D5
6420 000728 97335000     H61  SUB.B D3,0(A3,D5)
6430 00072C 99335001          SUB.B D4,1(A3,D5)
6440 000730 BA381014          CMP.B NUMPT,D5
6450 000734 6704              BEQ.S H9
6460 000736 5405              ADD.B #2,D5
6470 000738 60EE              BRA H61
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6480 00073A 4243              H9 CLR D3
6490 00073C 203C0000FF00      MOVE.L #$FF00,D0
6500 000742 024100FF          AND #$FF,D1
6510 000746 80C1              DIVU D1,D0
6520 000748 4245              CLR D5
6530 00074A 16335000          H12 MOVE.B 0(A3,D5),D3
6540 00074E C6C0              MULU D0,D3
6550 000750 E04B              LSR 8,D3
6560 000752 17835000          MOVE.B D3,0(A3,D5)
6570 000756 BA381014          CMP.B NUMPT,D5
6580 00075A 6704              BEQ.S H11
6590 00075C 5405              ADD.B #2,D5
6600 00075E 60EA              BRA H12
6610 000760 203C0000FF00      H11 MOVE.L #$FF00,D0
6620 000766 024200FF          AND #$FF,D2
6630 00076A 80C2              DIVU D2,D0
6640 00076C 4245              CLR D5
6650 00076E 16335001          H14 MOVE.B 1(A3,D5),D3
6660 000772 C6C0              MULU D0,D3
6670 000774 E04B              LSR 8,D3
6680 000776 17835001          MOVE.B D3,1(A3,D5)
6690 00077A BA381014          CMP.B NUMPT,D5
6700 00077E 6704              BEQ.S H13
6710 000780 5405              ADD.B #2,D5
6720 000782 60EA              BRA H14
6730 000784 31D31000          H13 MOVE (A3),X1
6740 000788 3E3C001C          H131 MOVE #$1C,D7
6750 00078C 54381014          H132 ADD.B #2,NUMPT
6760 000790 1A381014          MOVE.B NUMPT,D5
6770 000794 37935000          MOVE (A3),0(A3,D5)
6780 000798 3C3C0004          H15 MOVE #4,D6
6790 00079C 6100FD94          BSR RAND1
6800 0007A0 024000F           AND #$F,D0
6810 0007A4 67F2              BEQ H15
6820 0007A6 0C000008          CMP.B #$8,D0
6830 0007AA 67EC              BEQ H15
6840 0007AC 0C00000F          CMP.B #$F,D0
6850 0007B0 67E6              BEQ H15
6860 0007B2 4245              HP6 CLR D5
6870 0007B4 12335000          H17 MOVE.B 0(A3,D5),D1
6880 0007B8 14335001          MOVE.B 1(A3,D5),D2
6890 0007BC 6100008A          HP17 BSR LINE
6900 0007C0 BA381014          CMP.B NUMPT,D5
6910 0007C4 6748              BEQ.S H16
6920 0007C6 12335002          MOVE.B 2(A3,D5),D1
6930 0007CA 14335000          MOVE.B 0(A3,D5),D2
6940 0007CE 024100FF          AND #$FF,D1
6950 0007D2 024200FF          AND #$FF,D2
6960 0007D6 9242              SUB D2,D1
6970 0007D8 16381016          MOVE.B SCALE,D3
6980 0007DC 024300FF          AND #$FF,D3
6990 0007E0 C3C3              MULS D3,D1
7000 0007E2 E049              LSR 8,D1
7010 0007E4 D3335000          ADD.B D1,0(A3,D5)
7020 0007E8 12335003          MOVE.B 3(A3,D5),D1
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7030 0007EC 024100FF         AND #$FF,D1
7040 0007F0 14335001         MOVE.B l(A3,D5),D2
7050 0007F4 024200FF         AND #$FF,D2
7060 0007F8 9242             SUB D2,D1
7070 0007FA 16381016         MOVE.B SCALE,D3
7080 0007FE 024300FF         AND #$FF,D3
7090 000802 C3C3             MULS D3,D1
7100 000804 E049             LSR 8,D1
7110 000806 D3335001         ADD.B D1,l(A3,D5)
