# IBM

# IBM Monochrome
# Display and Printer
# Adapter

6361511

# Contents

# Introduction

The IBM Monochrome Display and Printer Adapter has two functions. The first is to provide an interface to the IBM Monochrome Display. The second is to provide a parallel interface for the IBM Printers. We will discuss this adapter by function.

# Monochrome Display Adapter Function

## Description

The IBM Monochrome Display and Printer Adapter is designed around the Motorola 6845 CRT Controller module. There are 4K bytes of RAM on the adapter that are used for the display buffer. This buffer has two ports to which the system unit's microprocessor has direct access. No parity is provided on the display buffer.

Two bytes are fetched from the display buffer in 553 ns, providing a data rate of 1.8M bytes/second.

The adapter supports 256 different character codes. An 8K-byte character generator contains the fonts for the character codes. The characters, values, and screen characteristics are given in "Of Characters, Keystrokes, and Colors" in your *Technical Reference* system manual.

This adapter, when used with a display containing P39 phosphor, does not support a light pen.

Where possible, only one low-power Schottky (LS) load is present on any I/O slot. Some of the address bus lines have two LS loads. No signal has more than two LS loads.

Characteristics of the adapter are:

- Supports 80-character by 25-line screen

- Has direct-drive output

- Supports 9-PEL by 14-PEL character box

- Supports 7-PEL by 9-PEL character

- Has 18-kHz monitor

- Has character attributes

The following is a block diagram of the monochrome display adapter portion of the IBM Monochrome Display and Printer Adapter.
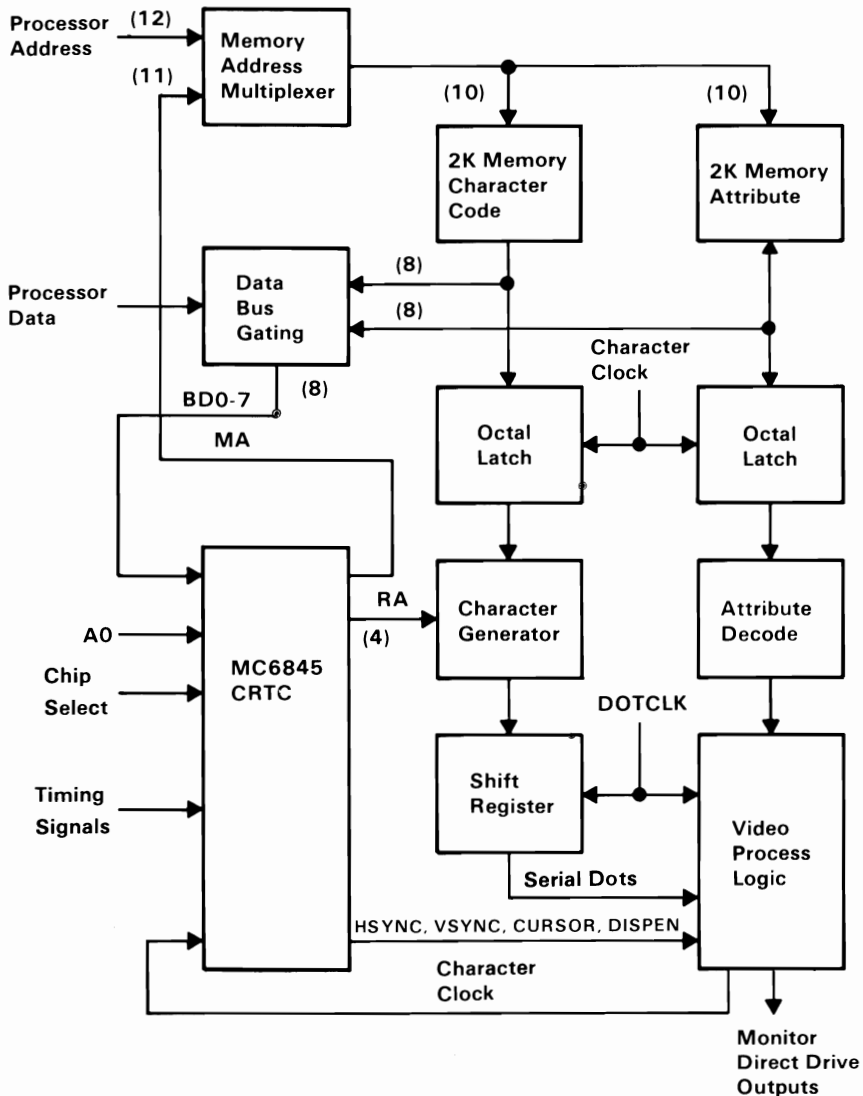


