



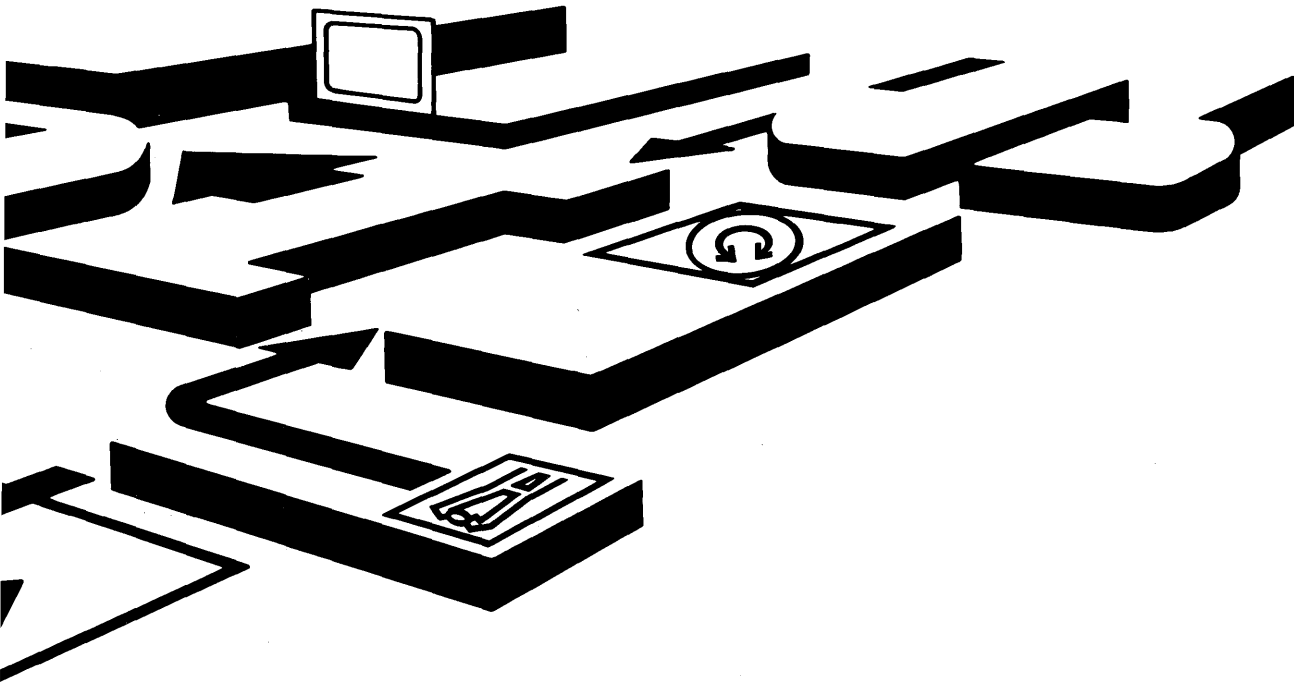
Technical Reference
Options and Adapters
Volume 1



IBM Industrial Computer



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Options and Adapters
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IBM Industrial Computer

Preface

The options and adapters manual is the second part of the *Technical Reference* publication. It is designed to be used in conjunction with any of the *Technical Reference* system unit manuals.

The information in this publication is for reference, and is intended for hardware and program designers, programmers, engineers, and anyone else with a knowledge of electronics and/or programming who needs to understand the design and operation of the options and adapters available for the IBM Industrial Computer and Personal Computer family of products.

This manual is modular in format, with each module providing information about a specific option or adapter available for the IBM Industrial Computer and Personal Computer family of products.

Modules having a large amount of text contain individual indexes.

The modules are grouped by type of device. To find a specific module:

1. Locate the full length hard tab with the type of device (Displays, Printers, Storage Devices, etc.) printed on it that describes the option or adapter you need information about.
2. Open the book to that section.
3. Leaf through that section to find the proper module.

The following pages provide a list of the options and adapters as they appear within each section.

The front matter of this manual also provides a "System to Adapter Compatibility Chart," to identify the adapters supported by each system, and an "Option to Adapter Compatibility Chart," to identify the options supported by each adapter.

Contents

Volume 1

- Expansion Unit
 - IBM Expansion Unit
- Displays
 - IBM Monochrome Display
 - IBM Portable Personal Computer Display
 - IBM Color Display
 - IBM Enhanced Color Display
- Printers
 - IBM Graphics Printer
- Storage Devices
 - IBM 5 1/4" Diskette Drive
 - IBM Slimline Diskette Drive
 - High Capacity Diskette Drive
 - Double Sided Diskette Drive
 - IBM 10MB Fixed Disk Drive
 - 20MB Fixed Disk Drive
- Memory Expansion
 - IBM 64/256KB Memory Expansion Option and IBM 64KB Memory Module Kit
 - 128KB Memory Expansion Option
 - 512KB Memory Expansion Option

System to Adapter Compatibility Chart

The following chart identifies the adapters supported by each system.

	IBM Personal Computer	IBM Personal Computer XT	IBM Portable Personal Computer	IBM Personal Computer AT	IBM Expansion Unit	IBM 5531 Industrial Computer	IBM 7531/7532 Industrial Computer
64KB Memory Module Kit	Yes	Yes	Yes	No	No	Yes	No
64/256KB Memory Expansion Option	Yes	Yes	Yes	No	No	Yes	No
128KB Memory Expansion Option	No	No	No	Yes	No	No	Yes
256KB Memory Expansion Option	Yes	Yes	Yes	No	No	Yes	No
512KB Memory Expansion Option	No	No	No	Yes	No	No	Yes
Monochrome Display and Printer Adapter	Yes	Yes	No	Yes	No	Yes	Yes
Color/Graphics Monitor Adapter	Yes	Yes	Yes	Yes	No	Yes	Yes
Printer Adapter	Yes	Yes	Yes	No	Yes	Yes	No
5 1/4 inch Diskette Drive Adapter	Yes	Yes	Yes	No	No	Yes	No
Fixed Disk Drive Adapter	Yes	Yes	No	No	Yes	Yes	No
Fixed Disk and Diskette Adapter	No	No	No	Yes	No	No	Yes

System to Adapter Compatibility Chart (Part 1 of 2)

Option to Adapter Compatability Chart

Because some adapters perform multiple functions, the following chart identifies the options supported by each adapter.

	Slimline Diskette Drive	Double Sided Diskette Drive	5 1/4" Diskette Drives	High Capacity Diskette Drive	Fixed Disk Drive	20MB Fixed Disk Drive	Monochrome Display	Color Display	Graphics Printer	Compact Printer	Color Printer	RF Modulator	Light Pen	Joystick
5 1/4" Diskette Drive Adapter	X	X												
Fixed Disk Drive Adapter					X									
Fixed Disk and Diskette Drive Adapter	X	X	X											
Color Graphics Monitor Adapter							X			X	X			
Monochrome Display and Printer Adapter					X	X	X							
Printer Adapter						X	X							
Asynchronous Communications Adapter								X						
Serial/Parallel Adapter						X	X	X						
Game Control Adapter													X	

X - Adapter Compatible with Option

Option to Adapter Compatability Chart

IBM Expansion Unit

Contents

Description	1
Programming Considerations	9
Interface	10
Specifications	11
Logic Diagrams	14

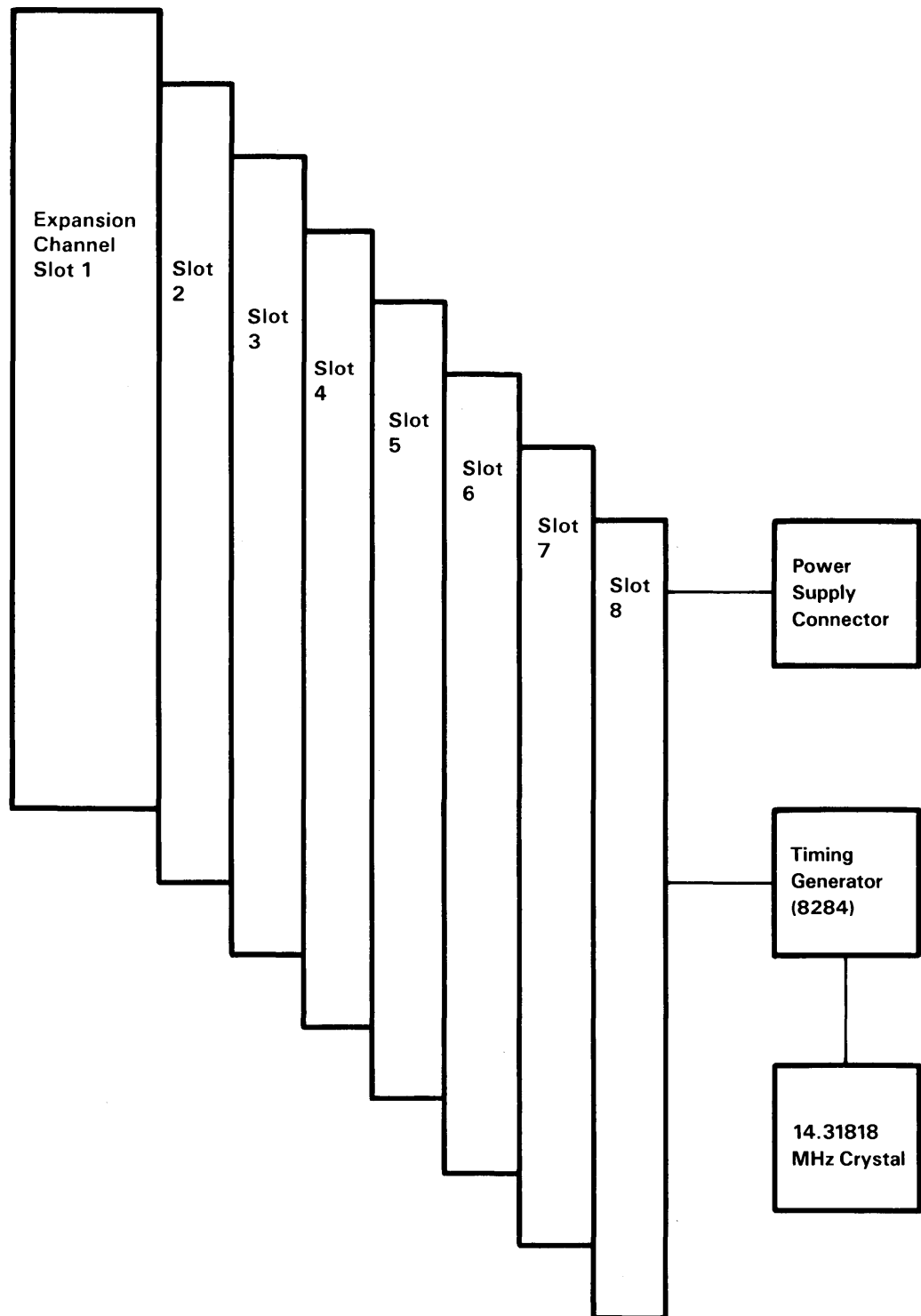
IBM Expansion Unit

Description

The IBM Expansion Unit option enhances the system unit by adding expansion slots in a separate unit. This option consists of an extender card, expansion unit cable, and the expansion unit. The expansion unit contains a power supply, an expansion board, and a receiver card. This option utilizes one expansion slot in the system unit to provide seven additional expansion slots in the expansion unit.

Description (continued)

The following is a block diagram of the expansion board.



Expansion Board Block Diagram

Description (continued)

Overvoltage and Overcurrent Protection

Voltage Nominal Vac	Type Protection	Rating Amps
110	Fuse	5
220	Fuse	3

Power On/Off Cycle: When the power supply is switched Off for a minimum of 1.0 second, and then switched On, the 'power good' signal is regenerated.

The 'power good' signal indicates that there is adequate power to continue processing. If the power goes below the specified levels, the 'power good' signal triggers a system shutdown.

This signal is the logical AND of the dc output-voltage 'sense' signal and the ac input-voltage 'fail' signal. This signal is TTL-compatible up-level for normal operation or down-level for fault conditions. The ac 'fail' signal causes 'power good' to go to a down-level when any output voltage falls below the regulation limits.

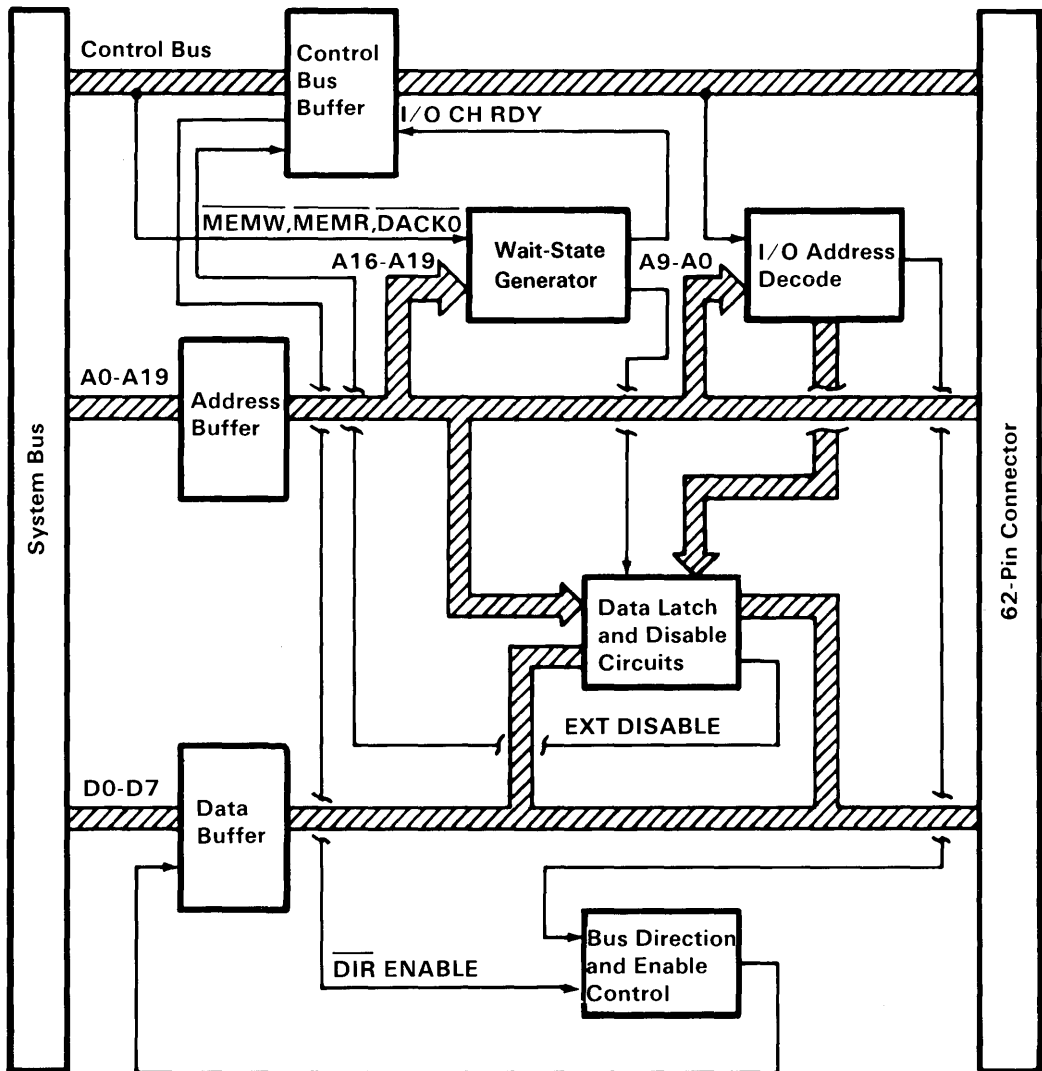
The dc output-voltage 'sense' signal holds the 'power good' signal at a down level (during power-on) until all output voltages have reached their respective minimum sense levels. The 'power good' signal has a turn-on delay of at least 100 ms but no greater than 500 ms.

The sense levels of the dc outputs are shown in the following table.

Output (Vdc)	Minimum (Vdc)	Sense Voltage Nominal (Vdc)	Maximum (Vdc)
+ 5	+ 4.5	+ 5.0	+ 5.5
- 5	- 4.3	- 5.0	- 5.5
+ 12	+ 10.8	+ 12.0	+ 13.2
- 12	- 10.2	- 12.0	- 13.2

Description (continued)

The following is a block diagram of the extender card.



Extender Card Block Diagram

Programming Considerations

Several registers associated with the Expansion Unit option are programmable and readable for diagnostic test purposes. The following figures indicate the locations and functions of the registers on the extender card and receiver card.

Location	Function
Memory FXXXX(*)	Write to memory to latch address bits
Port 210	Write to latch expansion bus data (ED0 - ED7)
Port 210	Read to verify expansion bus data (ED0 - ED7)
Port 211	Read high-order address bits (A8 - A15)
Port 211	Write to clear wait test latch
Port 212	Read low-order address bits (A0 - A7)
Port 213	Write 00 to disable expansion unit
Port 213	Write 01 to enable expansion unit
Port 213	Read status of expansion unit D0 = enable/disable D1 = wait-state request flag D2-D3 = not used D4-D7 = switch position 1 = Off 0 = On
(*) Example: Write to memory location F123:4 = 00 Read Port 211 = 12 Read Port 212 = 34 (All values in hexadecimal)	

Extender Card Registers

Location	Function
Memory FXXXX(*)	Write to memory to latch address bits
Port 214	Write to latch data bus bits (D0 - D7)
Port 214	Read data bus bits (D0 - D7)
Port 215	Read high-order address bits (A8 - A15)
Port 216	Read low-order address bits (A0 - A7)
(*) Example: Write to memory location F123:4 = 00 Read Port 215 = 12 Read Port 216 = 34 (All values in hexadecimal)	

Receiver Card Registers

The expansion unit is automatically enabled upon power-up. Both the extender card and receiver card will be written to, if the expansion unit is not disabled when writing to FXXXX. However, the system unit and the expansion unit are read back separately.

Specifications

Size	
Height	142 mm (5.5 in.)
Width	500 mm (19.6 in.)
Depth	410 mm (16.1 in.)
Weight	
	14.9 kg (33 lb)
Power Cable	
Length	1.83 m (6 ft)
Size	18 AWG
Signal Cable	
Length	1 m (3.28 ft)
Size	22 AWG

Physical Specifications

Voltage (Vac)			Frequency (Hz)	Current (Amps)
Nominal	Minimum	Maximum	± 3 Hz	Maximum
110	90	137	60	3 at 90 Vac
220/240	180	259	50	1.6 at 180 Vac

Input Requirements

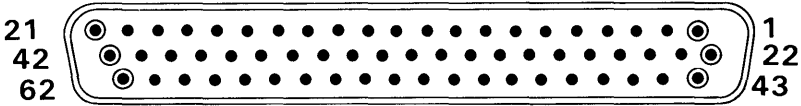
Environment	
Air Temperature	
System On	15.6 to 32.2°C (60 to 90°F)
System Off	10 to 43°C (50 to 110°F)
Humidity	
System On	8 to 80%
System Off	20 to 80%
Heat Output	717 BTU/hr

Additional Specifications

Specifications (continued)

Extender Card and Receiver Card

The extender card and receiver card rear-panel connectors are the same. Pin and signal assignments for the extender and receiver cards are shown below.