7120 00080A 5445             ADD #2,D5
7130 00080C 60A6             BRA H17
7140 00080E 5346         H16 SUB #1,D6
7150 000810 66A0             BNE HP6
7160 000812 5347             SUB #1,D7
7170 000814 6682             BNE H15
7180 000816 4E75             RTS
7190 000818 6100FE9A     Q8  BSR HP1
7200 00081C 283C000AFFFF     MOVE.L #$AFFFF,D4
7210 000822 6100FE2C         BSR DLYQ1
7220 000826 60F0             BRA Q8
7230                     *
7240                     *
7250                     *
7260 000828 12290002     DXDY MOVE.B 2(Al),D1
7270 00082C 9211             SUB.B (Al),D1
7280 00082E 650A             BCS.S XNEG
7290 000830 13410004         MOVE.B D1,4(Al)
7300 000834 42290006         CLR.B 6(Al)
7310 000838 4E75             RTS
7320 00083A 137C00010006 XNEG MOVE.B #1,6(Al)
7330 000840 4401             NEG.B D1
7340 000842 13410004         MOVE.B D1,4(Al)
7350 000846 4E75             RTS
7360                     *
7370                     *
7380         00000848     LINE EQU *
7390 000848 48E7FFFE     DRAW MOVEM.L D0~D7/A0~A6,-(A7)
7400 00084C 227C00001000     MOVE.L #X1,Al
7410 000852 13410002         MOVE.B D1,2(Al)
7420 000856 13420003         MOVE.B D2,3(Al)
7430 00085A 1211             MOVE.B (Al),D1
7440 00085C 14290001         MOVE.B l(Al),D2
7450 000860 6100FCF2         BSR DSP
7460 000864 61C2         DRAW1 BSR DXDY
7470 000866 5289             ADD.L #1,Al
7480 000868 61BE             BSR DXDY
7490 00086A 5389             SUB.L #1,Al
7500 00086C 1211             MOVE.B (Al),D1
7510 00086E 14290001         MOVE.B l(Al),D2
7520 000872 4A290004         TST.B 4(Al)
7530 000876 6766             BEQ.S DXZ
7540 000878 4A290005         TST.B 5(Al)
7550 00087C 67000088         BEQ DYZ
7560 000880 16290004         MOVE.B 4(Al),D3
7570 000884 B6290005         CMP.B 5(Al),D3
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7580 000888 660000B0          BNE FULMOV
7590 00088C 4A290006          TST.B 6(A1)
7600 000890 6626              BNE.S SXN
7610 000892 4A290007          TST.B 7(A1)
7620 000896 6636              BNE.S SYN
7630 000898 6100FCBA    XPYP1 BSR DSP
7640 00089C 5201              ADD.B #1,D1
7650 00089E 5202              ADD.B #1,D2
7660 0008A0 B2290002          CMP.B 2(A1),D1
7670 0008A4 66F2              BNE XPYP1
7680 0008A6 607E              BRA.S XYDONE
7690 0008A8 6100FCAA   SXNSYN BSR DSP
7700 0008AC 5301              SUB.B #1,D1
7710 0008AE 5302              SUB.B #1,D2
7720 0008B0 B2290002          CMP.B 2(A1),D1
7730 0008B4 66F2              BNE SXNSYN
7740 0008B6 606E              BRA.S XYDONE
7750 0008B8 4A290007      SXN TST.B 7(A1)
7760 0008BC 66EA              BNE.S SXNSYN
7770 0008BE 6100FC94      SNP BSR DSP
7780 0008C2 5301              SUB.B #1,D1
7790 0008C4 5202              ADD.B #1,D2
7800 0008C6 B2290002          CMP.B 2(A1),D1
7810 0008CA 66F2              BNE SNP
7820 0008CC 6058              BRA.S XYDONE
7830 0008CE 6100FC84      SYN BSR DSP
7840 0008D2 5201              ADD.B #1,D1
7850 0008D4 5302              SUB.B #1,D2
7860 0008D6 B2290002          CMP.B 2(A1),D1
7870 0008DA 66F2              BNE SYN
7880 0008DC 6048              BRA.S XYDONE