**IBM Monochrome Display Adapter Block Diagram**

**4**  **Monochrome Adapter**
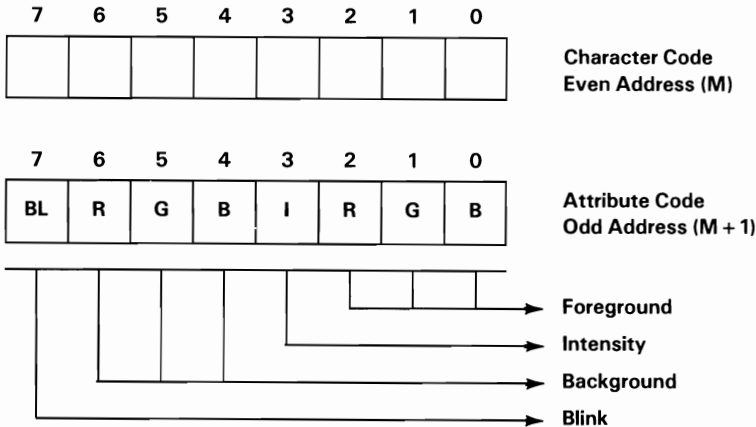
# Programming Considerations

The following table summarizes the 6845 controller module's internal data registers, their functions, and their parameters. For the IBM Monochrome Display, the values must be programmed into the 6845 to ensure proper initialization of the display.

| Register Number | Register File | Program Unit | IBM Monochrome Display (Address in hex) |
|---|---|---|---|
| R0 | Horizontal Total | Characters | 61 |
| R1 | Horizontal Displayed | Characters | 50 |
| R2 | Horizontal Sync Position | Characters | 52 |
| R3 | Horizontal Sync Width | Characters | F |
| R4 | Vertical Total | Character Rows | 19 |
| R5 | Vertical Total Adjust | Scan Line | 6 |
| R6 | Vertical Displayed | Character Row | 19 |
| R7 | Vertical Sync Position | Character Row | 19 |
| R8 | Interlace Mode | --------- | 02 |
| R9 | Maximum Scan Line Address | Scan Line | D |
| R10 | Cursor Start | Scan Line | B |
| R11 | Cursor End | Scan Line | C |
| R12 | Start Address (H) | --------- | 00 |
| R13 | Start Address (L) | --------- | 00 |
| R14 | Cursor (H) | --------- | 00 |
| R15 | Cursor (L) | --------- | 00 |
| R16 | Reserved | --------- | -- |
| R17 | Reserved | --------- | -- |

To ensure proper initialization, the first command issued to the IBM Monochrome Display and Printer Adapter must be sent to the CRT control port 1 (hex 3B8), and must be a hex 01, to set the high-resolution mode. If this bit is not set, the system unit's microprocessor's access to the adapter must never occur. If the high-resolution bit is not set, the system unit's microprocessor will stop running.

System configurations that have both an IBM Monochrome Display and Printer Adapter, and an IBM Color/Graphics Monitor Adapter, must ensure that both adapters are properly initialized after a power-on reset. Damage to either display may occur if not properly initialized.

The IBM Monochrome Display and Printer Adapter supports 256 different character codes. In the character set are alphanumerics and block graphics. Each character in the display buffer has a corresponding character attribute. The character code must be an even address, and the attribute code must be an odd address in the display buffer.

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
|   |   |   |   |   |   |   |   |

Character Code
Even Address (M)

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| BL | R | G | B | I | R | G | B |

Attribute Code
Odd Address (M + 1)

Foreground
Intensity
Background
Blink

The adapter decodes the character attribute byte as defined above. The blink and intensity bits may be combined with the foreground and background bits to further enhance the character attribute functions listed below:

| Background R G B | | | Foreground R G B | | | Function |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | Non-Display |
| 0 | 0 | 0 | 0 | 0 | 1 | Underline |
| 0 | 0 | 0 | 1 | 1 | 1 | White Character/Black Background |
| 1 | 1 | 1 | 0 | 0 | 0 | Reverse Video |

The 4K display buffer supports one screen of the 25 rows of 80 characters, plus a character attribute for each display character. The starting address of the buffer is hex B0000. The display buffer can be read using direct memory access (DMA); however, at least one wait state will be inserted by the system unit's microprocessor. The duration of the wait state will vary, because the microprocessor/monitor access is synchronized with the character clock on this adapter.