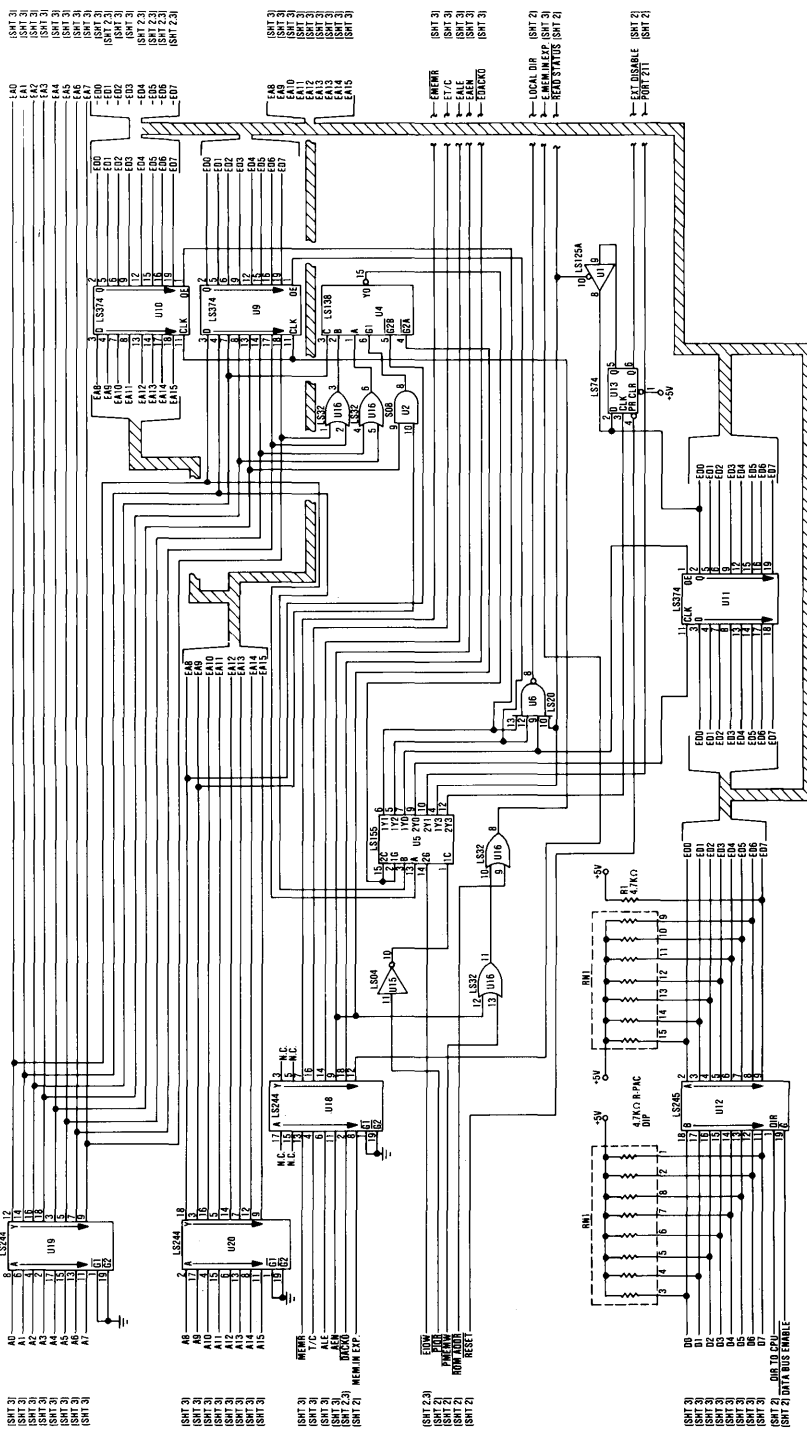


Pin	Signal	Pin	Signal	Pin	Signal
1	+ E IRQ6	22	+ E D5	43	+ E IRQ7
2	+ E DRQ2	23	+ E DRQ1	44	+ E D6
3	+ E DIR	24	+ E DRQ3	45	+ E I/O CH RDY
4	+ E ENABLE	25	RESERVED	46	+ E IRQ3
5	+ E CLK	26	+ E ALE	47	+ E D7
6	- E MEM IN EXP	27	+ E T/C	48	+ E D1
7	+ E A17	28	+ E RESET	49	- E I/O CH CK
8	+ E A16	29	+ E AEN	50	+ E IRQ2
9	+ E A5	30	+ E A19	51	+ E D0
10	- E DACK0	31	+ E A14	52	+ E D2
11	+ E A15	32	+ E A12	53	+ E D4
12	+ E A11	33	+ E A18	54	+ E IRQ5
13	+ E A10	34	- E MEMR	55	+ E IRQ4
14	+ E A9	35	- E MEMW	56	+ E D3
15	+ E A1	36	+ E A0	57	GND
16	+ E A3	37	- E DACK3	58	GND
17	- E DACK1	38	+ E A6	59	GND
18	+ E A4	39	- E IOR	60	GND
19	- E DACK2	40	+ E A8	61	GND
20	- E IOW	41	+ E A2	62	GND
21	+ E A13	42	+ E A7		

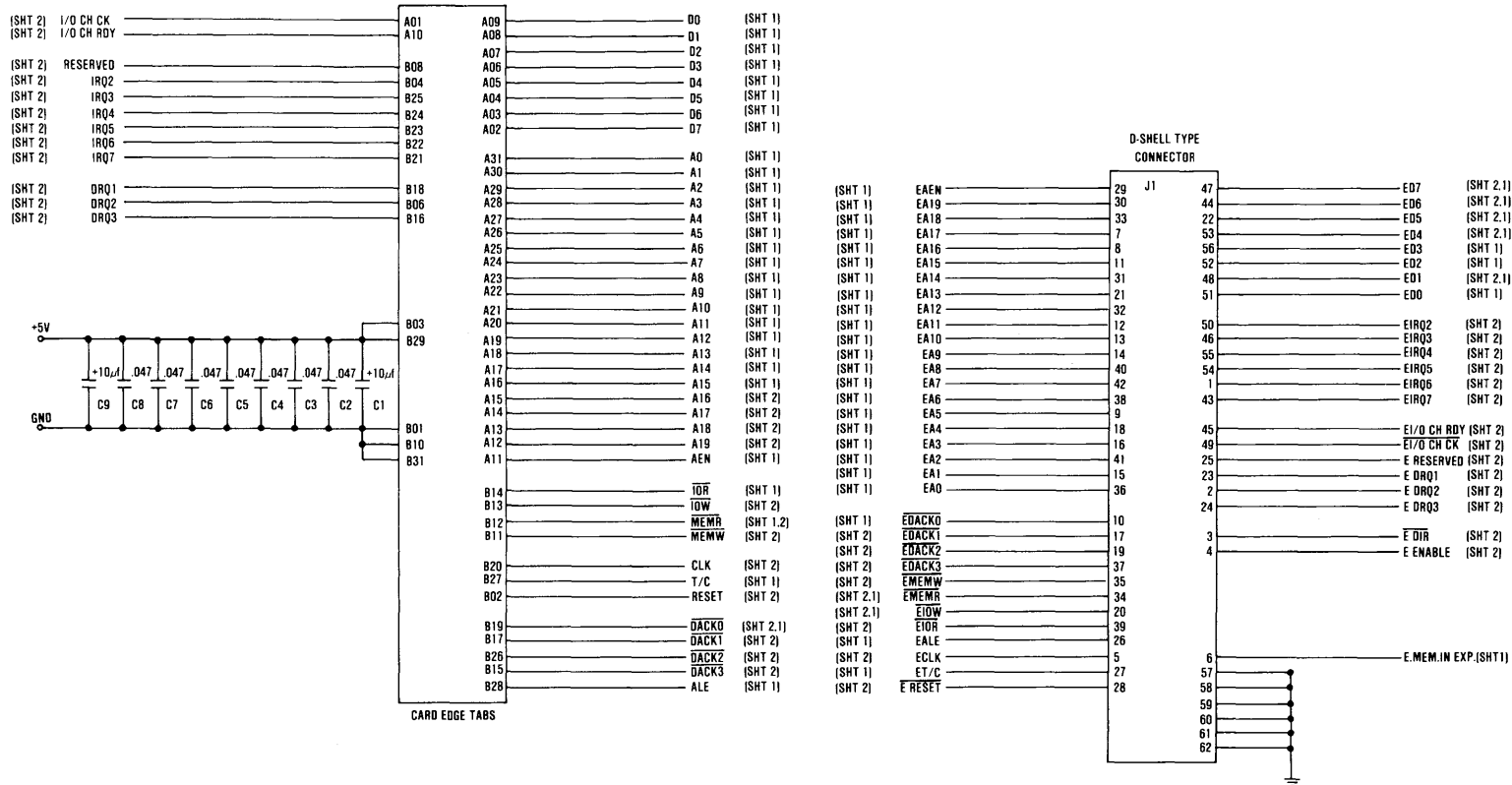
E = Extended

Connector Specifications

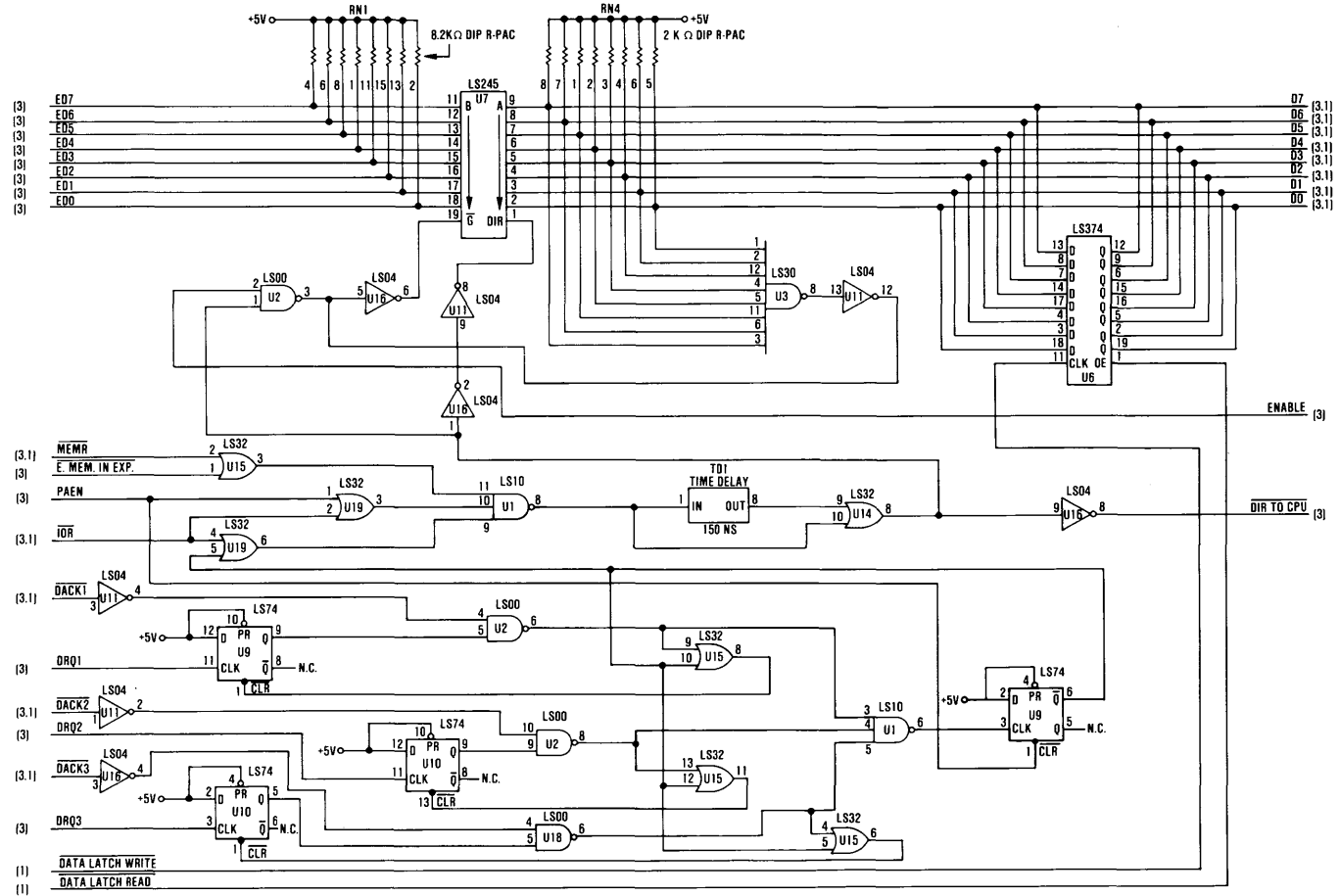
Logic Diagrams (continued)



Extender Card (Sheet 1 of 3)



Extender Card (Sheet 3 of 3)



Receiver Card (Sheet 2 of 3)

IBM Monochrome Display

Contents

Description	1
Specifications	3
Logic Diagrams	4

IBM Monochrome Display

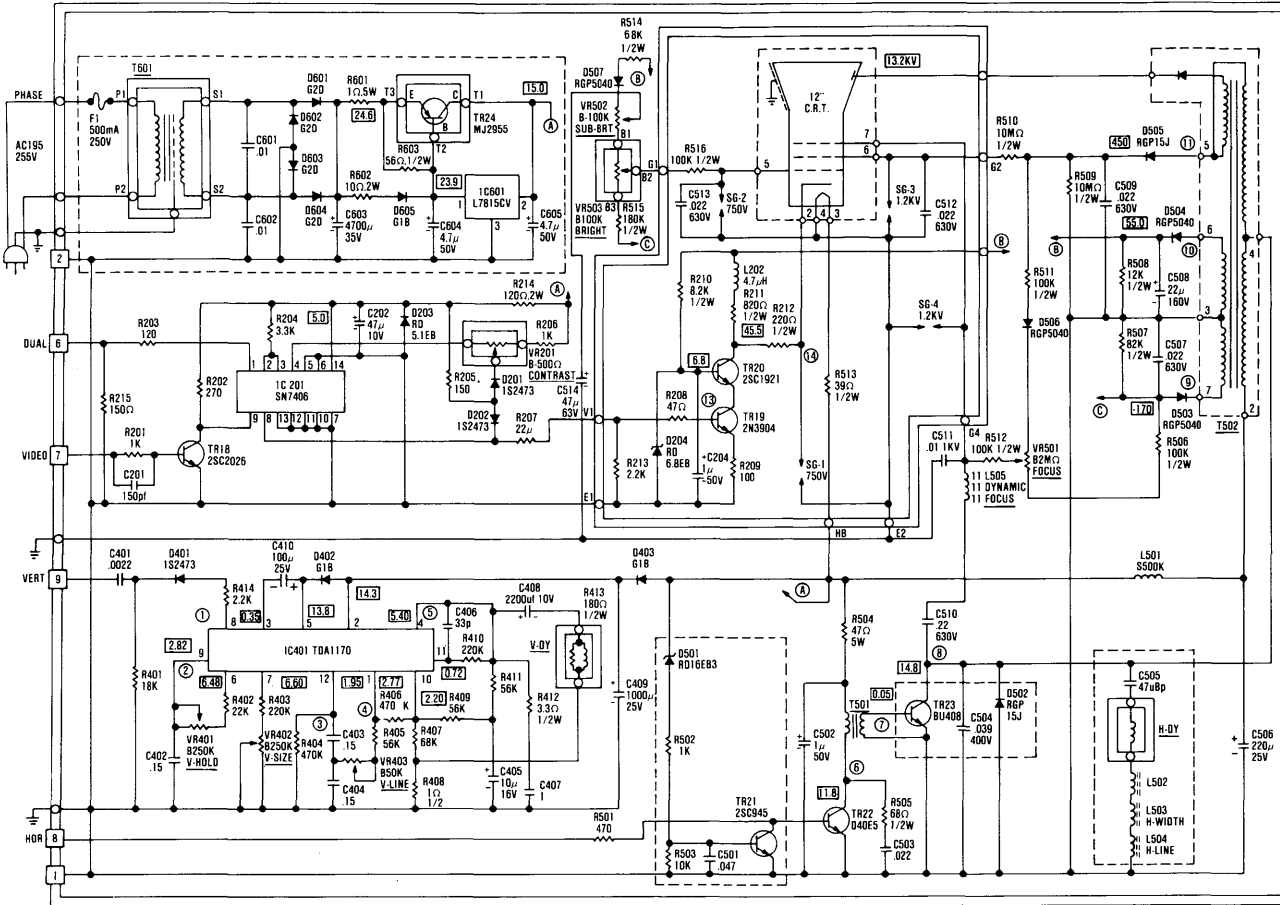
Description

The high resolution IBM Monochrome Display connects to the system unit through two cables. One cable is a signal cable from the display adapter to the display, and the other provides power to the display from the system unit. This arrangement eliminates the need for a wall outlet and allows the system-unit Power switch to control power to the display. The display unit has a 28.3 cm (11.5 in.) diagonal, 90° deflection cathode ray tube (CRT). The display may be placed on the system unit or on a nearby table or desk. Brightness and contrast controls are on the front surface and are easily accessible to the operator.

Specifications

Size	
Height	280 mm (11 in.)
Length	380 mm (14.9 in.)
Depth	350 mm (13.7 in.)
Weight	
	7.9 kg (17.3 lb)
Heat Output	
	325 BTU/hr
Power Cable	
Length	0.914 m (3 ft)
Size	18 AWG
Signal Cable	
Length	1.22 m (4 ft)
Size	22 AWG

Physical Specifications



DANGER
HAZARDOUS VOLTAGES
UP TO 450 VOLTS EXIST
ON THE PRINTED
CIRCUIT BOARDS

- NOTES:
 1. RESISTOR VALUES ARE IN Ω K = 1000 Ω M = 1,000,000 Ω
 2. ALL RESISTORS ARE 1/4W EXCEPT WHERE OTHERWISE INDICATED.
 3. ALL CAPACITORS ARE 50V EXCEPT WHERE OTHERWISE INDICATED.
 4. CAPACITORS VALUES ARE μ F UNLESS OTHERWISE INDICATED μ F = 10^{-6}
 5. AC WIRING INFORMATION
 PHASE = BLACK/BROWN WIRE
 NEUTRAL = WHITE/BLUE WIRE
 GROUND = GREEN AND YELLOW WIRE
 IMPORTANT: THE PHASE WIRE MUST GO TO THE FUSED SIDE OF TRANSFORMER.

220/240V ac Monochrome Display (Sheet 1 of 1)

IBM Portable Personal Computer Display

Contents

Description 1
Logic Diagrams 3

IBM Portable Personal Computer Display

Description

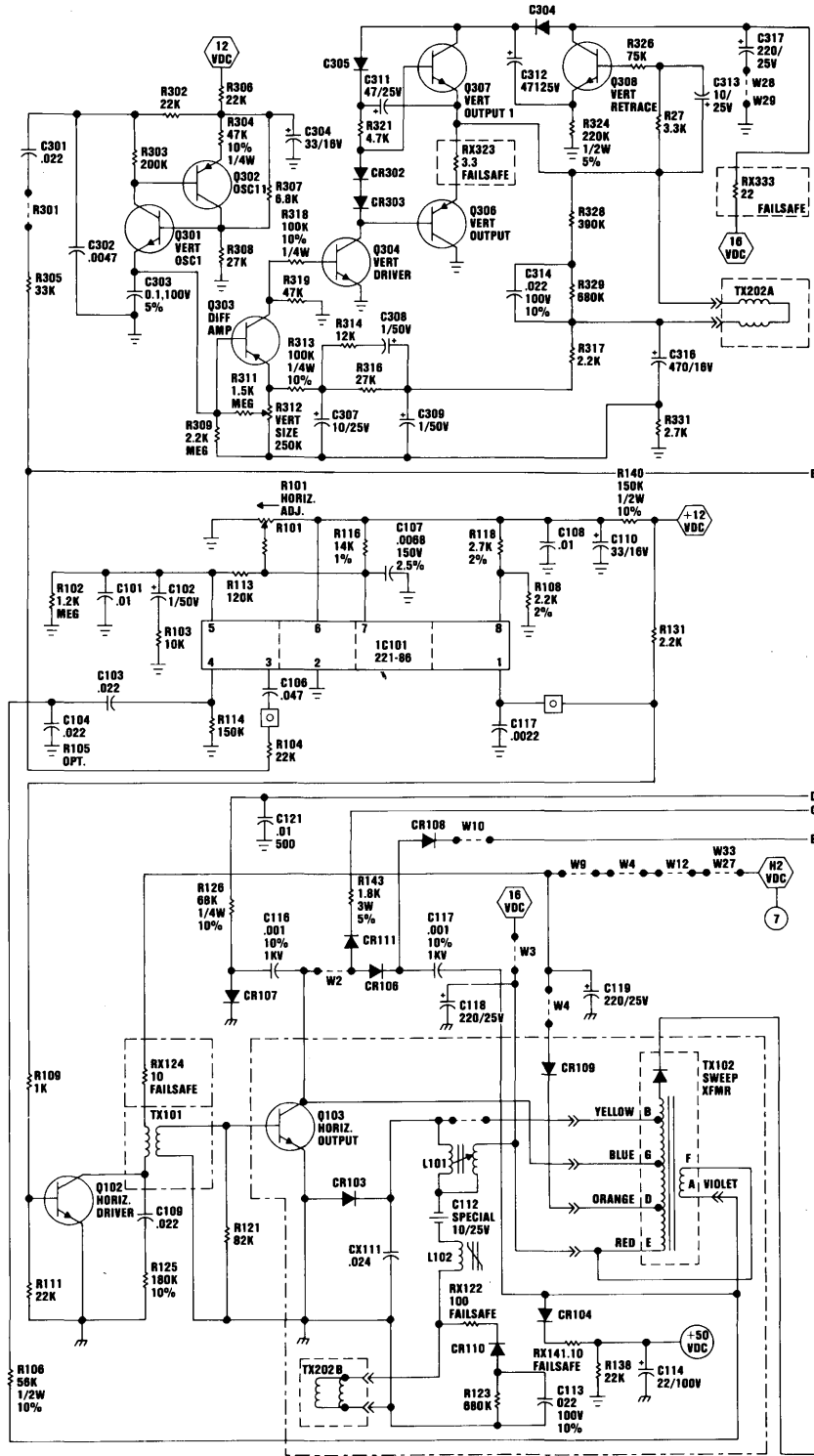
The IBM Portable Personal Computer Display attaches internally to the Color/Graphics Monitor Adapter in the system unit and to the power supply. A cable provides the composite drive signals from the Color/Graphics Monitor Adapter to the display. Another cable provides dc power to the display from the power supply.

The IBM Portable Personal Computer Display is designed to blank out the color-burst signal generated by the Color/Graphics Monitor Adapter. Blanking keeps the color-burst signal from appearing on the composite video screen.