7890 0008DE 4A290005      DXZ TST.B 5(A1)
7900 0008E2 6742              BEQ.S XYDONE
7910 0008E4 4A290007          TST.B 7(A1)
7920 0008E8 660E              BNE.S DXZYN
7930 0008EA 6100FC68     DXZ1 BSR DSP
7940 0008EE 5202              ADD.B #1,D2
7950 0008F0 B4290003          CMP.B 3(A1),D2
7960 0008F4 66F4              BNE DXZ1
7970 0008F6 602E              BRA.S XYDONE
7980 0008F8 6100FC5A    DXZYN BSR DSP
7990 0008FC 5302              SUB.B #1,D2
8000 0008FE B4290003          CMP.B 3(A1),D2
8010 000902 66F4              BNE DXZYN
8020 000904 6020              BRA.S XYDONE
8030 000906 4A290006      DYZ TST.B 6(A1)
8040 00090A 660E              BNE.S DYZN
8050 00090C 6100FC46     DYZ1 BSR DSP
8060 000910 5201              ADD.B #1,D1
8070 000912 B2290002          CMP.B 2(A1),D1
8080 000916 66F4              BNE DYZ1
8090 000918 600C              BRA.S XYDONE
8100 00091A 6100FC38     DYZN BSR DSP
8110 00091E 5301              SUB.B #1,D1
8120 000920 B2290002          CMP.B 2(A1),D1
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8130 000924 66F4              BNE DYZN
8140 000926 32A90002  XYDONE  MOVE 2(A1),(A1)
8150 00092A 1211              MOVE.B (A1),D1
8160 00092C 14290001          MOVE.B 1(A1),D2
8170 000930 6100FC22          BSR DSP
8180 000934 4CDF7FFF          MOVEM.L (A7)+,D0-D7/A0-A6
8190 000938 4E75              RTS
8200 00093A 33510008  FULMOV  MOVE (A1),8(A1)
8210 00093E 16290004          MOVE.B 4(A1),D3
8220 000942 96290005          SUB.B 5(A1),D3
8230 000946 6208              BHI.S FUL1
8240 000948 337C0001000A      MOVE #$1,10(A1)
8250 00094E 6046              BRA.S FUL4
8260 000950 337C0100000A FUL1 MOVE #$100,10(A1)
8270 000956 603E              BRA.S FUL4
8280 000958 16290008  FUL2    MOVE.B 8(A1),D3
8290 00095C 9611              SUB.B (A1),D3
8300 00095E 6402              BCC.S FUL21
8310 000960 4403              NEG.B D3
8320 000962 02430FF   FUL21   AND #$FF,D3
8330 000966 18290005          MOVE.B 5(A1),D4
8340 00096A 02440FF           AND #$FF,D4
8350 00096E C6C4              MULU D4,D3
8360 000970 18290009          MOVE.B 9(A1),D4
8370 000974 98290001          SUB.B 1(A1),D4
8380 000978 6402              BCC.S FUL22
8390 00097A 4404              NEG.B D4
8400 00097C 1A290004  FUL22   MOVE.B 4(A1),D5
8410 000980 02440FF           AND #$FF,D4
8420 000984 02450FF           AND #$FF,D5
8430 000988 C8C5              MULU D5,D4
8440 00098A 4A29000A          TST.B 10(A1)
8450 00098E 660E              BNE.S FULY
8460 000990 B883              CMP.L D3,D4
8470 000992 6710              BEQ.S GREAT
8480 000994 620E              BHI.S GREAT
8490 000996 3369000A000E FUL4 MOVE 10(A1),14(A1)
8500 00099C 600C              BRA.S SAME
8510 00099E B883      FULY    CMP.L D3,D4
8520 0009A0 6702              BEQ.S GREAT
8530 0009A2 62F2              BHI.S FUL4
8540 0009A4 337C0101000E GREAT MOVE #$0101,14(A1)
8550 0009AA 12290008  SAME    MOVE.B 8(A1),D1
8560 0009AE 14290009          MOVE.B 9(A1),D2
8570 0009B2 4A290007          TST.B 7(A1)
8580 0009B6 6606              BNE.S NEGY
8590 0009B8 D429000F          ADD.B 15(A1),D2
8600 0009BC 6004              BRA.S S2