Interrupt level 7 is used on the parallel interface.  Interrupts can be enabled or disabled through the printer control port.  The interrupt is a high-level active signal.

The following table breaks down the functions of the I/O address decode for the adapter.  The I/O address decode is from hex 3B0 through hex 3BF.  The bit assignment for each I/O address follows:

| I/O Register Address | Function |
| --- | --- |
| 3B0 | Not Used |
| 3B1 | Not Used |
| 3B2 | Not Used |
| 3B3 | Not Used |
| 3B4 | 6845 Index Register |
| 3B5 | 6845 Data Register |
| 3B6 | Not Used |
| 3B7 | Not Used |
| 3B8 | CRT Control Port 1 |
| 3B9 | Reserved |
| 3BA | CRT Status Port |
| 3BB | Reserved |
| 3BC | Parallel Data Port |
| 3BD | Printer Status Port |
| 3BE | Printer Control Port |
| 3BF | Not Used |

**I/O Address and Bit Map**

| Bit<br>Number | Function |
|---|---|
| 0 | + High Resolution Mode |
| 1 | Not Used |
| 2 | Not Used |
| 3 | + Video Enable |
| 4 | Not Used |
| 5 | + Enable Blink |
| 6,7 | Not Used |

**6845 CRT Control Port 1 (Hex 3B8)**

| Bit<br>Number | Function |
|---|---|
| 0 | + Horizontal Drive |
| 1 | Reserved |
| 2 | Reserved |
| 3 | + Black/White Video |

**6845 CRT Status Port (Hex 3BA)**

**8 Monochrome Adapter**

# Specifications



**9-Pin Monochrome Display connector**
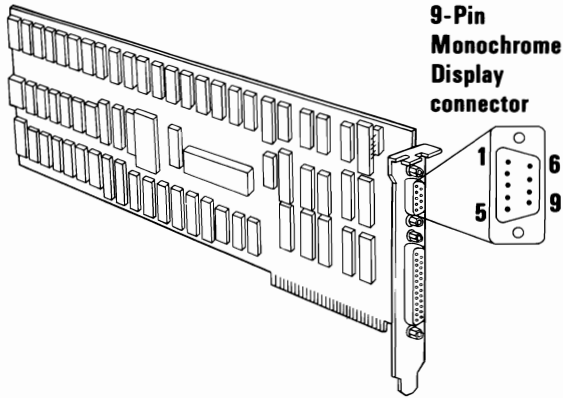
At Standard TTL Levels

| IBM Monochrome Display | | | | IBM Monochrome Display and Printer Adapter |
|---|---|---|---|---|
| | Ground | | 1 | |
| | Ground | | 2 | |
| | | Not Used | 3 | |
| | | Not Used | 4 | |
| | | Not Used | 5 | |
| | + Intensity | | 6 | |
| | + Video | | 7 | |
| | + Horizontal | | 8 | |
| | − Vertical | | 9 | |

Note: Signal voltages are 0.0 to 0.6 Vdc at down level and + 2.4 to 3.5 Vdc at high level.

## Connector Specifications

# Printer Adapter Function

## Description

The printer adapter portion of the IBM Monochrome Display and
Printer Adapter is specifically designed to attach printers with a
parallel-port interface, but it can be used as a general
input/output port for any device or application that matches its
input/output capabilities. It has 12 TTL-buffer output points,
which are latched and can be written and read under program
control using the microprocessor In or Out instruction. The
adapter also has five steady-state input points that may be read
using the microprocessor's In instructions.

In addition, one input can also be used to create a microprocessor
interrupt. This interrupt can be enabled and disabled under
program control. A reset from the power-on circuit is also ORed
with a program output point, allowing a device to receive a
'power-on reset' when the system unit's microprocessor is reset.

The input/output signals are made available at the back of the
adapter through a right-angle, printed-circuit-board-mounted,
25-pin, D-shell connector. This connector protrudes through the
rear panel of the system unit or expansion unit, where a cable may
be attached.

When this adapter is used to attach a printer, data or printer
commands are loaded into an 8-bit, latched, output port, and the
strobe line is activated, writing data to the printer. The program
then may read the input ports for printer status indicating when
the next character can be written, or it may use the interrupt line
to indicate "not busy" to the software.

The output ports may also be read at the card's interface for
diagnostic loop functions. This allows faults to be isolated to the
adapter or the attaching device.