The display is a 228.6 mm (9 in.), amber cathode ray tube (CRT). Brightness and Contrast controls on the front panel are easily accessible.

Logic Diagrams

The following pages contain the logic diagrams for the IBM Portable Personal Computer Display.



Portable Personal Computer Display (Sheet 1 of 2)

IBM Color Display

Contents

Description	1
Specifications	3
Logic Diagrams	4

IBM Color Display

Description

The IBM Color Display connects to the system unit with a signal cable of approximately 1.5 meters (5 feet) in length. This signal cable is a direct-drive interface from the Color/Graphics Monitor Adapter.

A second cable provides power to the display from an electrical outlet. The display unit has its own power control and indicator and will accept either 120-volt 60-Hz or 220-volt 50-Hz power. The power supply in the display automatically switches to match the applied power.

The display has a 340-millimeter (13-inch) CRT. The display may be placed on the system unit or on a nearby table or desk. The front panel of the display has a Power-On control, Power-On indicator, Brightness control, and Contrast control. The rear panel has the Vertical Hold and Vertical Size controls.

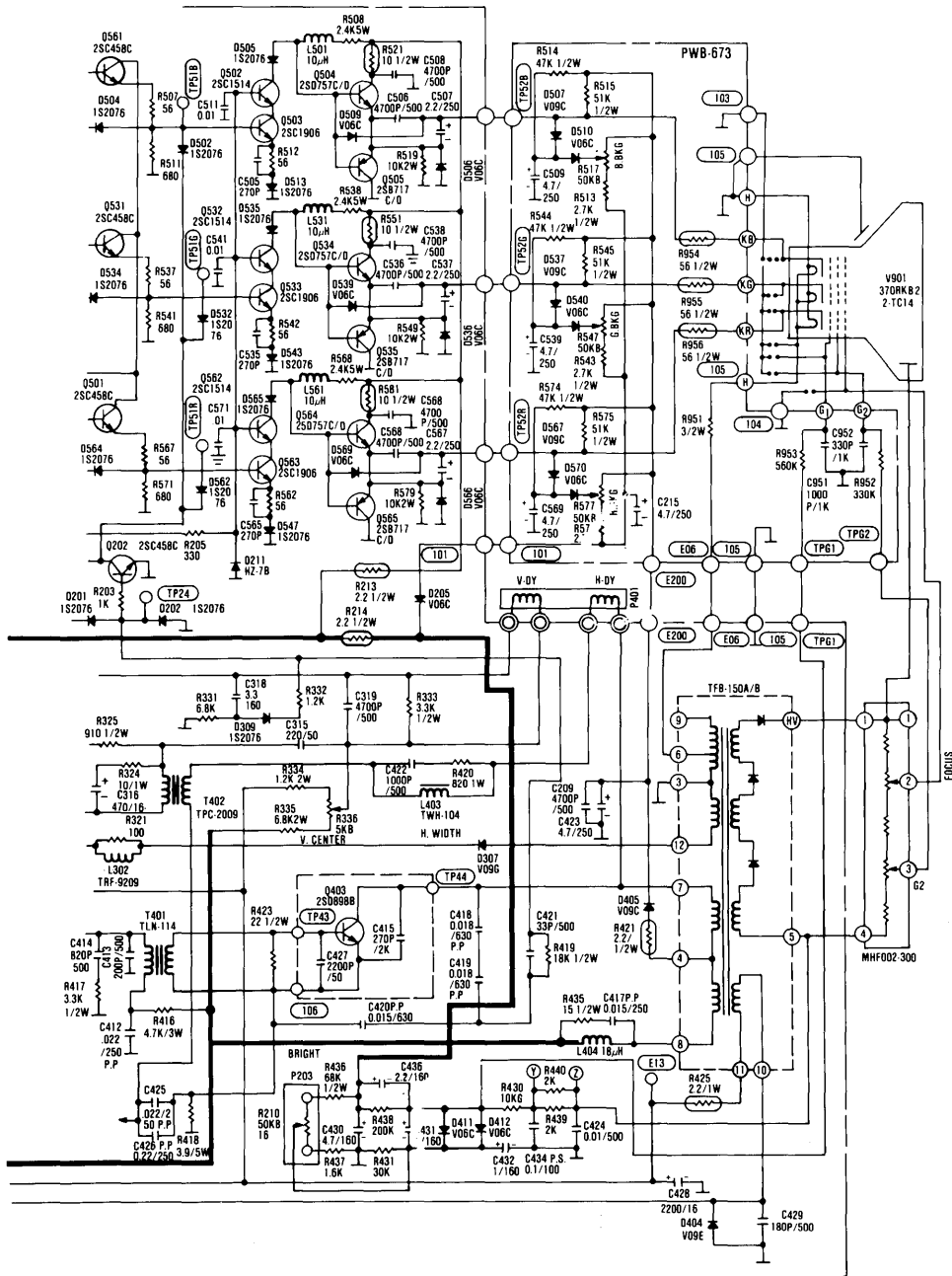
Specifications

Size	
Height	297 mm (11.7 in.)
Length	392 mm (15.4 in.)
Depth	407 mm (15.6 in.)
Weight	
	11.8 kg (26 lb)
Heat Output	
	240 BTU/hr
Power Cable	
Length	1.83 m (6 ft)
Size	18 AWG
Signal Cable	
Length	1.5 m (5 ft)
Size	22 AWG

Physical Specifications

Logic Diagram (continued)

DANGER
HAZARDOUS VOLTAGES
UP TO 450 VOLTS EXIST
ON THE PRINTED
CIRCUIT BOARDS



IBM Enhanced Color Display

Contents

Description	1
Operating Characteristics	2
Specifications	5
Connector Information	6

IBM Enhanced Color Display

Description

The IBM Enhanced Color Display is an advanced color display capable of operating in two separate modes. Mode 1 is a 16 color 640 by 200 overscan mode with a horizontal scan frequency of 15.75 kHz. Mode 2 is a 64 color 640 by 350 mode with a horizontal scan frequency of 21.8 kHz. Both modes are non-interlaced. The monitor determines which mode to operate in by decoding the vertical sync polarity.

The IBM Enhanced Color Display attaches to the system unit by a signal cable that is approximately 3.5 feet (1.07 meters) in length. This signal cable provides a direct-drive interface from the IBM Personal Computer.

A second cable provides ac power to the display from a standard wall outlet. The display has its own power control and indicator. Three models are provided. Model 001 is for northern hemisphere operation and operates on 120 volts 50/60 Hz. Model 002 is for northern hemisphere operation and operates on 220/240 volts 50/60 Hz. Model 003 is for southern hemisphere operation and operates on 220/240 volts 50/60 Hz.

The display has a 13-inch, high-contrast CRT. The CRT and analog circuits are packaged in an enclosure so the display may sit either on top of the system unit or on a nearby tabletop or desk. Front panel controls and indicators include: Power-On control, Power-On indicator, Brightness and Contrast controls. Additional controls on the rear of the display are: Vertical Size 1 and Vertical Size 2. There are two service controls on the rear of the unit, black level adjustment and contrast default value adjustment.

Operating Characteristics *(continued)*

Vertical Sync

- Uses polarity of Vertical Sync signal to automatically select Mode 1 or Mode 2 operation. Mode 1 is selected by a normally low positive going TTL pulse. Mode 2 is selected by a normally high negative going TTL pulse.
- Screen may be refreshed from 50 to 60 Hz. At 60 Hz there are either 200 or 350 vertical lines of resolution depending on the mode selected.
- 700 μ sec retrace time

Horizontal Sync

- Normally low, positive going TTL pulse
- In Mode 1, 15.75 kHz.
- In Mode 2, 21.8 kHz.
- 6 μ sec retrace time

Specifications

Size:

- Length - 15.4 in (392 mm)
- Depth - 15.6 in (407 mm)
- Height - 11.7 in (297 mm)

Weight:

- 32 lbs

Heat Output:

- 300 BTU/hr

Power Cable:

- Length - 6 ft (1.83 m)
- Size - 18 AWG

Signal Cable:

- Length - 3.5 ft (1.07 m)

IBM Graphics Printer

Contents

Description	1
Programming Considerations	2
Interface	22
Specifications	23
Connector Pin Assignments	25
Logic Diagrams	28

IBM Graphics Printer

Description

The IBM Graphics Printer is a self-powered, stand-alone, tabletop unit. It prints in two directions at 80 characters per second (cps).

A 9-wire print head is used to print characters in a 9-by-9 dot matrix. The IBM Graphics Printer can print in a compressed mode of 132 characters per line, in a standard mode of 80 characters per line, in a double-width compressed mode of 66 characters per line, and in a double-width mode of 40 characters per line. The printer can print double-size characters and double-strike characters.

Besides printing the standard ASCII 96-character uppercase and lowercase character sets, the IBM Graphics Printer has additional capabilities including: an extended character set for international languages, subscript, superscript, an underline mode, and programmable graphics. It can also accept commands setting the line-feed control desired for the application.

The printer unit obtains ac power from a standard 120-Vac wall outlet. A 220-Vac model and a 240-Vac model are also available. A 1.83 m (6 ft) signal cable connects the printer to the system unit's Printer Adapter or combination Monochrome Display and Printer Adapter. The cable is a 25-lead shielded cable with a 25-pin D-shell connector at the system unit end, and a 36-pin connector at the printer end.

Programming Considerations *(continued)*

Printer Code	Printer Function
BEL	Bell Sounds the printer buzzer for 1 second. Example: LPRINT CHR\$(7);
CAN	Cancel Clears the printer buffer. Control codes, except SO, remain in effect. Example: LPRINT CHR\$(24);
CR	Carriage Return Ends the line that the printer is on and prints the data remaining in the printer buffer. (No Line Feed operation takes place.) Note: IBM Personal Computer BASIC adds a Line Feed unless CHR\$(128) is added; for example, CHR\$(141). Example: LPRINT CHR\$(13);
DC2	Device Control 2 (Compressed Off) Cancels the Compressed print mode. Example: LPRINT CHR\$(18);
DC4	Device Control 4 (Double Width Off) Cancels the Double Width print mode. Example: LPRINT CHR\$(20);
ESC	Escape Signals the printer that the next data sent is a printer command. Example: LPRINT CHR\$(27);

Programming Considerations *(continued)*

Printer Code	Printer Function
ESC E	Escape E (Emphasized) Sets the printer to the Emphasized print mode. The speed of the printer is reduced to half speed during the Emphasized print mode. Example: LPRINT CHR\$(27);CHR\$(69);
ESC F	Escape F (Emphasized Off) Cancels the Emphasized print mode. Example: LPRINT CHR\$(27);CHR\$(70);
ESC G	Escape G (Double Strike) Sets the printer to the Double Strike print mode. The paper is spaced 1/216 inch before the second pass of the print head. Example: LPRINT CHR\$(27);CHR\$(71);
ESC H	Escape H (Double Strike Off) Cancels the Double Strike mode. Example: LPRINT CHR\$(27);CHR\$(72);
ESC J	Escape J (Sets Variable Line Feeding) Format: ESC J;n; When ESC J is sent to the printer, the paper will advance in increments of n/216 inch. The value of n must be between 1 and 255. The example that follows sets the line feed to 50/216 inch. ESC J is canceled after the line feed takes place. Example: LPRINT CHR\$(27);CHR\$(74);CHR\$(50);

Programming Considerations *(continued)*

Printer Code	Printer Function																												
ESC K Cont.	<p>Data sent to the printer.</p> <table border="1"> <tr> <td>Data A</td> <td>ESC</td> <td>K</td> <td>n₁</td> <td>n₂</td> <td>Data B</td> <td>Data C</td> <td>ESC</td> <td>K</td> <td>n₁</td> <td>n₂</td> <td>Data D</td> </tr> </table> <table border="1"> <tr> <td>Text Data</td> <td></td> <td>Length of bit image data</td> <td>Bit-image data</td> <td>Text data</td> <td></td> <td>Length of bit image data</td> <td>Bit-image data</td> </tr> <tr> <td></td> <td></td> <td></td> <td>v₁ - v_k</td> <td></td> <td></td> <td></td> <td>v₁ - v_k</td> </tr> </table> <p>← 480 bit-image positions →</p> <p>Note: Assume a total of 20 characters of text data (data A and data C). In Text mode, 20 characters correspond to 120 bit-image positions (20 x 6 = 120). The printable portion left for Bit-Image Graphics data (data B and data D) is 360 bit-image positions (480 - 120 = 360).</p> <p>Example:</p> <pre> 1 'OPEN PRINTER IN RANDOM MODE WITH LENGTH OF 255 2 WIDTH "LPT1:",255 3 OPEN "LPT1:" AS #1 4 PRINT #1,CHR\$(13);CHR\$(10); 5 SLASH\$=CHR\$(1)+CHR\$(02)+ CHR\$(04)+CHR\$(08) 6 SLASH\$=SLASH\$+CHR\$(16)+CHR\$(32)+ CHR\$(64)+CHR\$(128)+CHR\$(0) 7 GAP\$=CHR\$(0)+CHR\$(0)+CHR\$(0) 8 NDOTS=480 9 'ESC K N1 N2 10 PRINT #1,CHR\$(27);"K";CHR\$(NDOTS MOD 256); CHR\$(FIX (NDOTS/256)); 11 'SEND NDOTS NUMBER OF BIT IMAGE BYTES 12 FOR I=1 TO NDOTS/12 'NUMBER OF SLASHES TO PRINT USING GRAPHICS 13 PRINT #1,SLASH\$;GAP\$; 14 NEXT I 15 CLOSE 16 END </pre> <p>This example will give you a row of slashes printed in the Bit-Image Graphics mode.</p>	Data A	ESC	K	n ₁	n ₂	Data B	Data C	ESC	K	n ₁	n ₂	Data D	Text Data		Length of bit image data	Bit-image data	Text data		Length of bit image data	Bit-image data				v ₁ - v _k				v ₁ - v _k
Data A	ESC	K	n ₁	n ₂	Data B	Data C	ESC	K	n ₁	n ₂	Data D																		
Text Data		Length of bit image data	Bit-image data	Text data		Length of bit image data	Bit-image data																						
			v ₁ - v _k				v ₁ - v _k																						

Programming Considerations *(continued)*

Printer Code	Printer Function
ESC W	<p>Escape W (Double Width) Format: ESC W;n; Sets the printer to the Double Width print mode when ESC W is followed by a 1. This mode must be canceled with ESC W followed by a 0 (zero) Example: LPRINT CHR\$(27);CHR\$(87);CHR\$(1);</p>
ESC Y	<p>Escape Y (960 Bit-Image Graphics Mode Normal Speed) Format: ESC Y n₁;n₂;v₁;v₂;...v_k; Changes from the Text mode to the 960 Bit-Image Graphics mode, at normal speed. The printer cannot print dots on consecutive dot positions. The input of data is similar to ESC L.</p>
ESC Z	<p>Escape Z (1920 Bit-Image Graphics Mode) Format: ESC Z;n₁;n₂;v₁;v₂;...v_k; Changes from the Text mode to the 1920 Bit-Image Graphics mode. The input is similar to the other Bit-Image Graphics modes. ESC Z can print only every third dot position.</p>
ESC 0	<p>Escape 0 (1/8-Inch Line Feeding) Sets paper feeding to 3.175 mm (1/8 in.). Example: LPRINT CHR\$(27);CHR\$(48);</p>
ESC 1	<p>Escape 1 (7/72-Inch Line Feeding) Sets paper feeding to 2.47 mm (7/72 in.). Example: LPRINT CHR\$(27);CHR\$(49);</p>
ESC 2	<p>Escape 2 (Start Variable Line Feeding) ESC 2 is an execution command for ESC A. If no ESC A command is given, line feeding returns to 4.23mm (1/6 in.). Example: LPRINT CHR\$(27);CHR\$(50);</p>
ESC 3	<p>Escape 3 (Variable Line Feeding) Format: ESC 3;n; Changes the paper feeding to n/216 inch. The example that follows sets the paper feeding to 1/4 inch. The value of n must be between 1 and 255. Example: LPRINT CHR\$(27);CHR\$(51);CHR\$(54);</p>
ESC 6	<p>Escape 6 (Select Character Set 2) Selects Character Set 2. (See "Graphics Printer Character Set 2" later in this section.) Example: LPRINT CHR\$(27);CHR\$(54);</p>

Programming Considerations *(continued)*

Printer Code	Printer Function
LF	Line Feed Advances the paper up one line. Line spacing is 4.23 mm (1/6 in.) unless reset by ESC A, ESC 0, ESC 1, ESC 2 or ESC 3. Example: LPRINT CHR\$(10);
NUL	Null Used with ESC B and ESC D as a list terminator. NUL also is used with other printer control codes to select options (for example, ESC S). Example: LPRINT CHR\$(0);
SI	Shift In (Compressed) Changes the printer to the Compressed print mode. Example: LPRINT CHR\$(15);
SO	Shift Out (Double Width) Changes the printer to the Double Width print mode.

Programming Considerations *(continued)*

Graphics, 960 bit-image, 1/2 speed	ESC L	76
Graphics, 960 bit-image, full speed	ESC Y	89
Graphics 1920 bit-image	ESC Z	90
Head, home	ESC <	60
Home head	ESC <	60
Horizontal tab	HT	9
Horizontal tab stops set	ESC D	68
Ignore paper end	ESC 8	56
Ignore paper end, cancel	ESC 8	56
Length-of-page set in inches	ESC C	67
Length-of-page set in lines	ESC C	67
Line-feed, set 1/6 inch	LF	10
Line-feed, set 1/8 inch	ESC 0	48
Line-feed, set 7/72 inch	ESC 1	49
Line-feed, set variable	ESC 3	51
Line-feed, set variable	ESC A	65
Line-feed, set variable	ESC J	74
Line-feed, start variable	ESC 2	50
Line-feed, set variable	ESC J	74
Null	NUL	0
Page eject	FF	12
Page length, set in inches	ESC C	67
Page length, set in lines	ESC C	67
Paper eject	FF	12
Paper end, ignore	ESC 8	56
Perforation skip Off	ESC O	79
Perforation skip set	ESC N	78
Print double-width one line	SO	14
Print double-width multiple lines	ESC W	87
Print emphasized	ESC E	69
Print emphasized Off	ESC F	70
Print 10 characters per inch	DC2	18
Print unidirectional On/Off	ESC U	85
Printer buffer, clear	CAN	24
Return carriage	CR	13
Select character set 1	ESC 7	55
Select character set 2	ESC 6	54
Set 1 (character set 1)	ESC 7	55
Set 1/8-inch line feed	ESC 0	48
Set 2 (character set 2)	ESC 6	54
Set 7/72-inch line feed	ESC 1	49
Set variable line feed	ESC 3	51
Set horizontal tab stops	ESC D	68
Set page length in lines	ESC C	67
Set page length in inches	ESC C	67
Set perforation skip	ESC N	78
Set variable line feed	ESC A	65
Skip perforation Off	ESC O	79
Skip perforation On	ESC N	78
Start 7/72 inch line feed	ESC 1	49

Programming Considerations *(continued)*

Print Mode Combinations

The IBM Graphics Printer can use any of the combinations of print modes listed in the following table. The print mode can be changed at any place within a line. Modes can be selected and combined if they are in the same vertical column.