8610 0009BE 9429000F  NEGY    SUB.B 15(A1),D2
8620 0009C2 13420009  S2      MOVE.B D2,9(A1)
8630 0009C6 4A290006          TST.B 6(A1)
8640 0009CA 6606              BNE.S NEGX
8650 0009CC D229000E          ADD.B 14(A1),D1
8660 0009D0 6004              BRA.S S3
8670 0009D2 9229000E  NEGX    SUB.B 14(A1),D1
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8680 0009D6 13410008      S3 MOVE.B D1,8(A1)
8690 0009DA 6100FB78      FUL3 BSR DSP
8700 0009DE B2290002      CMP.B 2(A1),D1
8710 0009E2 670A          BEQ.S DRAW2
8720 0009E4 B4290003      CMP.B 3(A1),D2
8730 0009E8 6704          BEQ.S DRAW2
8740 0009EA 6000FF6C      BRA FUL2
8750 0009EE 32A90008      DRAW2 MOVE 8(A1),(A1)
8760 0009F2 6000FE70      BRA DRAW1
8770 0009F6 0000          END
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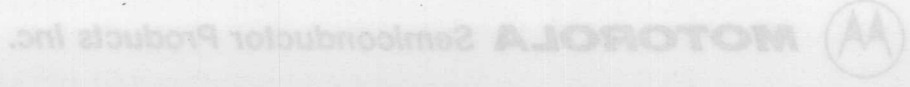
****** TOTAL ERRORS   0---   0

SYMBOL TABLE

ARRAY	001080	BA	000454	BL1	000364	BL2	000358
BL3	000368	BLACK	000308	BLINK	00034A	BLUE	0002FC
BX	00018A	BX1	00019A	BX11	0001B4	BX2	0001A4
BX22	0001C0	BX3	000190	BX33	0001D0	BX44	0001DA
CHAR	0003B6	CHARED	0003A0	CHARED1	0003CE	CHARED2	0003D0
CHARED3	0003D4	CHARED4	0003F8	CHTAB	0009F6	CLRM	000074
CM	000068	CMD	000204	CMD1	00026A	CMD2	000288
CMD3	000270	CMD4	000276	CMDTAB	001800	CMQ	000656
CMQ1	000662	COLOR	001010	CR	00027C	CRTC	0000D2
CYAN	00031A	DBLUE	00032C	DCYAN	000344	DGR	000326
DLY	00044A	DLY1	00044E	DLYQ	00064A	DLYQ1	000650
DMAG	00033E	DOT	00041C	DRAW	000848	DRAW1	000864
DRAW2	0009EE	DRED	000320	DSP	000554	DSP1	000566
DSPLY	00055A	DSPLY1	0005A8	DSPLY2	0005A0	DWARROW	000258
DWH	000332	DXDY	000828	DXZ	0008DE	DXZ1	0008EA
DXZYN	0008F8	DYEL	000338	DYZ	000906	DYZ1	00090C
DYZN	00091A	ED	0001E8	ED1	0001FA	EQU1	0005AC
EQU2	0005BE	EQU3	0005D0	EQU4	0005E2	EQU5	0005F4
FIXBUF	021F18	FUL1	000950	FUL2	000958	FUL21	000962
FUL22	00097C	FUL3	0009DA	FUL4	000996	FULMOV	00093A
FULY	00099E	GETADD	00057A	GREAT	0009A4	GREEN	0002F6
H1	0006FA	H11	000760	H12	00074A	H13	000784
H131	000788	H132	00078C	H14	00076E	H15	000798
H16	00080E	H17	0007B4	H2	000700	H3	000712
H4	000718	H5	000722	H6	0006E8	H61	000728
H8	000722	H9	00073A	HP	0006AC	HP1	0006B4
HP17	0007BC	HP6	0007B2	INIT	00002C	INIT1	000038
INPUT	00016E	L1	000466	L2	000482	LINE	000848
LOGO	00066A	LOOP	000474	LTARROW	000264	MACSBUG	0200F6
MAG	000314	MSG	0200EE	NCOLOR	001011	NEGX	0009D2
NEGY	0009BE	NTABLE	000082	NUMPT	001014	OCOLOR	001012
OUTPUT	00017C	OUTPUT2	021BC2	Q1	000498	Q2	0004A4
Q3	0004B0	Q4	0004BC	Q5	0004C8	Q8	000818
Q9	000606	Q91	00060C	Q92	000610	RANADD	001018
RAND	000514	RAND1	000532	RAND2	000520	READK	000436
RED	0002F0	RETURN	00007C	RTARROW	00025E	RTS	000256
RTS1	000254	RTS2	0002EC	RUN	0004D2	RUN1	0004DA
RUN2	0004E2	S2	0009C2	S3	0009D6	SAME	0009AA
SCALE	001016	SET	00040A	SETUP	000000	SETUP1	00000E

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SETUP2	00001C	SETUP21	000060	SH	0000E2	SH1	0000F4
SH2	000106	SH3	000146	SH4	000154	SHOW	0001B2
SHQ	0000E8	SNP	0008BE	SXN	0008B8	SXNSYN	0008A8
SYN	0008CE	TABLECH	001100	UPARROW	000250	WHITE	000302
X1	001000	X2	001002	XNEG	00083A	XPYP1	000898
XYDONE	000926	Y1	001001	Y2	001003	YELLOW	00030E

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