The following is a block diagram of the printer adapter portion of the Monochrome Display and Printer Adapter.
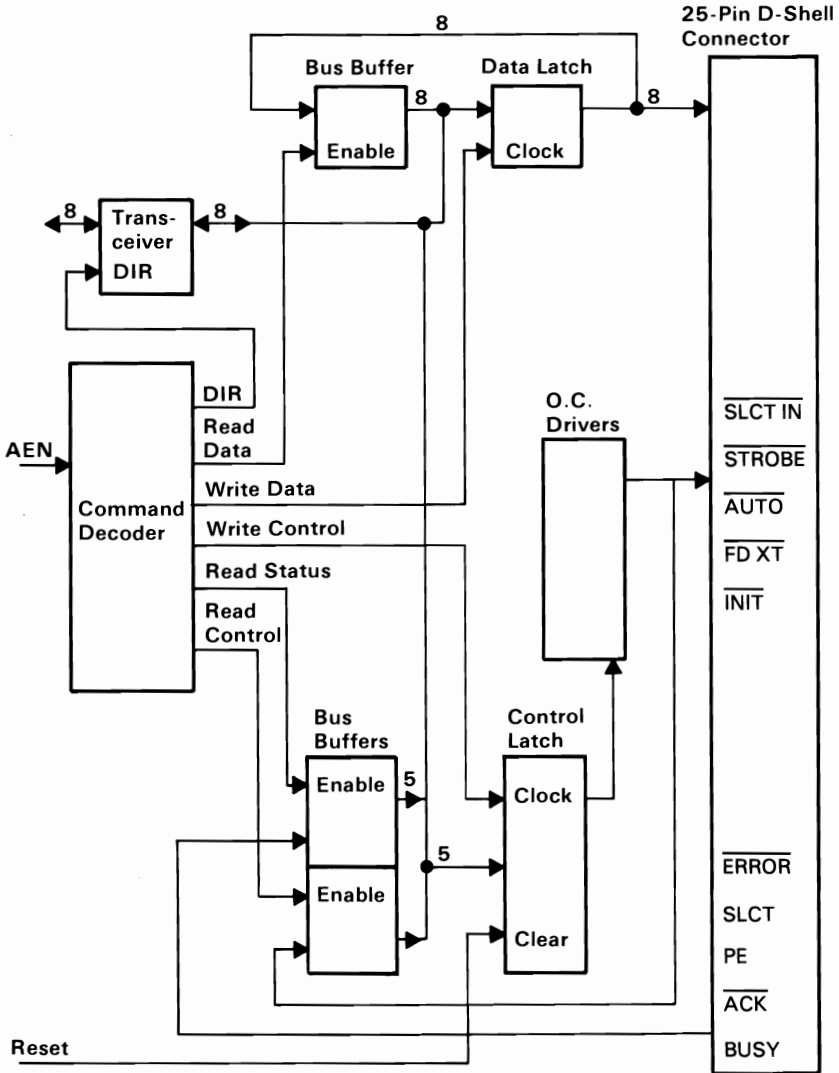


**Printer Adapter Block Diagram**

# Programming Considerations

The printer adapter portion of the IBM Monochrome Display and Printer Adapter responds to five I/O instructions: two output and three input. The output instructions transfer data into 2 latches whose outputs are presented on pins of a 25-pin D-shell connector.

Two of the three input instructions allow the system unit's microprocessor to read back the contents of the two latches. The third allows the system unit's microprocessor to read the real-time status from a group of pins on the connector.

A description of each instruction follows.

| IBM Monochrome Display & Printer Adapter | | | |
|---|---|---|---|
| Output to address hex 3BC | | | |
| Bit 7 | Bit 6 | Bit 5 | Bit 4 |
| Pin 9 | Pin 8 | Pin 7 | Pin 6 |

The instruction captures data from the data bus and is present on the respective pins. Each of these pins is capable of sourcing 2.6 mA and sinking 24 mA.

It is essential that the external device does not try to pull these lines to ground.

| IBM Monochrome Display & Printer Adpater | |
|---|---|
| Output to address hex 3BE | |
| | Bit 4 |
| | IRQ Enable |

This instruction causes the latch to capture the five least significant bits of the data bus. The four least significant bits present their outputs, or inverted versions of their outputs, to the

respective pins as shown in the previous figure. If bit 4 is written as a 1, the card will interrupt the system unit's microprocessor on the condition that pin 10 changes from high to low.