Printer Modes											
Normal	X	X	X								
Compressed					X	X	X				
Emphasized									X	X	X
Double Strike	X				X				X		
Subscript		X				X				X	
Superscript			X				X				X
Double Width	X	X	X		X	X	X		X	X	X
Underline	X	X	X		X	X	X		X	X	X

Programming Considerations *(continued)*

130	131	132	133	134	135	136	137	138	139
					BEL		HT	LF	VT
140	141	142	143	144	145	146	147	148	149
FF	CR	SO	SI			DC2		DC4	
150	151	152	153	154	155	156	157	158	159
		CAN			ESC				
160	161	162	163	164	165	166	167	168	169
á	í	ó	ú	ñ	Ñ	<u>a</u>	<u>o</u>	¿	⌞
170	171	172	173	174	175	176	177	178	179
⌞	½	¼	¡	<<	>>	▒	▒	▒	▒
180	181	182	183	184	185	186	187	188	189
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
190	191	192	193	194	195	196	197	198	199
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
200	201	202	203	204	205	206	207	208	209
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
210	211	212	213	214	215	216	217	218	219
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
220	221	222	223	224	225	226	227	228	229
▒	▒	▒	▒	α	β	Γ	Π	Σ	σ
230	231	232	233	234	235	236	237	238	239
μ	τ	ϕ	θ	Ω	δ	∞	∅	ε	∩
240	241	242	243	244	245	246	247	248	249
≡	±	≥	≤	∫	J	÷	≈	○	■
250	251	252	253	254	255				
-	√	n	²	■	SP				

Graphics Printer Character Set 1 (Part 2 of 2)

Programming Considerations *(continued)*

130	131	132	133	134	135	136	137	138	139
é	â	ä	à	ã	ç	ê	ë	è	ï
140	141	142	143	144	145	146	147	148	149
î	ì	Ä	Å	É	æ	Æ	ô	ö	ò
150	151	152	153	154	155	156	157	158	159
û	ù	ÿ	ö	ü	ç	£	¥	℞	f
160	161	162	163	164	165	166	167	168	169
á	í	ó	ú	ñ	Ñ	à	o	¿	⌞
170	171	172	173	174	175	176	177	178	179
⌞	½	¼	ı	<<	>>	▒	▒	▒	▒
180	181	182	183	184	185	186	187	188	189
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
190	191	192	193	194	195	196	197	198	199
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
200	201	202	203	204	205	206	207	208	209
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
210	211	212	213	214	215	216	217	218	219
⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞	⌞
220	221	222	223	224	225	226	227	228	229
▒	▒	▒	▒	α	β	Γ	Π	Σ	σ
230	231	232	233	234	235	236	237	238	239
μ	τ	ϕ	θ	Ω	δ	∞	∅	ε	∩
240	241	242	243	244	245	246	247	248	249
≡	±	≥	≤	∫	J	÷	≈	○	■
250	251	252	253	254	255				
-	√	n	2	■	SP				

Graphics Printer Character Set (Part 2 of 2)

Programming Considerations *(continued)*

Switch Number	Function	On	Off	Factory-Set Condition
1-1	Not Applicable	—	—	On
1-2	CR	Print Only	Print & Line Feed	On
1-3	Buffer Full	Print Only	Print & Line Feed	Off
1-4	Cancel Code	Invalid	Valid	Off
1-5	Not Applicable	—	—	On
1-6	Error Buzzer	Sound	Does Not Sound	On
1-7	Character Generator	Set 2	Set 1	Off
1-8	SLCT IN Signal	Fixed Internally	Not Fixed Internally	On

Functions and Conditions of DIP Switch 1 (Graphics)

Switch Number	Function	On	Off	Factory-Set Condition
2-1	Form Length	304.8 mm (12 inches)	279.4 mm (11 inches)	Off
2-2	Line Spacing	3.175 mm (1/8 inch)	4.23 mm (1/6 inch)	Off
2-3	Auto Feed XT Signal	Fixed Internally	Not Fixed Internally	Off
2-4	1 Inch Skip Over Perforation	Valid	Not Valid	Off

Functions and Conditions of DIP Switch 2 (Graphics)

Specifications

Size	
Height	107 mm (4.2 in.)
Width	400 mm (15.7 in.)
Depth	305 mm (12 in.)
Weight	
	5.5 kg (12 lb)
Power Cable	
Length	1.83 m (6 ft)
Size	18 AWG
Signal Cable	
Length	1.83 m (6 ft)
Size	22 AWG

Physical Specifications

Voltage (Vac)			Frequency (Hz)	Current (Amps)	Power (Watts)
Nominal	Minimum	Maximum	± 3 Hz	Maximum	Maximum
120	104	127	60	1.0	100
220	198	242	50/60	0.5	100
240	216	264	50/60	0.5	100

Electrical Specifications

Connector Pin Assignments

Signal Pin No.	Return Pin No.	Signal	Direction	Description
1	19	STROBE	In	STROBE pulse to read data in. Pulse width must be more than 0.5 μ s at receiving terminal. The signal level is normally "high"; read-in of data is performed at the "low" level of this signal.
2	20	DATA 1	In	These signals represent information of the 1st to 8th bits of parallel data respectively. Each signal is at "high" level when data is logical "1" and "low" when logical "0."
3	21	DATA 2	In	
4	22	DATA 3	In	
5	23	DATA 4	In	
6	24	DATA 5	In	
7	25	DATA 6	In	
8	26	DATA 7	In	
9	27	DATA 8	In	
10	28	$\overline{\text{ACKNLG}}$	Out	Approximately 5 μ s pulse; "low" indicates that data has been received and the printer is ready to accept other data.
11	29	BUSY	Out	A "high" signal indicates that the printer cannot receive data. The signal becomes "high" in the following cases: <ol style="list-style-type: none"> 1. During data entry. 2. During printing operation. 3. In "offline" state. 4. During printer error status.

**Connector Pin Assignment and Descriptions of Interface Signals
(Part 1 of 3)**

Connector Pin Assignments (*continued*)

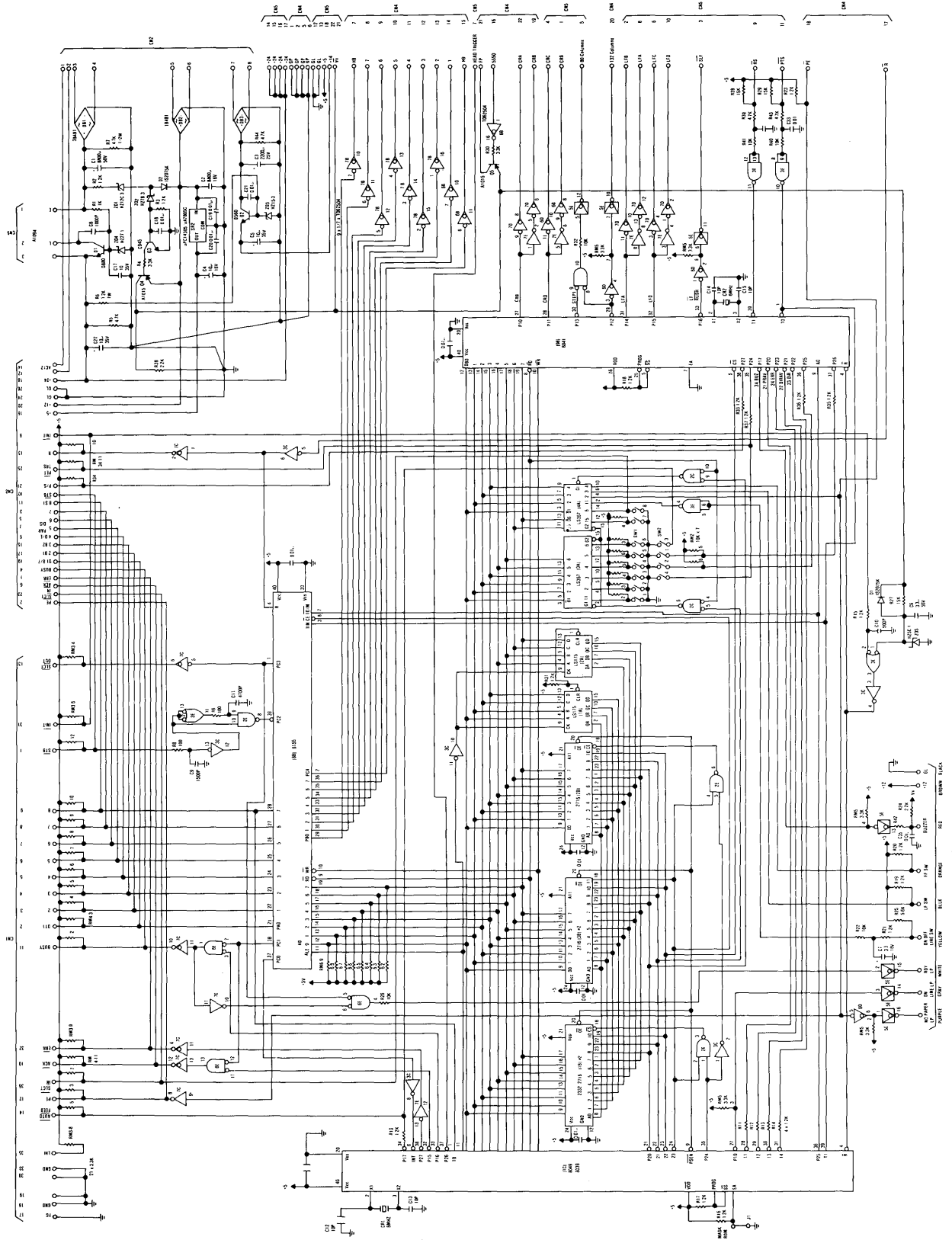
Signal Pin No.	Return Pin No.	Signal	Direction	Description
32		ERROR	Out	The level of this signal becomes "low" when the printer is in "Paper End" state, "Offline" state and "Error" state.
33	—	GND	—	Same as with pin numbers 19 to 30.
34	—	NC	—	Not used.
35				Pulled up to + 5 Vdc through 4.7 k-ohms resistance.
36	—	SLCT IN	In	Data entry to the printer is possible only when the level of this signal is "low." (Internal fixing can be carried out with DIP SW 1-8. The condition at the time of shipment is set "low" for this signal.)

Notes:

- "Direction" refers to the direction of signal flow as viewed from the printer.
- "Return" denoted "Twisted-Pair Return" and is to be connected at signal-ground level.
When wiring the interface, be sure to use a twisted-pair cable for each signal and never fail to complete connection on the return side. To prevent noise effectively, these cables should be shielded and connected to the chassis of the system unit and printer, respectively.
- All interface conditions are based on TTL level. Both the rise and fall times of each signal must be less than 0.2 μ s.
- Data transfer must not be carried out by ignoring the ACKNLG or BUSY signal. (Data transfer to this printer can be carried out only after confirming the ACKNLG signal or when the level of the BUSY signal is "low.")

Connector Pin Assignment and Descriptions of Interface Signals (Part 3 of 3)

Logic Diagrams (continued)



Graphics Printer (Sheet 2 of 2)

IBM 5-1/4'' Diskette Drive

Contents

Description	1
Specifications	3
Logic Diagrams	4

IBM 5-1/4" Diskette Drive

Description

The system unit has space and power for one or two 5-1/4 inch diskette drives. A drive can be single-sided or double-sided with 40 tracks for each side. The diskette drive is a self-contained unit consisting of a spindle drive system, a read positioning system, and a read/write/erase system.

The diskette drive uses modified frequency modulation (MFM) to read and write digital data, with a track-to-track access time of 6 milliseconds.

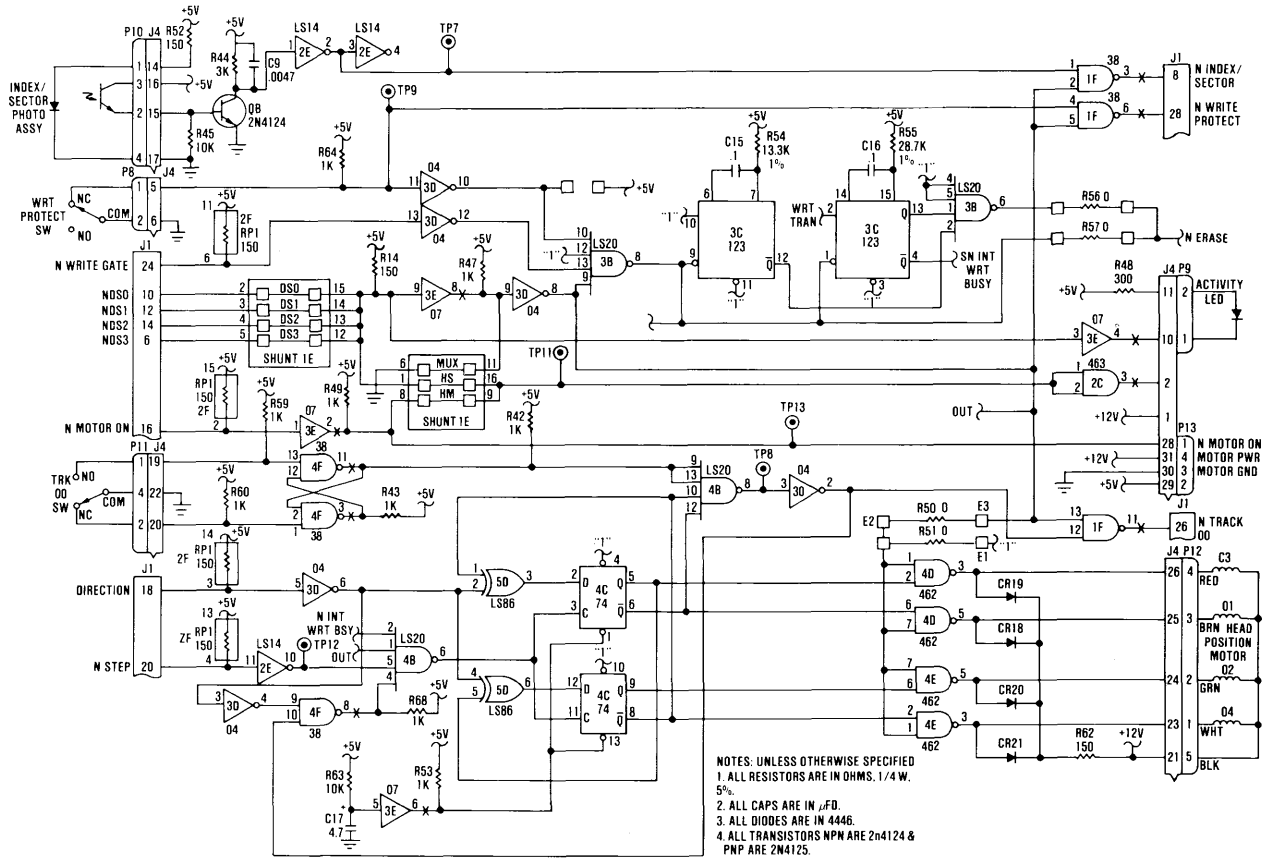
The IBM 5-1/4" Diskette Drive uses a standard 133.4 millimeter (5.25 inch) diskette. Single-sided, double-density, soft-sector diskettes are used for single-sided drives. Double-sided drives use double-sided, double-density, soft-sector diskettes.

This recording medium is a flexible magnetic disk enclosed in a protective jacket. The protected disk, free to rotate within the jacket, is continuously cleaned by the soft fabric lining of the jacket during normal operation. Read/write/erase head access is made through an opening in the jacket. Openings for the drive hub and diskette index hole are also provided. The following figure is a simplified drawing of the diskette used with the IBM 5-1/4" Diskette Drive.

Specifications

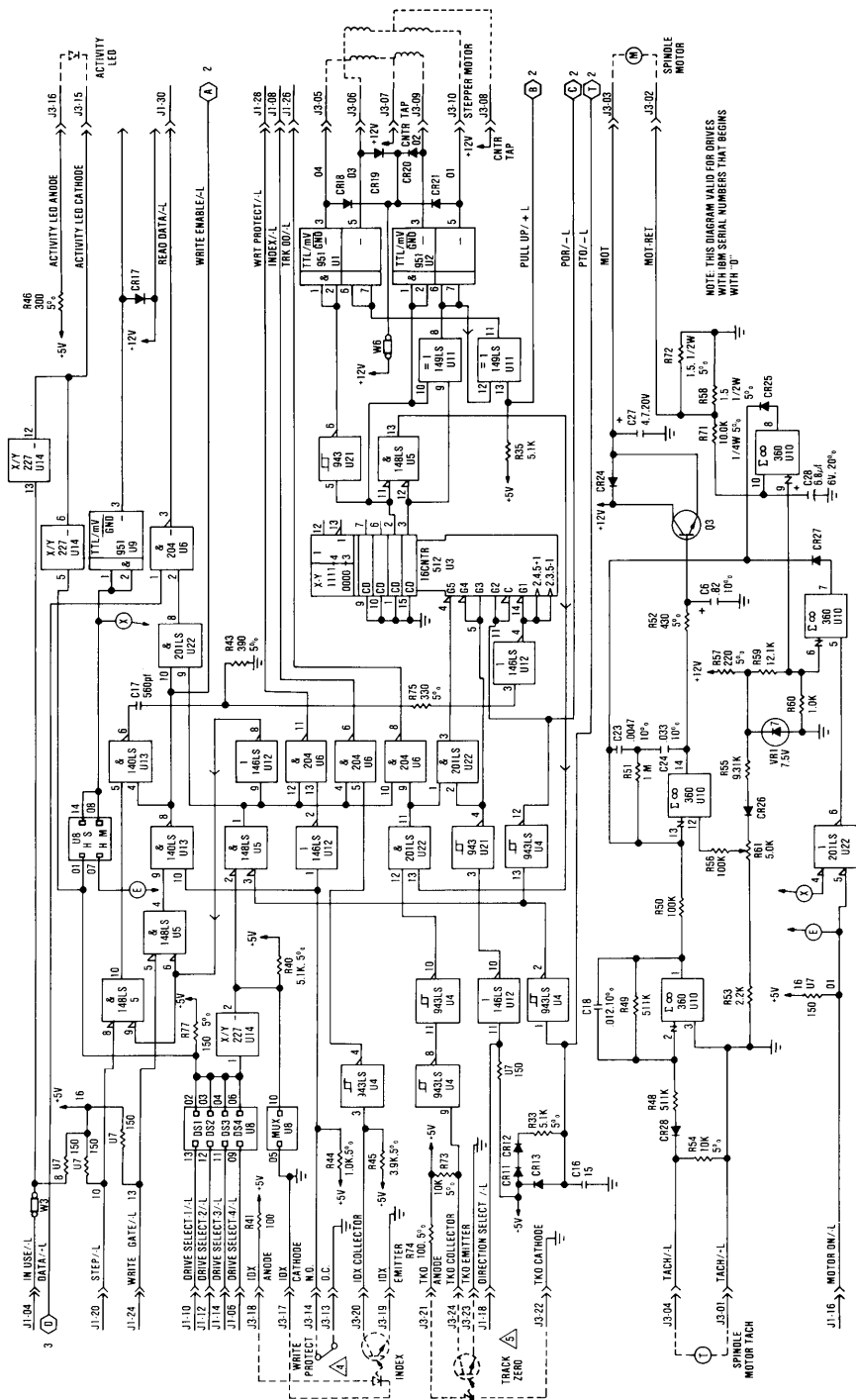
Size (maximum)	
Height	86 mm (3.4 in.)
Width	149 mm (5.9 in.)
Depth	203 mm (8.0 in.)
Weight	2.04 kg (4.5 lb)
Power	+12 Vdc \pm 5%, (900 mA average) +5 Vdc \pm 5%, (600 mA average)
Media	Industry-compatible 5-1/4 inch diskette
Tracks per Inch	48
Number of Tracks	40
Temperature (exclusive of media)	
Operating	10 to 44°C (50 to 112°F)
Non-operating	-40 to 60°C (-40 to 140°F)
Relative humidity (exclusive of media)	
Operating	20 to 80% (non-condensing)
Non-operating	5 to 95% (non-condensing)
Seek Time	6 ms track-to-track
Head Settling Time	15 ms (last track addressed)
Error Rate	
Recoverable	1 per 10 ⁹ bits read
Irrecoverable	1 per 10 ¹² bits read
Seek Errors	1 per 10 ⁶ seeks
Head Life	20,000 hours (normal use)
Media Life	3.0 X 10 ⁶ passes per track
Disk Speed	
Long term	300 rpm \pm 1.5%
Instantaneous	300 rpm \pm 3.0%
Start Time	500 ms (maximum)
Transfer Rate	250K bps
Recording Mode	MFM

Mechanical and Electrical Specifications



5-1/4 Inch Diskette Drive — Type 1 (Sheet 2 of 3)

Logic Diagrams (continued)



5-1/4 Inch Diskette Drive — Type 2 (Sheet 1 of 2)

IBM Slimline Diskette Drive

Contents

Description	1
Specifications	4
Logic Diagrams	5

IBM Slimline Diskette Drive

Description

The IBM Portable Personal Computer has space and power for one or two 5-1/4 inch slimline diskette drives. Each drive can use single-sided or double-sided diskettes with 40 tracks on each side. The drive is completely self contained, and consists of a spindle drive system, a head positioning system, and a read/write/erase system.

The recording medium is a flexible magnetic disk enclosed in a protective jacket. The protected disk, free to rotate within the jacket, is continuously cleaned by the soft fabric lining of the jacket during normal operation. Read/write/erase head access is made through an opening in the jacket. Openings for the drive hub and diskette index hole are also provided. The following figure is a simplified drawing of the diskette used with the IBM 5-1/4 Diskette Drive.

Description *(continued)*

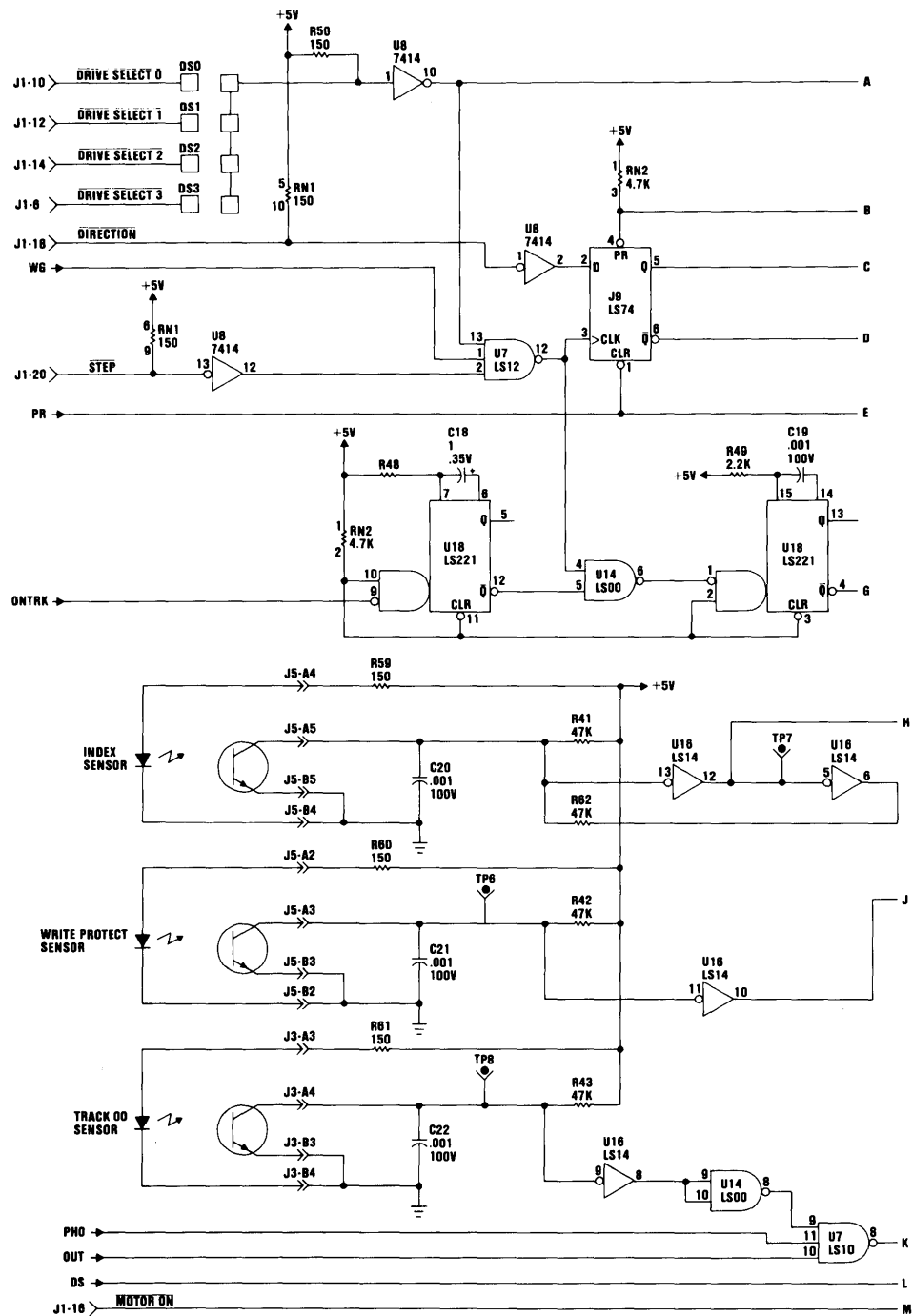
The diskette drive also has the following sensor systems:

- The track 00 switch, which senses when the head/carriage assembly is at track 00.
- The index sensor, which consists of a light emitting diode (LED) light source and phototransistor. This sensor is positioned so that a digital signal is generated when the index hole is detected.
- The write-protect sensor disables the diskette-drive write circuits whenever the diskette has a write-protect tab.

For interface information and programming considerations, refer to “IBM 5-1/4” Diskette Drive Adapter” in this manual.

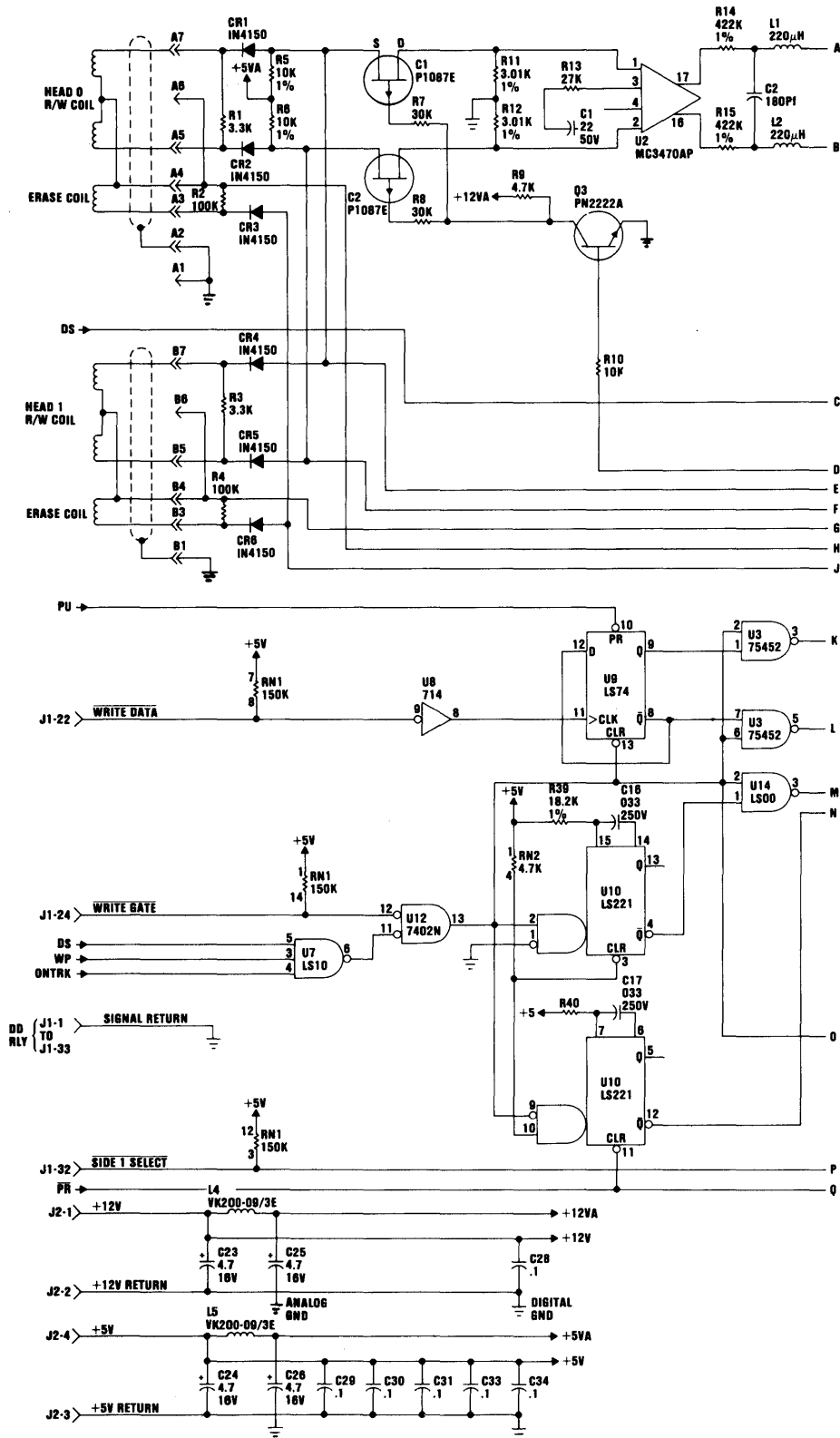
Logic Diagrams

The following pages contain the logic diagrams for the IBM Slimline Diskette Drive.



Slimline Diskette Drive (Sheet 1 of 4)

Logic Diagrams (continued)



Slimline Diskette Drive (Sheet 3 of 4)

High Capacity Diskette Drive

Contents

Description	1
Interfaces	3
Input Signals	4
Output Signals	6
Drive-in-Use Indicator	6
Specifications	7
Logic Diagrams	8

High Capacity Diskette Drive

Description

The IBM Personal Computer AT High Capacity Diskette Drive is a direct-access device that can store 1.2Mb of data on a dual-sided 5-1/4 inch diskette. All data format and access control is in the system. The following figure describes the type of high-density diskette required by this drive. Diskettes, which meet these specifications may not be used in either a 160/180Kb or a 320/360Kb diskette drive.

Interfaces

The diskette drive has two types of interface: control and dc power. The following show the signals and pin assignments for the control interface.

Signal Name	I/O	Signal Pin	Ground Pin
-Reduced Write	I	2	1
Reserved	-	4	3
-Drive Select 3	I	6	5
-Index	O	8	7
-Drive Select 0	I	10	9
-Drive Select 1	I	12	11
-Drive Select 2	I	14	13
-Motor On	I	16	15
-Direction Select	I	18	17
-Step	I	20	19
-Write Data	I	22	21
-Write Gate	I	24	23
-Track 00	O	26	25
-Write Protect	O	28	27
-Read Data	O	30	29
-Side 1 Select	I	32	31
-Diskette Change	O	34	33

Control Interface (P1/J1)

The signals and pin assignments for the dc power interface are as follows:

Signal Name	Pin
+12 Vdc	1
+12 Vdc Return	2
+5 Vdc Return	3
+5 Vdc	4

DC Power Interface (P2/J2)

All signals operate between + 5 Vdc and ground with the following definitions:

Inactive Level: + 2.5 to + 5.25 Vdc

Active Level: 0.0 to + 0.4 Vdc

All outputs from the drive can sink 40 mA at the active level. The system provides pull-up registers.

Input Signals *(continued)*

-Write Gate

An active level of this input enables the write current circuits, and the '-Write Data' input controls the writing of information. Transitions of this line occur 4 to 8 microseconds before the first significant data bit, and 4 to 8 microseconds after the last significant data bit. Making this input inactive removes all current from the read/write heads and allows the read circuits to operate within 590 microseconds. All motor-start, head-settle, and head-load times are complied with before the line becomes active.

-Side 1 Select

This signal determines which side of the two-sided diskette will be used for reading or writing. An inactive level of this signal selects the read/write head on the 0 side of the diskette; an active level selects the 1 side. A 100-microsecond delay must be allowed after switching from one head to the other before starting to read or write.

Specifications

The following figures show the physical and performance specifications for this drive.

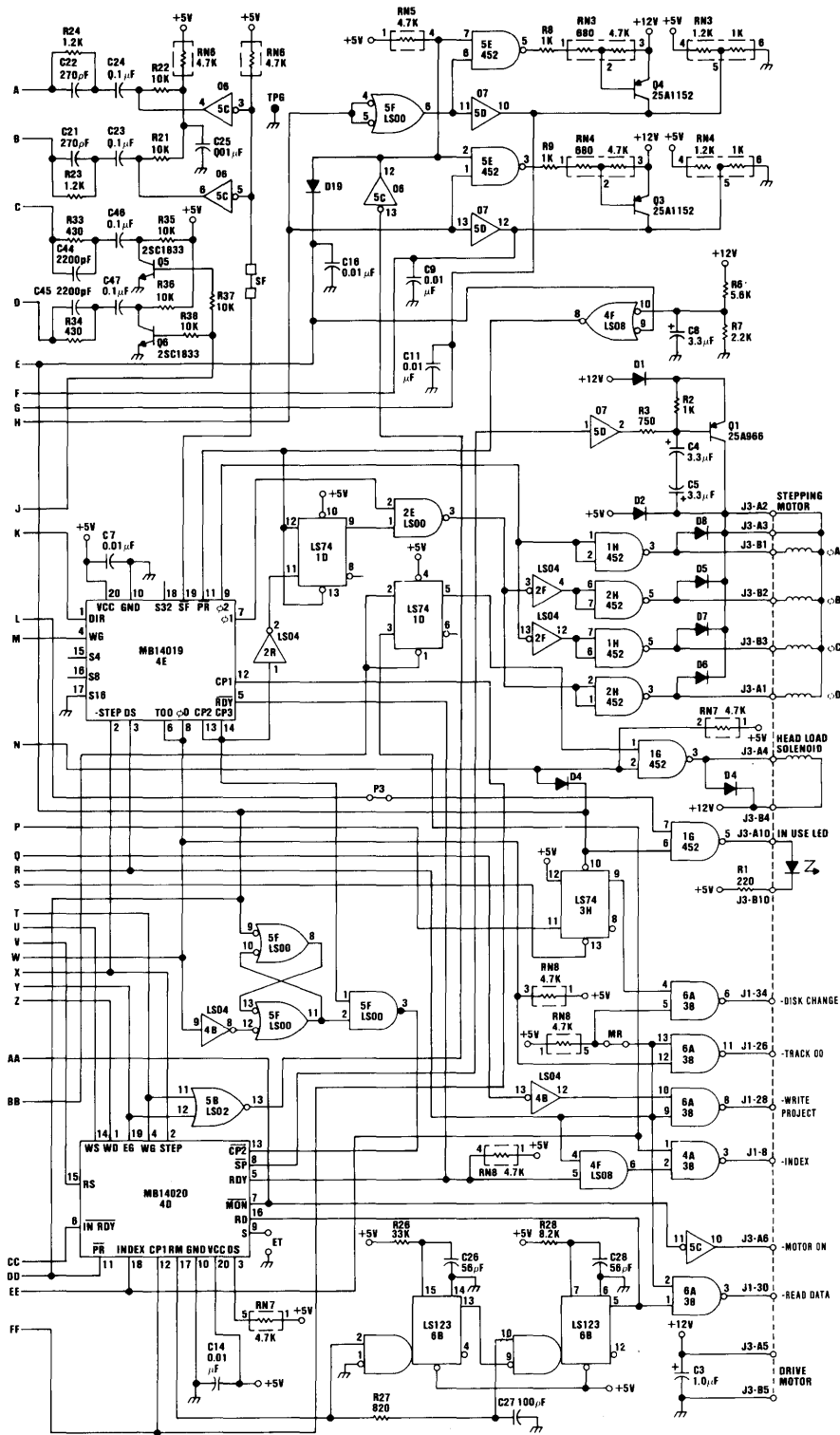
Power Dissipation	11 W (Typical)
Operating Limits	Ambient Temperature 5 to 46 Degrees C (41 to 114.8 Degrees Fahrenheit) Relative Humidity 20 to 80 % Maximum Wet Bulb 29 Degrees Celsius (84 Degrees Fahrenheit)
Non-Operating Limits	Ambient Temperature -40 to 60 Degrees C (-40 to 140 Degrees Fahrenheit) Humidity no Condensation
Mechanical Dimensions	Width 146.0 mm (5.8 in) Height 41.0 mm (1.6 in) Depth 203.2 mm (8 in)
Weight	1.6 kg

Physical Specifications

Capacity Unformatted	500Kb
Capacity Formatted:	
9 Sectors Per Track	368.6Kb
8 Sectors Per Track	320.0Kb
Recording Density	5876 Bits Per Inch
Track Density	48 TPI
Cylinders	40
Tracks	80
Encoding Method	MFM
Rotational Speed	300 RPM
Transfer Rate	250K Bits/Second
Latency (Average)	100 ms
Access Time:	
Average	81 ms
Track to Track	5 ms
Settling Time	20 ms
Head Load Time	50 ms
Motor Start Time	750 ms

Performance Specifications

Logic Diagrams (continued)



High Capacity Diskette Drive (Sheet 2 of 2)

Double Sided Diskette Drive

Contents

Description	1
Interfaces	2
Input Signals	3
Output Signals	4
Drive-in-Use Indicator	4
Specifications	5
Logic Diagrams	6

Double Sided Diskette Drive

Description

The IBM Personal Computer AT Double Sided Diskette Drive is a direct-access device that can store 320/360Kb of data on a dual-sided 5-1/4 inch diskette. All data format and access control is in the system. The following figure describes the type of diskette required by this drive.

Characteristic	Requirement
Certification	Double-Sided 48 TPI 40 Tracks/Surface Soft Sector
Recording Density	5876 Bits Per Inch
Media Coercivity	300 to 350 Oersteds
Jacket	Standard 5-1/4 Inch

The signals for operating the diskette drive are generated through the IBM Personal Computer AT Fixed Disk and Diskette Drive Adapter.

Input Signals

All input signals are active when low.

Drive Select 0 through 3

These '-drive select' signals enable or disable all other drive interfact signals, except '-motor on'. When '-drive select' is at the active level, the drive is enabled. When it is at the inactive level, all controlled inputs are ignored, and all drive outputs are disabled. The enabled or disabled condition of the drive is established within 500 nanoseconds after a change to the select input, excluding head-load time and settling times.

-Motor On

An active level of this signal starts the drive motor. There must be a 750' millisecond delay after '-motor on' becomes active before any read or write operation starts.

-Direction Select

This signal determines the direction the read/write head moves when the step signal is pulsed. An active level indicates away from the center of the diskette (out); and inactive level indicates toward the center of the diskette (in). Any change in the '-direction select' signal must be made at least 1 microsecond before the leading edge of the step pulse, and at least 1 microsecond after the trailing edge of the step pulse.

-Step

This signal causes the read/write heads to move in the direction determined by the '-direction select' signal. Motion is started each time the signal changes from an active to inactive level (at the trailing edge of the pulse).

-Write Data

Each time this signal changes from the inactive to active level, the current through the read/write heads reverses, and writes a data bit. This signal is enabled when '-write gate' is at the active level. A 250-nanosecond active pulse of this signal causes a bit to be written on the diskette. These pulses may occur with either a 4, 6 or 8-microsecond spacing ($\pm 0.5\%$).

-Write Gate

An active level of this input enables the write current circuits, and the '-Write Data' input controls the writing of information. Transitions of this line occur 4 to 8 microseconds before the first significant data bit, and 4 to 8 microseconds after the last significant data bit. After deactivating '-write gate', deactivation of '-drive select' and '-motor on', and changing '-side 1 select' must be delayed 1 millisecond, because the erase head is active for this period.

-Side 1 Select

This signal determines which side of the two-sided diskette will be used for reading or writing. An inactive level of this signal selects the read/write head on the 0 side of the diskette; an active level selects the 1 side. A 100-microsecond delay must be allowed after switching from one head to the other before starting to read or write.

Specifications

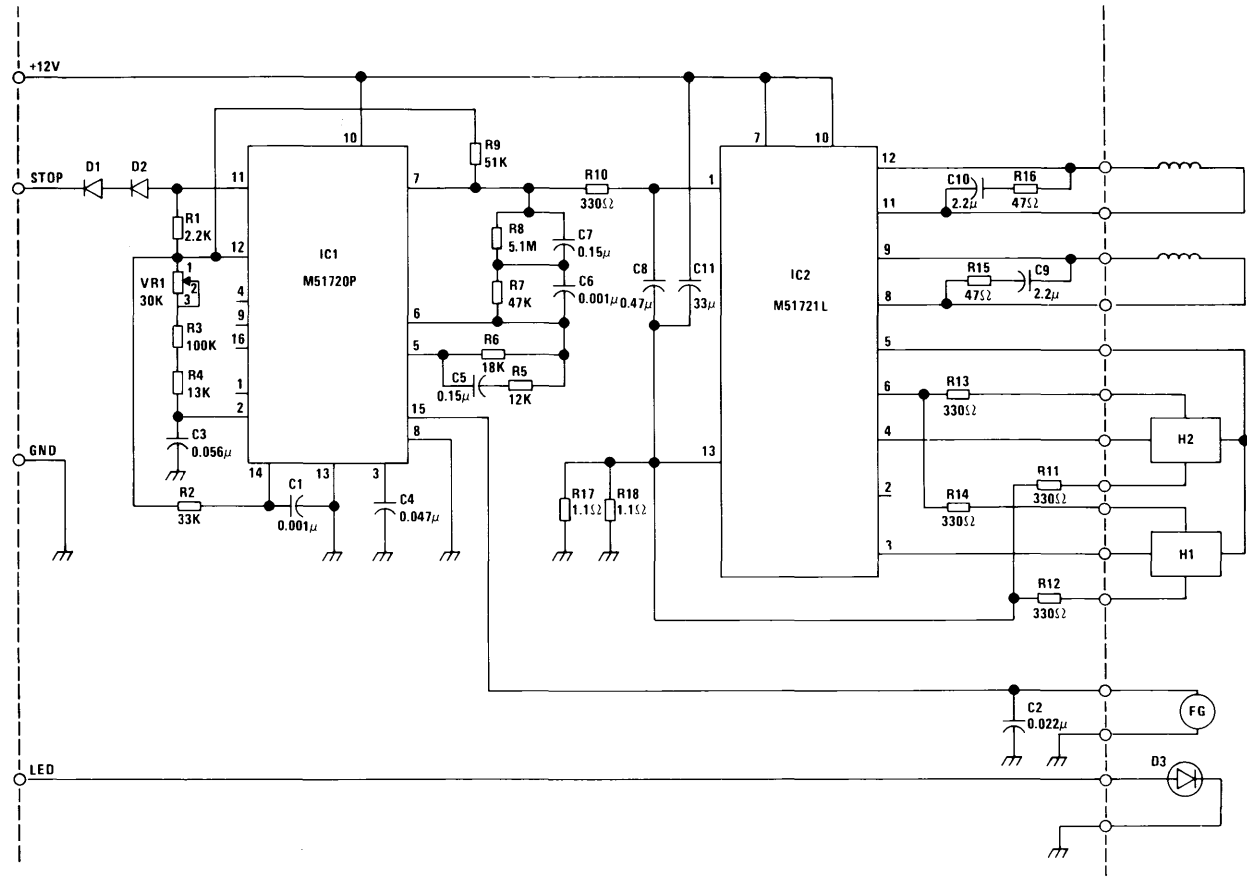
The following figures show the physical, and performance specifications for this drive.

Power Dissipation	11 W (TYP)
Operating Limits	Ambient Temperature 5 to 46 Degrees Celsius (41 to 114.8 Degrees Fahrenheit) Relative Humidity 20 to 80 % Maximum Wet Bulb 29 Degrees Celsius (84 Degrees Fahrenheit)
Non-operating Limits	Ambient Temperature -40 to 60 Degrees Celsius (-40 to 140 Degrees Fahrenheit) Humidity no Condensation
Mechanical Dimensions	Width 146.0 mm (5.8 in) Height 41.0 mm (1.6 in) Depth 203.2 mm (8 in)
Weight	1.6 kg

Physical Specifications

Capacity Unformatted	1604Kb
Capacity Formatted	1.2Mb
15 Sectors Per Track	9646 Bits Per Inch
Recording Density	96 TPI
Track Density	80
Cylinders	160
Tracks	MFM
Encoding Method	360 RPM
Rotational Speed	500K Bits/Second
Transfer Rate	83 ms
Latency (Average)	
Access Time	
Average	91 ms
Track to Track	3 ms
Settling Time	18 ms
Head Load Time	50 ms
Motor Start Time	750 ms

Performance Specifications



Double Sided Diskette Drive (Sheet 2 of 2)

IBM 10MB Fixed Disk Drive

Contents

Description 1
Specifications 3
Logic Diagrams 4

IBM 10MB Fixed Disk Drive

Description

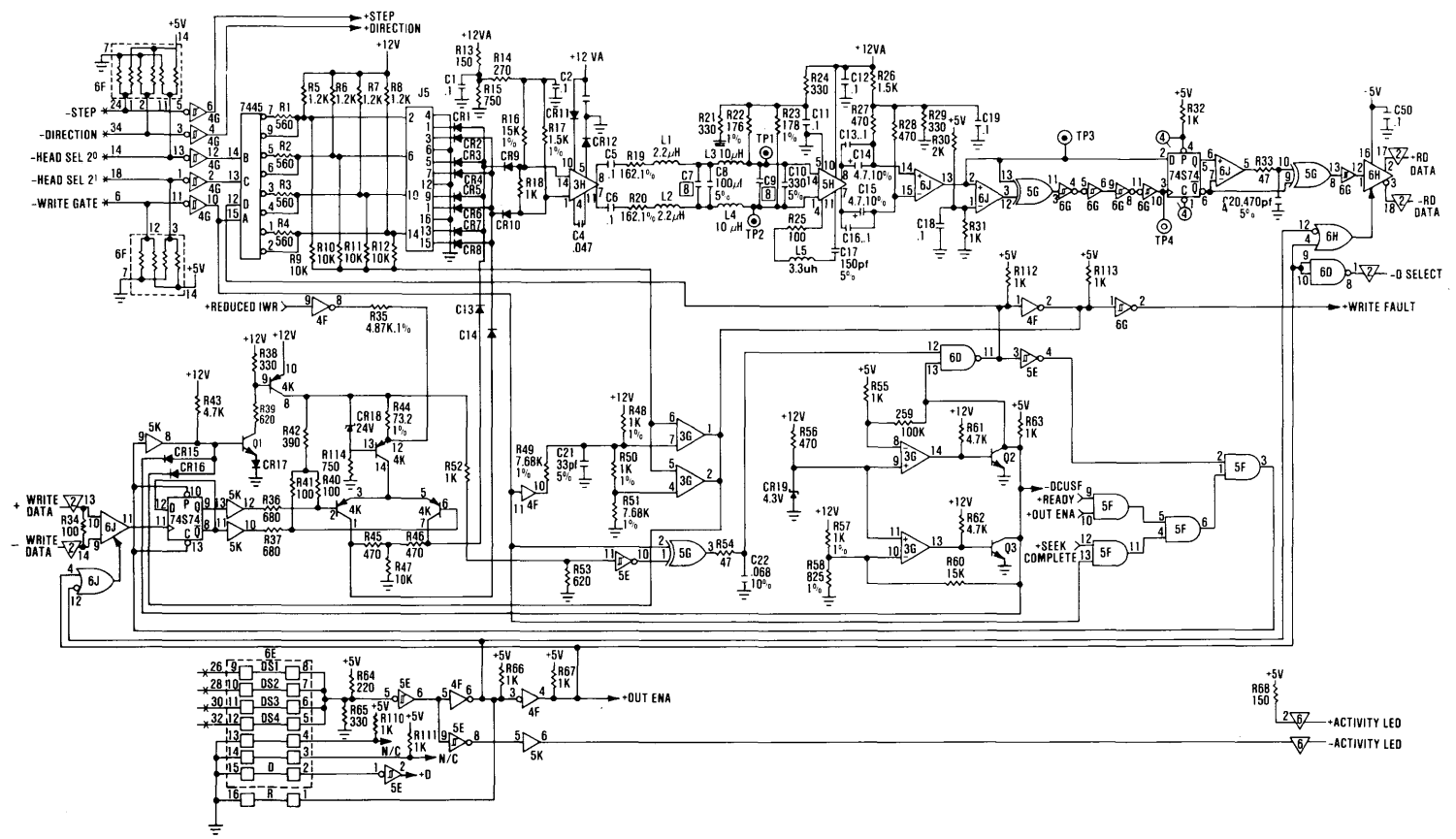
The IBM 10MB Fixed Disk Drive is a random-access storage device that uses two non-removable 5-1/4 inch disks for storage. Each disk surface employs one movable head to service 306 cylinders. The total formatted capacity of the four heads and surfaces is 10M bytes (17 sectors per track with 512 bytes per sector and a total of 1224 tracks).

An impact-resistant enclosure provides mechanical and contamination protection for the heads, actuator, and disks. A self-contained air recirculating system, which consists of an internal filter and a breather filter, maintains a clean-air environment. Thermal isolation of the stepper and spindle motor assemblies from the disk enclosure results in a very low temperature rise within the enclosure. This isolation provides a greater off-track margin and the ability to perform read and write operations immediately after power-up with no thermal stabilization delay.

Specifications

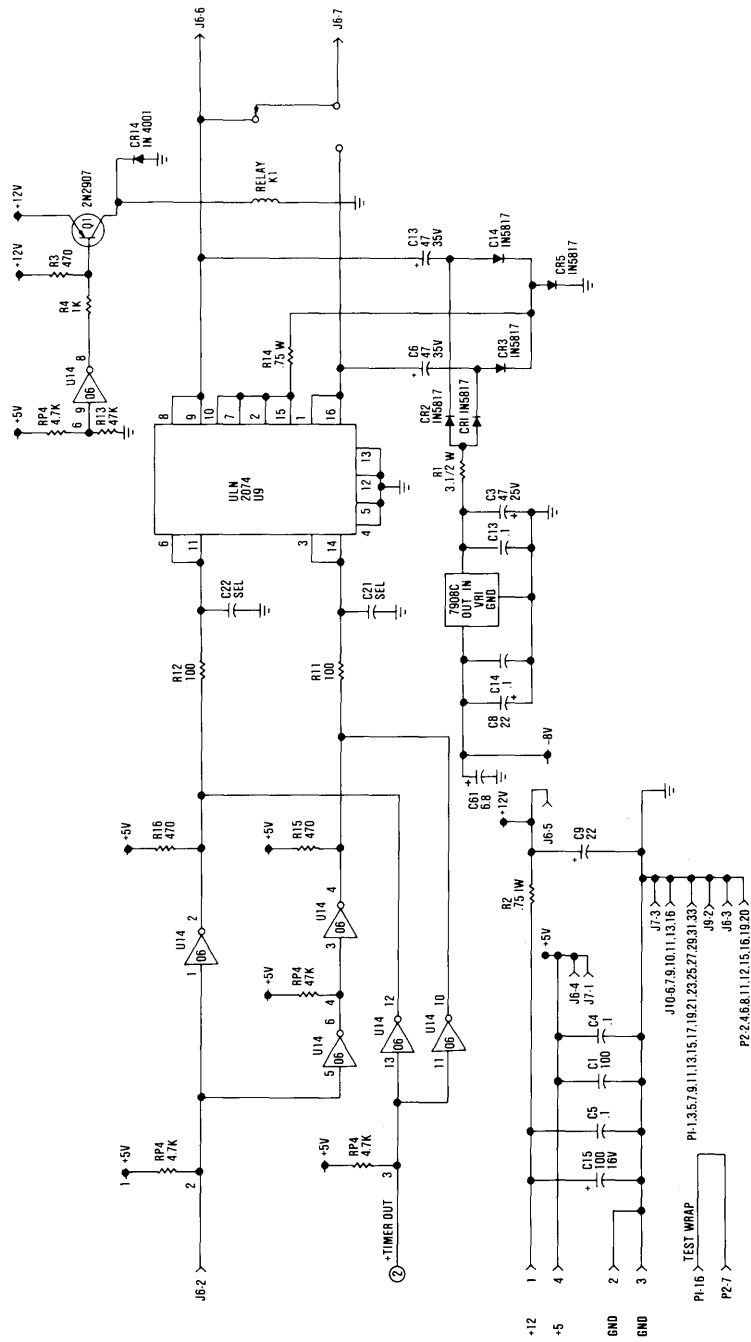
Size (maximum)	
Height	82.55 mm (3.25 in.)
Width	146.05 mm (5.75 in.)
Depth	203 mm (8.0 in.)
Weight	2.08 kg (4.6 lb)
Power	+12 Vdc \pm 5%, 1.8 A (4.5 A maximum) +5 Vdc \pm 5%, 0.7 A (1.0 A maximum)
Maximum Ripple	1% with equivalent resistive load
Media	Rigid media disk
Track Density	345 tracks per inch
Number of Tracks	1224
Temperature	
Operating	4 to 50°C (40 to 122°F)
Non-operating	-40 to 60°C (-40 to 140°F)
Relative humidity	
Operating	8 to 80% (non-condensing)
Maximum Wet Bulb	26°C (78°F)
Shock	
Operating	10 Gs
Non-operating	20 Gs
Access Time	3 ms track-to-track
Average Latency	8.33 ms
Error Rates	
Recoverable	1 per 10 ¹⁰ bits read
Irrecoverable	1 per 10 ¹² bits read
Seek Errors	1 per 10 ⁶ seeks
Design Life	5-years (8,000 hours MTF)
Disk speed	3600 rpm \pm 1%
Transfer Rate	5.0M bps
Recording Mode	MFM

Mechanical and Electrical Specifications



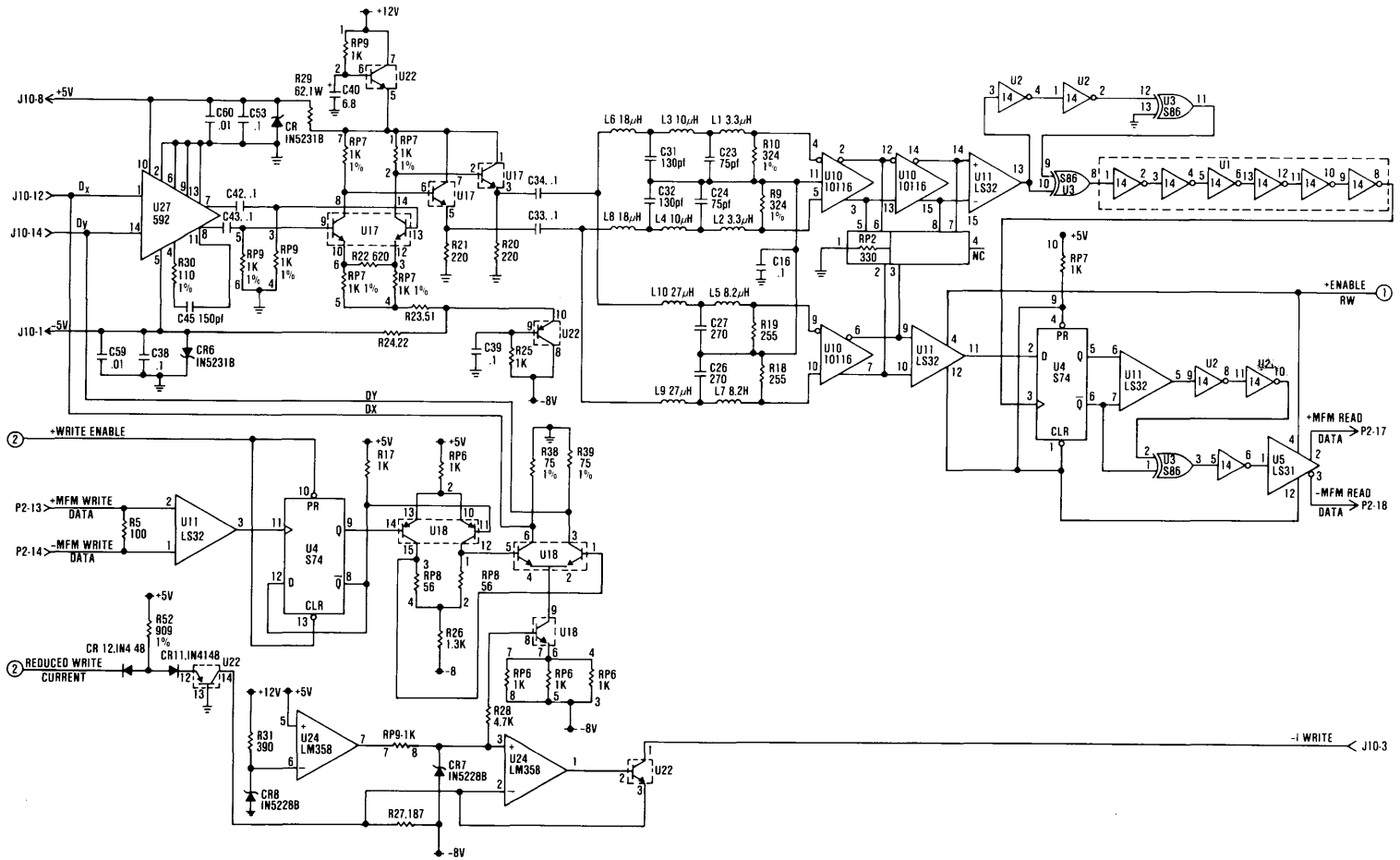
Fixed Disk Drive — Type 1 (Sheet 2 of 3)

Logic Diagrams (continued)



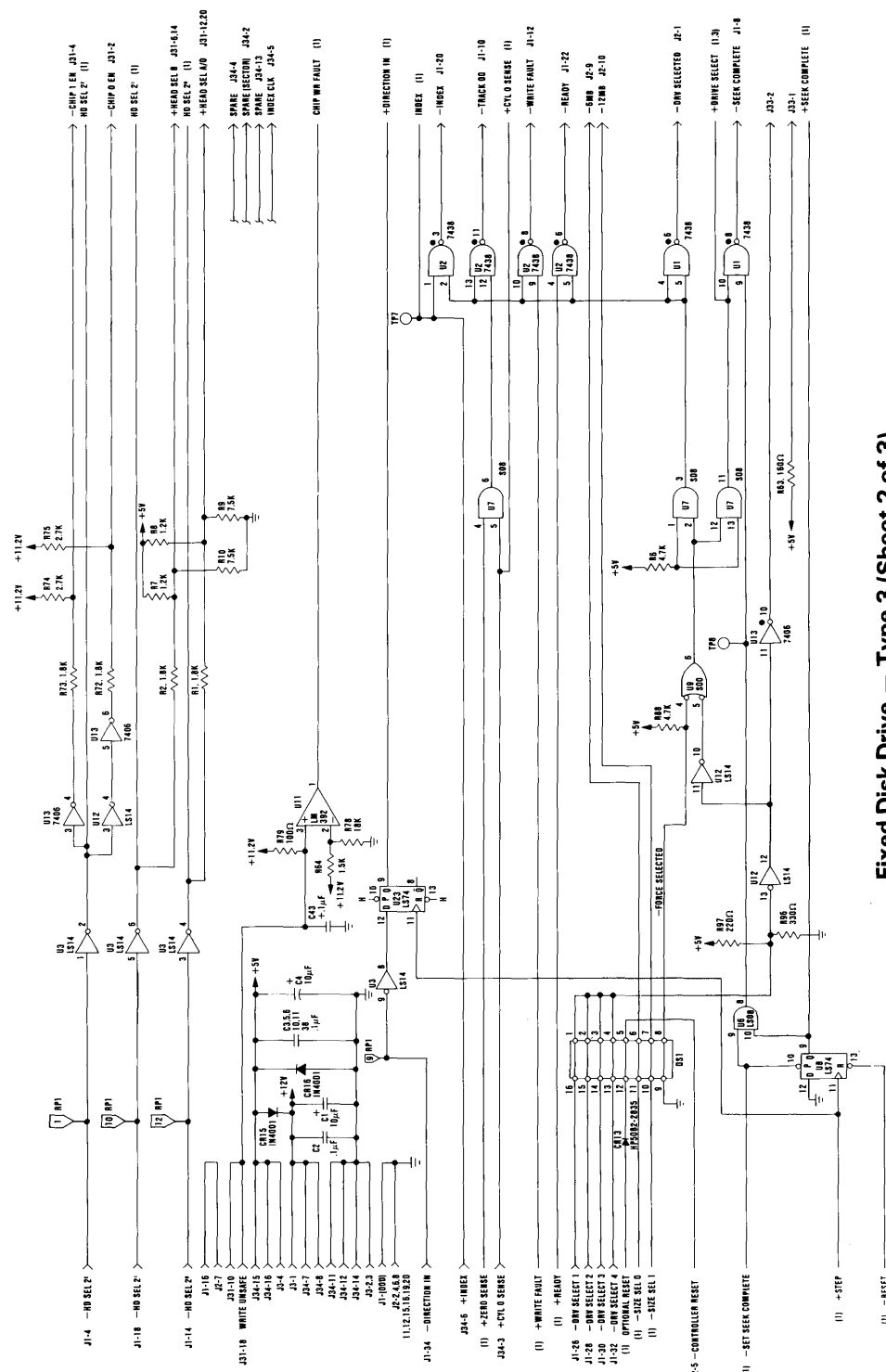
- NOTES:
1. SHEET TO SHEET CONNECTION IS AS FOLLOWS:
 2. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE 1/4W 5% VALUE IN OHMS
 3. ET IS A PROGRAMMABLE JUMPER SOCKET

Fixed Disk Drive — Type 2 (Sheet 1 of 3)



Fixed Disk Drive — Type 2 (Sheet 3 of 3)

Logic Diagrams (continued)



20MB Fixed Disk Drive

Contents

Description	1
Interfaces	2
Control Input Signals	4
Output Control Signals	5
Data-Transfer Signals	7
Overlapped Seek	7
Specifications	8
Logic Diagrams	9

20MB Fixed Disk Drive

Description

The IBM Personal Computer AT 20MB Fixed Disk Drive is a direct-access device that can store up to 20Mb of formatted data. The average access time is 40 milliseconds using a quasi closed-loop servo positioner.

Interfaces (continued)

The data transfer interface is a 20 Pin PCB connector. The signals and pin assignments are as follows:

Signal Name	Signal Pin
- Drive Selected	1
+MFM Write Data	13
-MFM Write Data	14
+MFM Read Data	17
-MFM Read Data	18
Ground	2, 4, 6, 8, 11, 12, 15, 16, 19

Data-Transfer Interface

The dc power interface is a 4-pin PCB connector. The signals and pin assignments follow.

Signal Name	Pin
+12 Vdc	1
+12 Vdc Return	2
+5 Vdc	4
+5 Vdc Return	3

DC Power Interface

Output Control Signals

The drive control signals are open collector outputs that can sink a maximum of 40 mA in the active state, with a maximum output voltage of 0.4 Vdc. When the output is inactive, the collector's cutoff current is a maximum of 250 microamperes.

-Seek Complete

This signal goes active when the read/write heads settle on the final track at the end of a seek. Reading or writing is not attempted when '-Seek Complete' is inactive. The following situations force '-Seek Complete' inactive:

- When power-on starts a recalibration sequence because the read/write heads are not over track 0.
- When less than 5 microseconds have elapsed after the trailing edge of a step pulse or a series of step pulses.
- If the +5 or +12 Vdc fluctuates or is lost momentarily but restored.
- If the drive attempts to retry a seek after settling on a track.

-Seek Complete returns to the active level no later than 100 milliseconds (1 second if a seek retry occurs) after the trailing edge of the last -Step pulse.

-Track 000

This signal is at an active level when the drive's read/write heads are at the outermost track.

-Write Fault

This signal means that a condition at the drive is causing improper operation of the disk. An active level of this signal prevents further writing and stepping at the drive until drive power is switched off.

This signal goes active when any of the following conditions occur:

- Write current exists in the head without '-Write Gate' active, or no write current exists in the head with '-Write Gate' active and '-Drive Selected' active
- More than one seek retry between Seek commands from the controller
- A step pulse is received while '-Write Gate' is active.

Data-Transfer Signals

All signals associated with the transfer of data between the drive and the system are differential (pairs of balanced signals) and are not multiplexed.

Two pairs of balanced signals are used for the transfer of data: '-Write Data' and '-Read Data'. The following describes the data-transfer signals.

MFM Write Data

This is a differential pair that defines signal shifts written on the track. When '+ MFM Write Data' goes more positive than '-MFM Write Data', flux reverses on the track, provided that '-Write Gate' is active. The system drives '-MFM Write Data' to an active level ('-MFM Write Data' more negative than '+ MFM Write Data') when in the read mode.

To ensure data integrity, the controller applies a write-precompensation of ± 12 nanoseconds to all write data on cylinders 300 and greater.

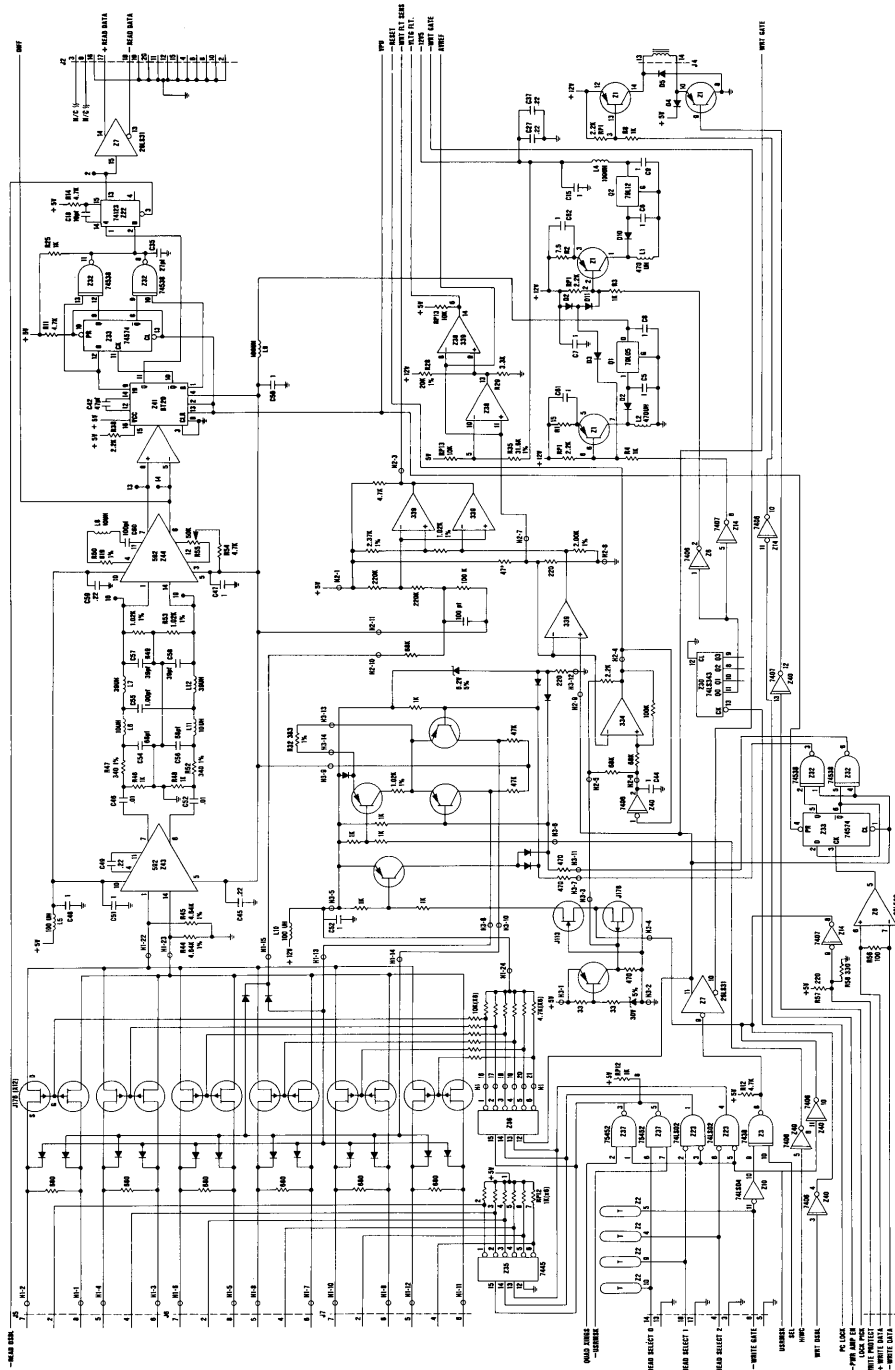
MFM Read Data

Read data is sent to the system through the differential pair of MFM Read Data lines. When '+ MFM Read Data' goes more positive than '-MFM Read Data', flux reverses on the track of the selected head.

Overlapped Seek

The drive supports overlapped-seek operations. An overlapped seek occurs when the drive is deselected 20 microseconds after the last step pulse is sent. Another drive is then selected, and the '-Step' and '-Direction In' signals are set by the operation desired. The controller provides at least 100 nanoseconds of hold time on '-Step' and '-Direction In' after '-Drive Select' is deactivated.

Logic Diagrams (continued)



20MB Fixed Disk Drive (Sheet 3 of 4)

IBM 64/256KB Memory Expansion Option and 64KB Memory Module Kit

Contents

Description	1
Switch-Configurable Start Address	3
Operating Characteristics	4
Specifications	5
Logic Diagrams	6

IBM 64/256KB Memory Expansion Option and 64KB Memory Module Kit

Description

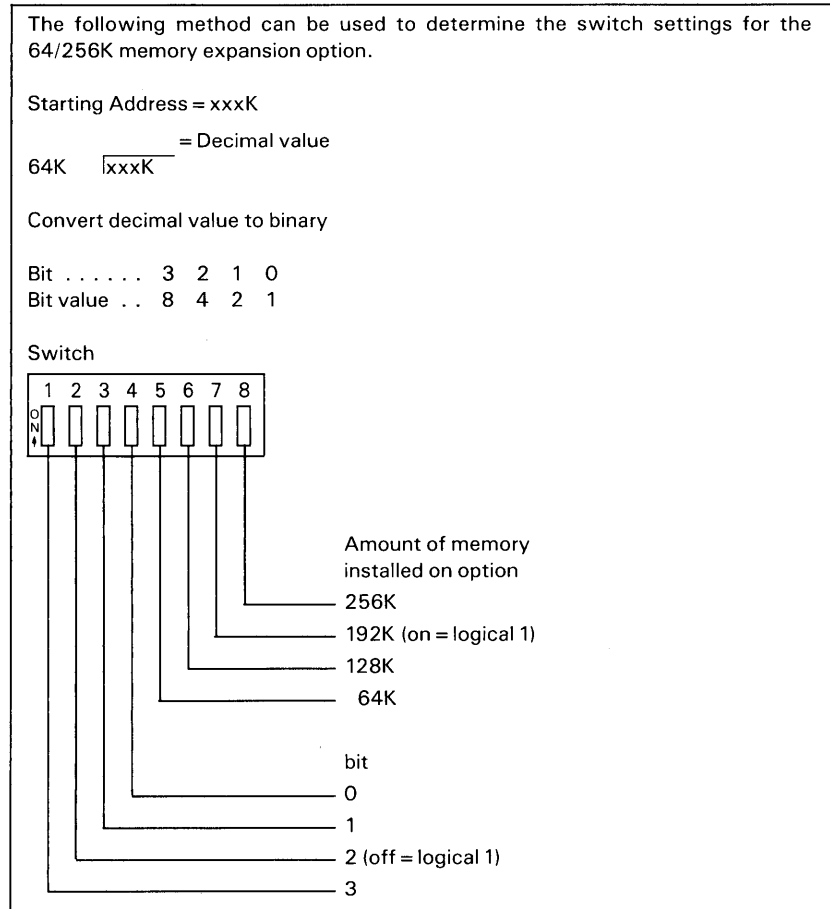
The 64KB Memory Module Kit and the 64/256KB Memory Expansion Option are available for the IBM Personal Computer family of products. Depending upon the amount of memory currently installed on the system board, memory module kits can be added to provide a maximum of 256KB of RAM without using any of the system unit expansion slots for a memory expansion option. The system board must be populated to the maximum 256KB of RAM before a 64/256KB Memory Expansion Option can be installed.

Switch-Configurable Start Address

The 64/256KB Memory Expansion Option must be configured to reside at a sequential 64K memory address boundary within the system address space. This is done by setting dual-in-line package (DIP) switches on the option. The 64/256KB expansion option has a small DIP module containing eight switches. The switches are used to set the card start address as follows:

Number	64/256K Options
1	ON: A 19 = 0; OFF: A 19 = 1
2	ON: A 18 = 0; OFF: A 18 = 1
3	ON: A 17 = 0; OFF: A 17 = 1
4	ON: A 16 = 0; OFF: A 16 = 1
5	ON: Select 64K
6	ON: Select 128K
7	ON: Select 192K
8	ON: Select 256K

DIP Module Start Address



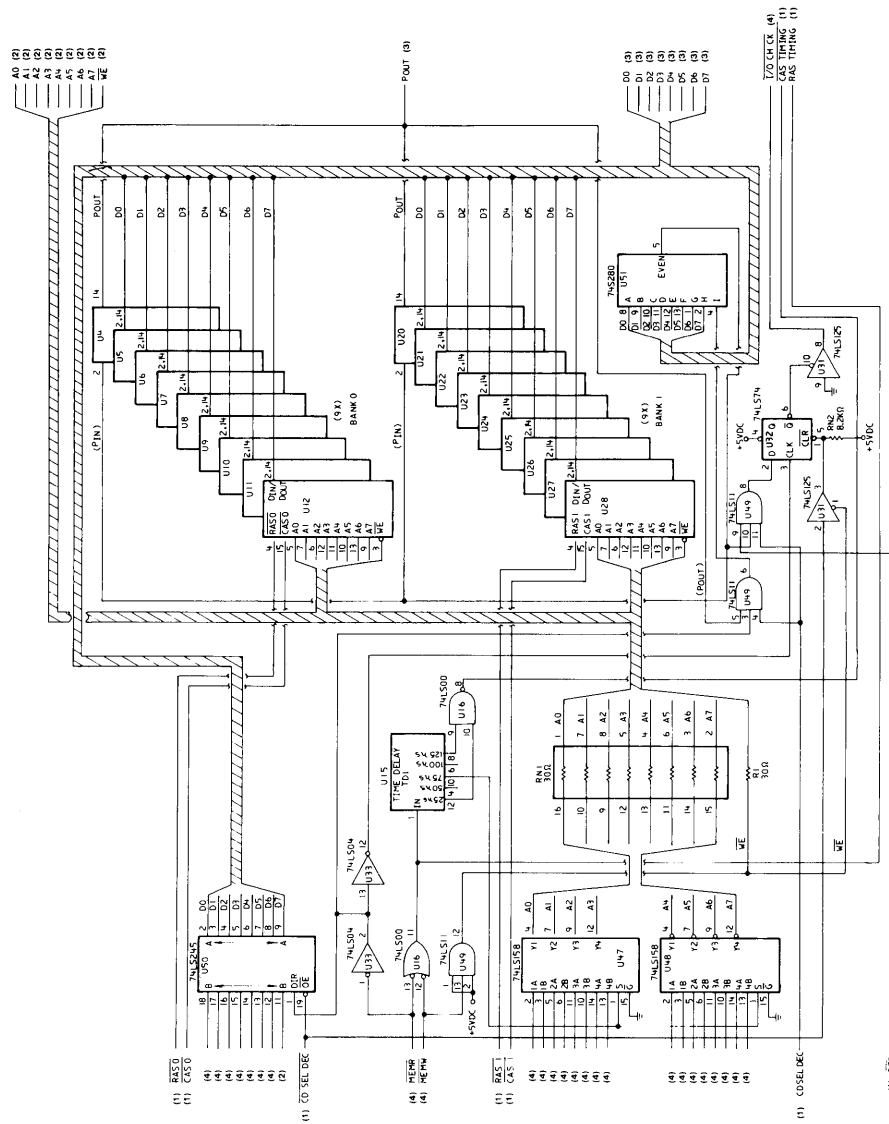
Specifications

Pin	64K by 1 Bit Module (used on 64/256K option and 64/256K system board)
1	N/C
2	Data In * *
3	- Write
4	- RAS
5	A0
6	A2
7	A1
8	- 5 Vdc
9	A7
10	A5
11	A4
12	A3
13	A6
14	Data Out * *
15	- CAS
16	GND
17	*
18	*

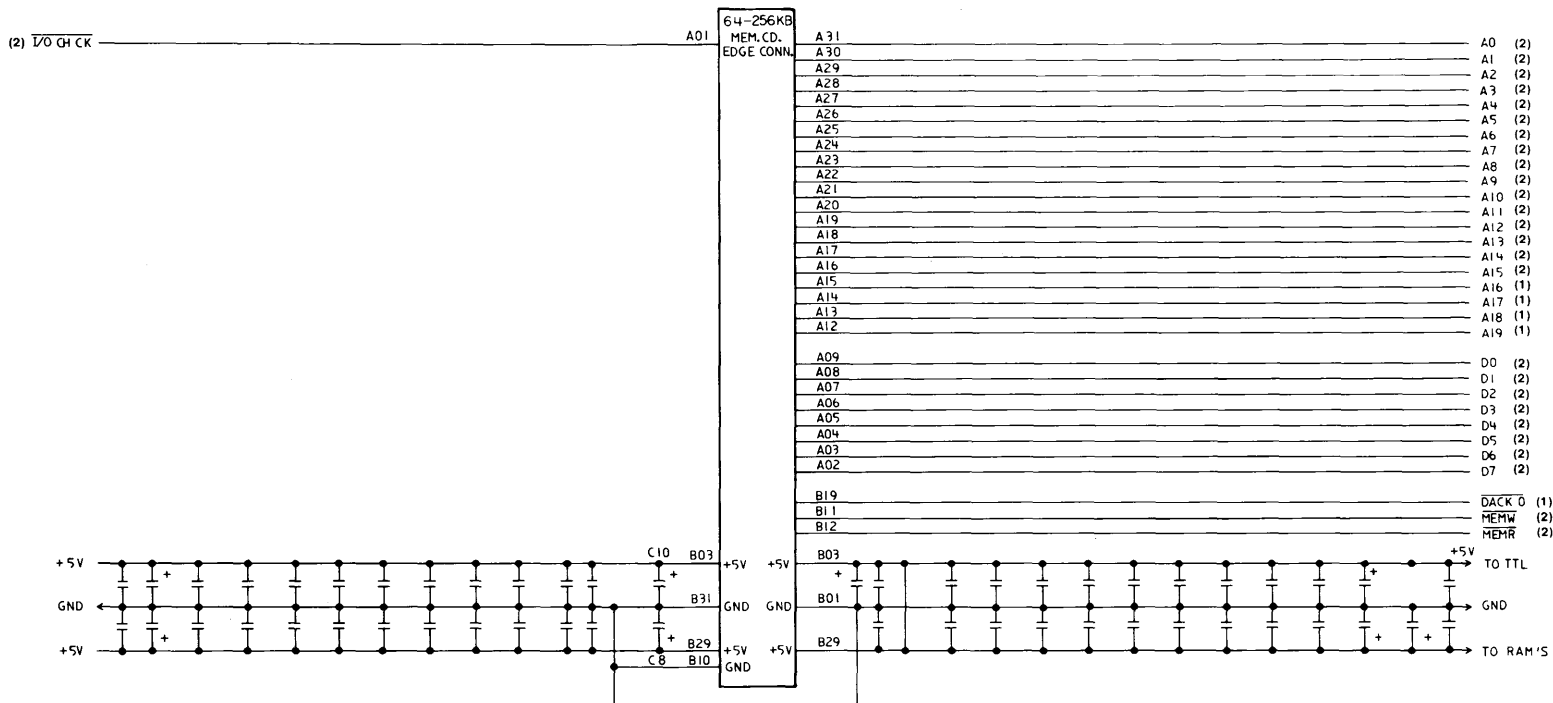
*64K by 1 bit modules have 16 pins.
**Data In and Data Out are tied together on Data Bits 0-7 (three state bus).

Memory Module Pin Configuration

Logic Diagrams (continued)



64/256KB Memory Expansion Option (Sheet 2 of 4)



64/256KB Memory Expansion Option (Sheet 4 of 4)

128KB Memory Expansion Option

Contents

Description	1
Specifications	3
Logic Diagrams	4

128KB Memory Expansion Option

Description

The IBM Personal Computer AT 128Kb Memory Expansion Option has 18 RAM modules (64K x 1) for a total capacity of 128Kb.

Specifications

Voltage Tolerances

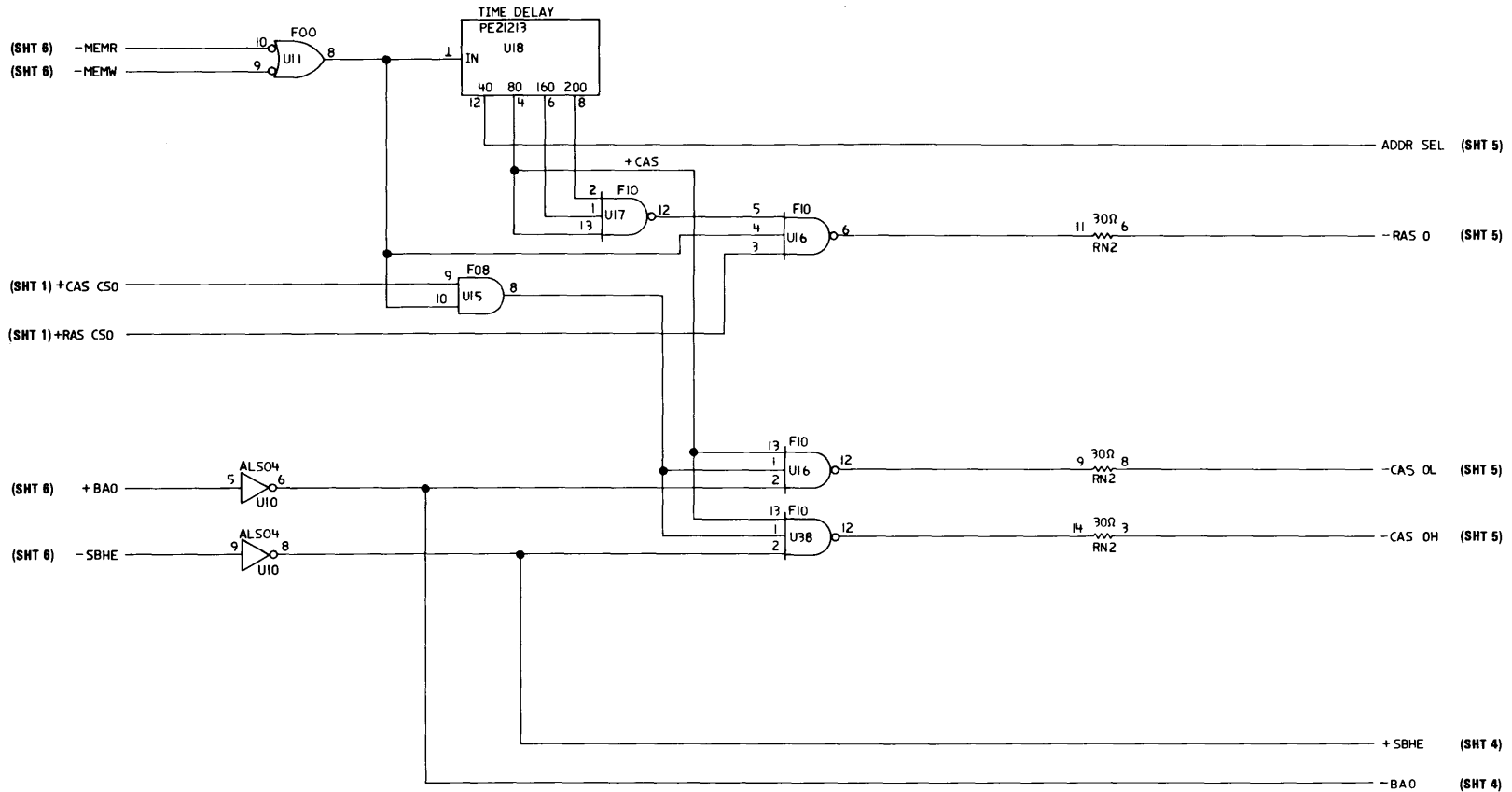
The maximum variation of the + 5 Vdc is $\pm 5\%$ at the adapter pins.

Power Dissipation

The + 5 Vdc power used by the adapter is a maximum of 5.25 watts, and the maximum current used is 1 ampere.

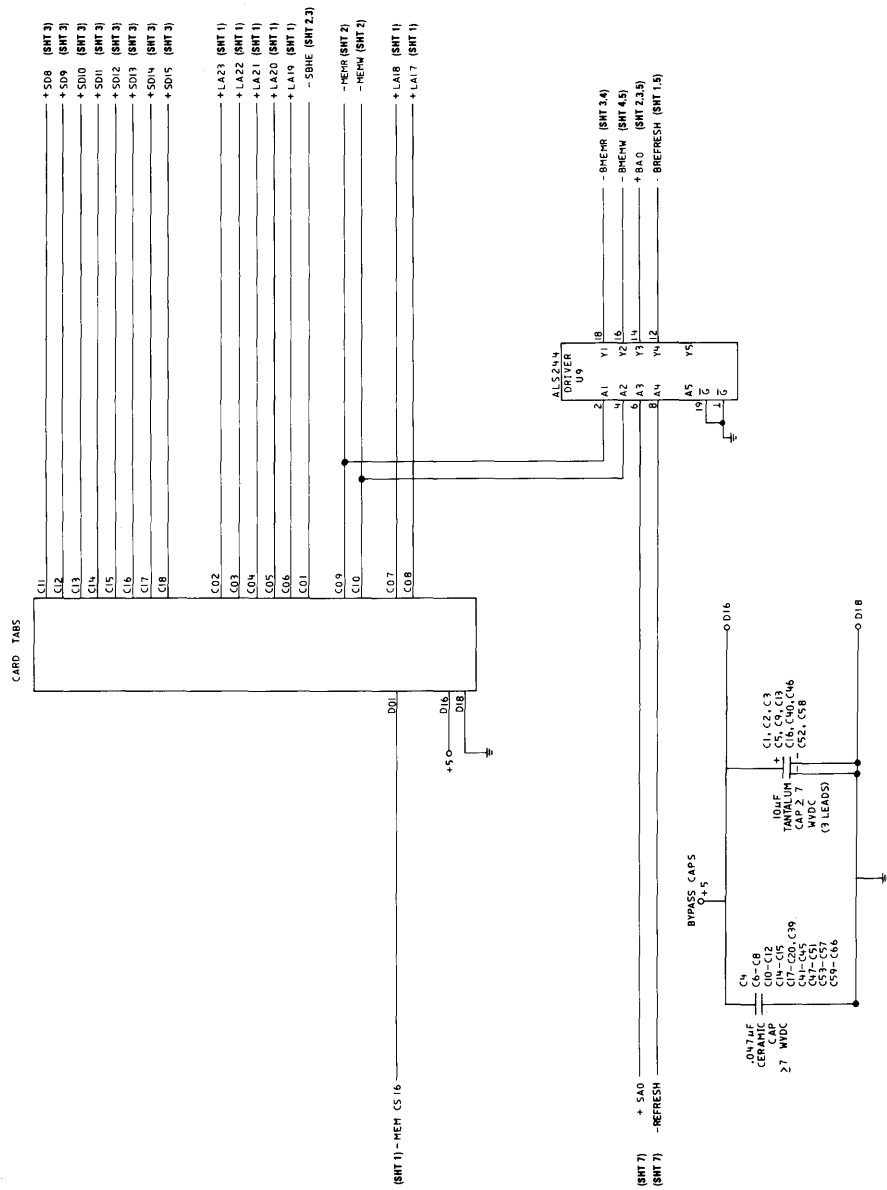
Temperature Variation

The adapter will operate between 10 and 50 degrees Celsius (50 and 122 degrees Fahrenheit).



128KB Memory Expansion Option (Sheet 2 of 7)

Logic Diagrams (continued)



128KB Memory Expansion Option (Sheet 6 of 7)

512KB Memory Expansion Option

Contents

Description	1
Memory Cycles	1
Memory Address Switches	1
I/O Channel Check	3
Specifications	3
Logic Diagrams	4

512KB Memory Expansion Option

Description

The IBM Personal Computer AT 512Kb Memory Expansion option has 36 RAM modules (128Kb x 1) for a total capacity of 512Kb.

Memory Cycles

Memory read and write commands require a 1-wait-state, 3-clock memory cycle. Data moves as a byte (8 data bits and 1 parity bit) or as a word (16 data bits and 2 parity bits) and is parity-checked on the adapter. A parity error causes an I/O channel check (non-maskable interrupt) to the system.

Memory Address Switches

There are two banks of memory address switches on each memory adapter. These switches are set to values for the first, second, third, etc. memory adapter in the system.

The first memory expansion adapter must start at address space hex 100000. If more than one adapter is installed, no gaps between memory are allowed. All expansion memory must be one contiguous block starting at address hex 100000.

The figure on the following page shows the switch settings for each adapter.

I/O Channel Check

When the I/O channel check occurs, a non-maskable interrupt (NMI) results. Bits 6 and 7 of hex address 0061 are the status bits used to determine the source of the NMI (bit 6 is I/O channel check, and bit 7 is system board parity check.) Writing to the failing card will clear the status bit.

Specifications

Voltage Tolerances

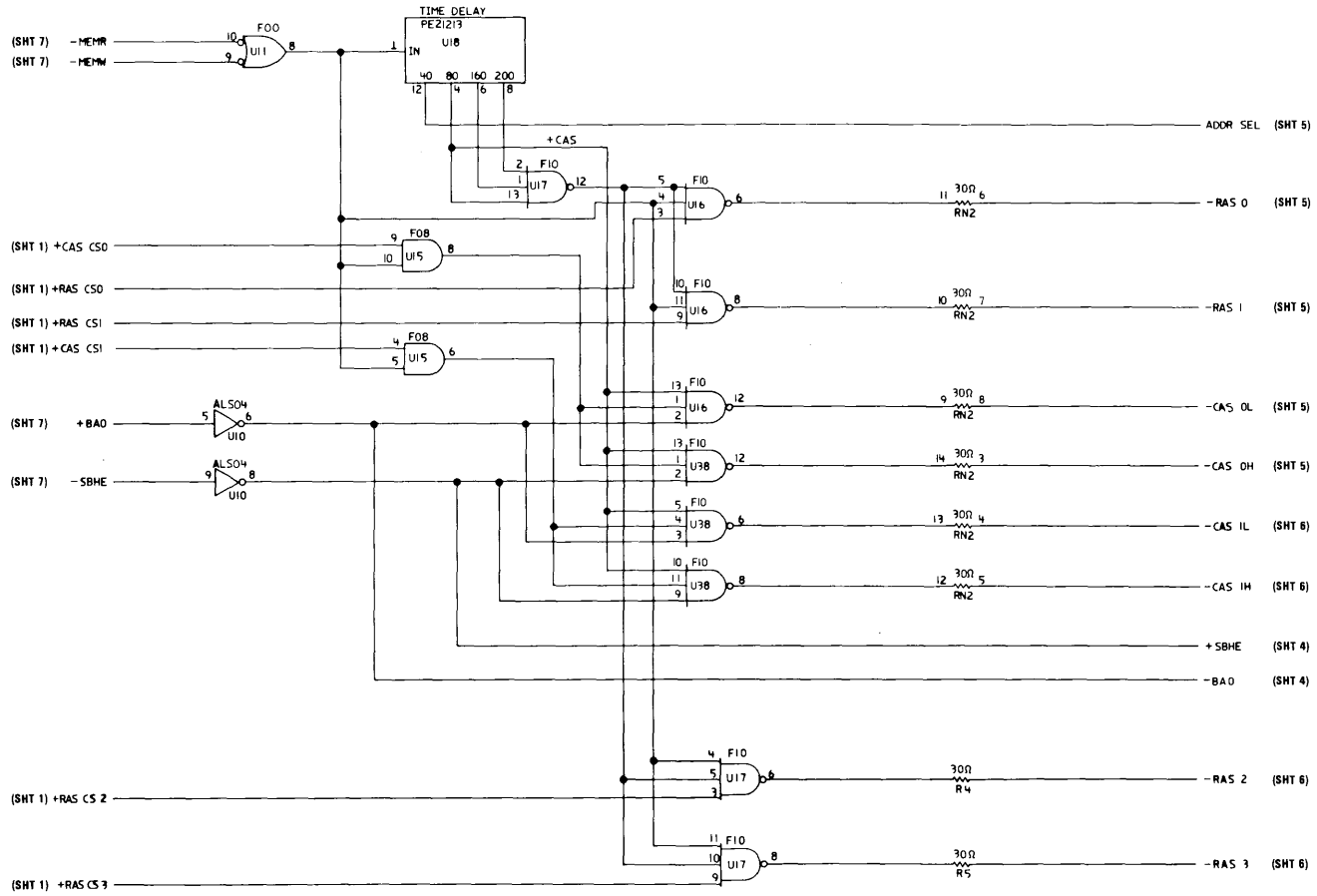
The maximum variation of the + 5 Vdc is $\pm 5\%$ at the adapter pins.

Power Dissipation

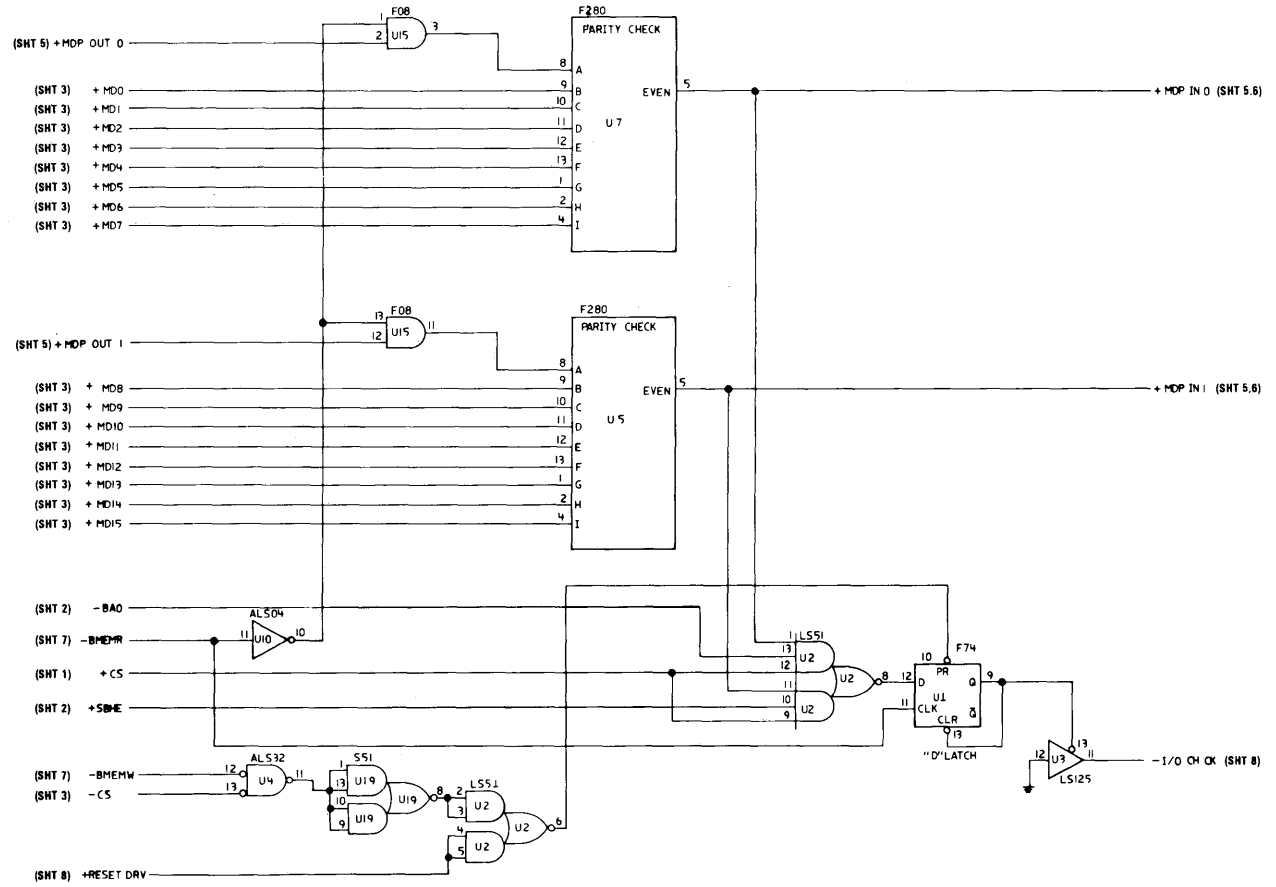
The + 5 Vdc power used by the adapter is a maximum of 5.25 watts, and the maximum current used is 1 ampere.

Temperature Variation

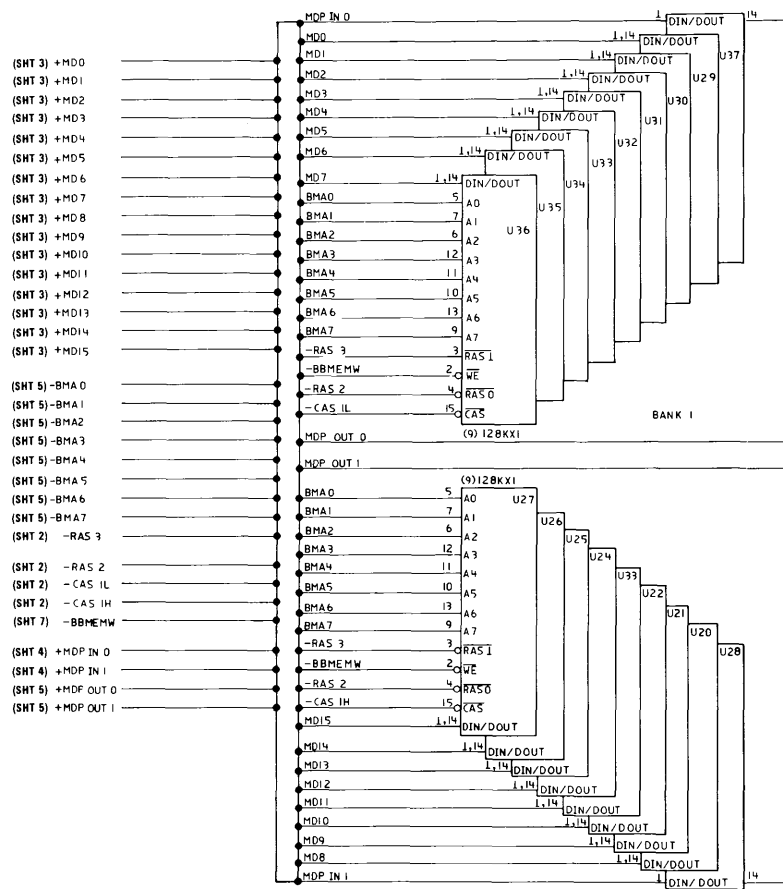
The adapter will operate between 10 and 50 degrees Celsius (50 and 122 degrees Fahrenheit).



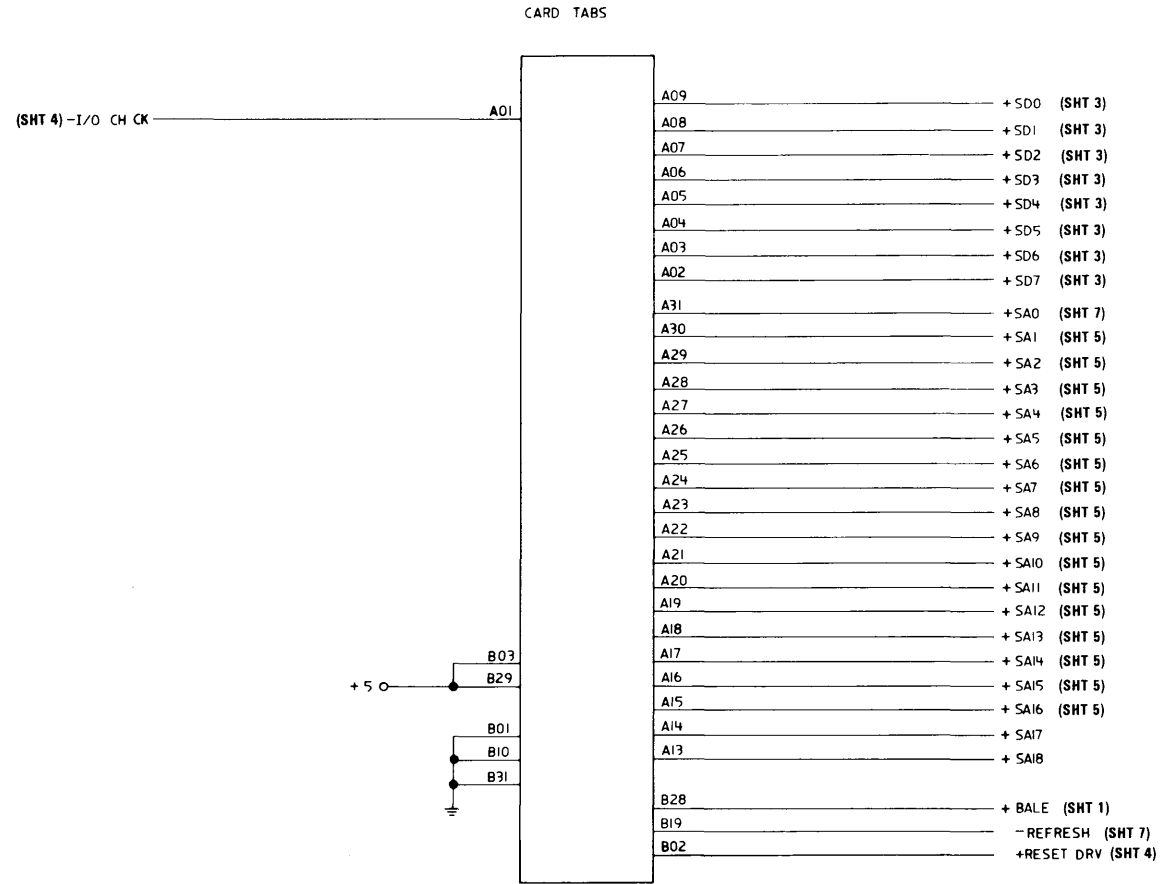
512 KB Memory Expansion Option (Sheet 2 of 8)



512 KB Memory Expansion Option (Sheet 4 of 8)



512 KB Memory Expansion Option (Sheet 6 of 8)



512 KB Memory Expansion Option (Sheet 8 of 8)

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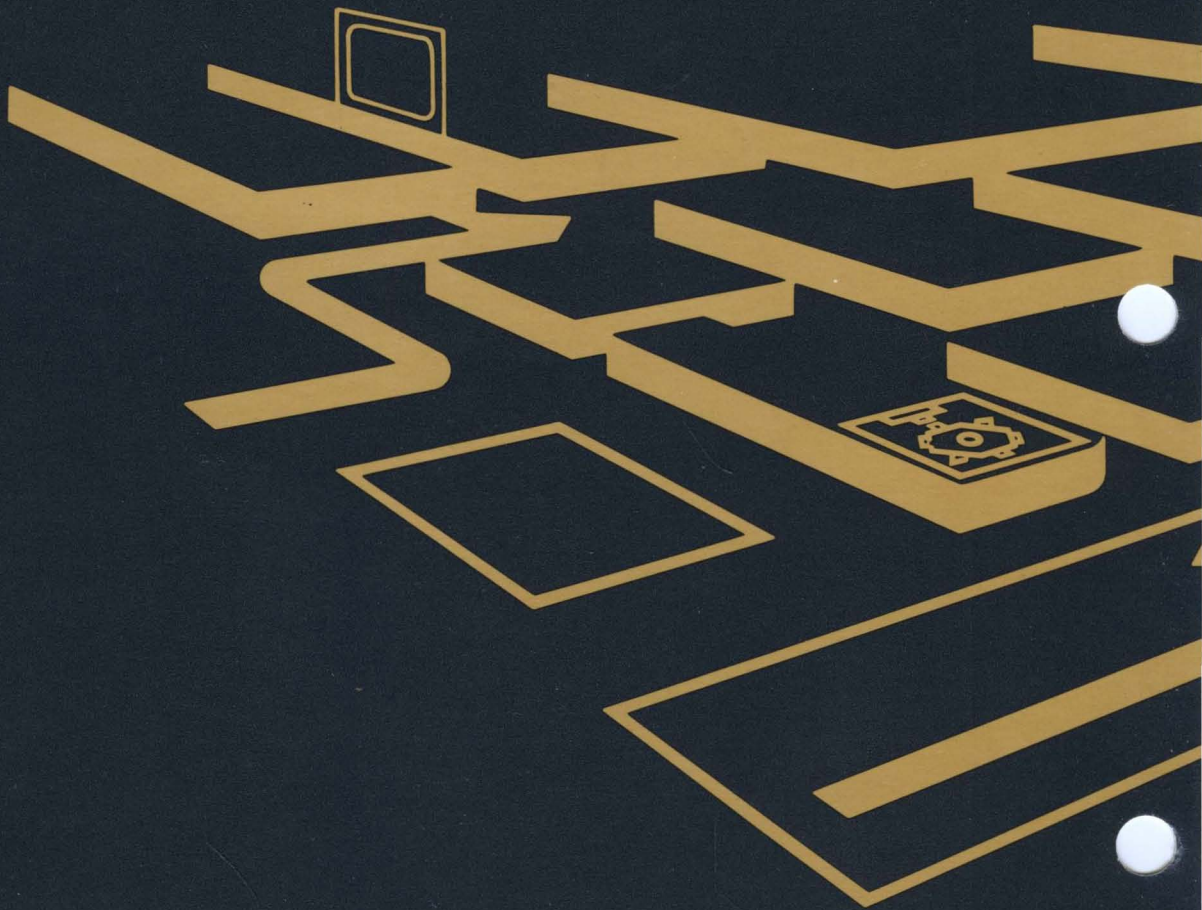
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