These pins are driven by open-collector drivers pulled to +5 Vdc through 4.7 kΩ resistors. They can each sink approximately 7 mA and maintain 0.8 volts down-level.

| IBM Monochrome Display & Printer Adapter |
| --- |
| Input from address hex 3BC |

This instruction presents the system unit's microprocessor with data present on the pins associated with the output to hex 3BC. This should normally reflect the exact value that was last written to hex 3BC. If an external device should be driving data on these pins at the time of an input (in violation of usage ground rules), this data will be ORed with the latch contents.

| IBM Monochrome Display & Printer Adapter |
| --- |
| Input from address hex 3BD |

This instruction presents the real-time status to the system unit's microprocessor from the pins as follows.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Pin 11 | Pin 10 | Pin 12 | Pin 13 | Pin 15 | — | — | — |

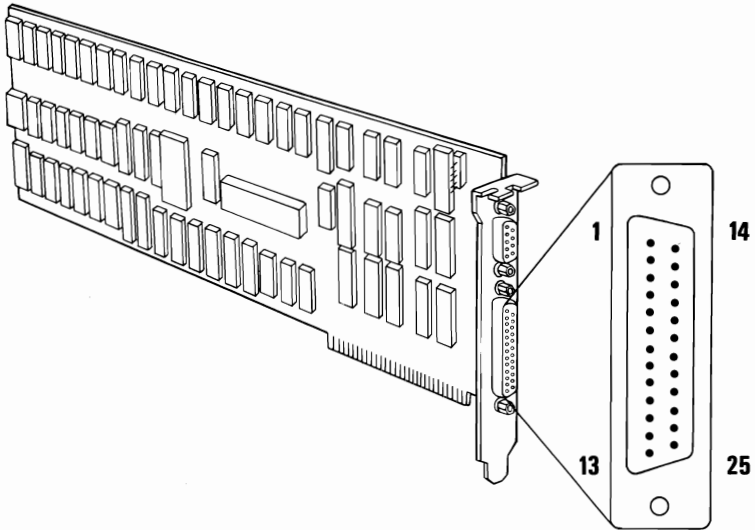| IBM Monochrome Display & Printer Adapter |
| --- |
| Input from address hex 3BE |

This instruction causes the data present on pins 1, 14, 16, 17, and the IRQ bit to be read by the system unit's microprocessor. In the absence of external drive applied to these pins, data read by the system unit's microprocessor will match data last written to hex 3BE in the same bit positions. Notice that data bits 0–2 are not included. If external drivers are dotted to these pins, that data will be ORed with data applied to the pins by the hex 3BE latch.
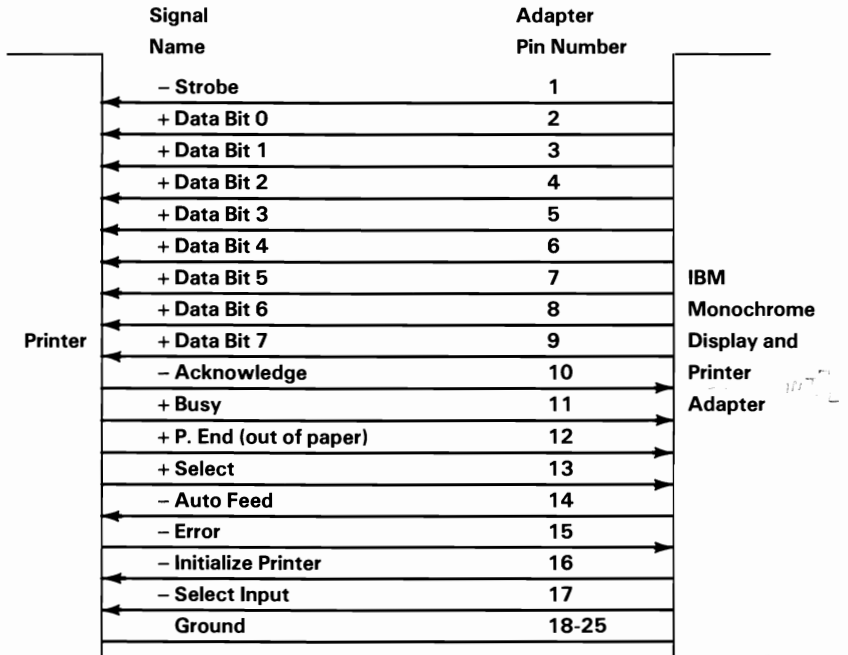
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|-------|-------|-------|-------|-------|-------|-------|-------|
|       |       |       | IRQ Enable | $\overline{\text{Pin 17}}$ | Pin 16 | $\overline{\text{Pin 14}}$ | $\overline{\text{Pin 1}}$ |
|       |       |       | Por = 0 | Por = 1 | Por = 0 | Por = 1 | Por = 1 |

These pins assume the states shown after a reset from the system unit's microprocessor.
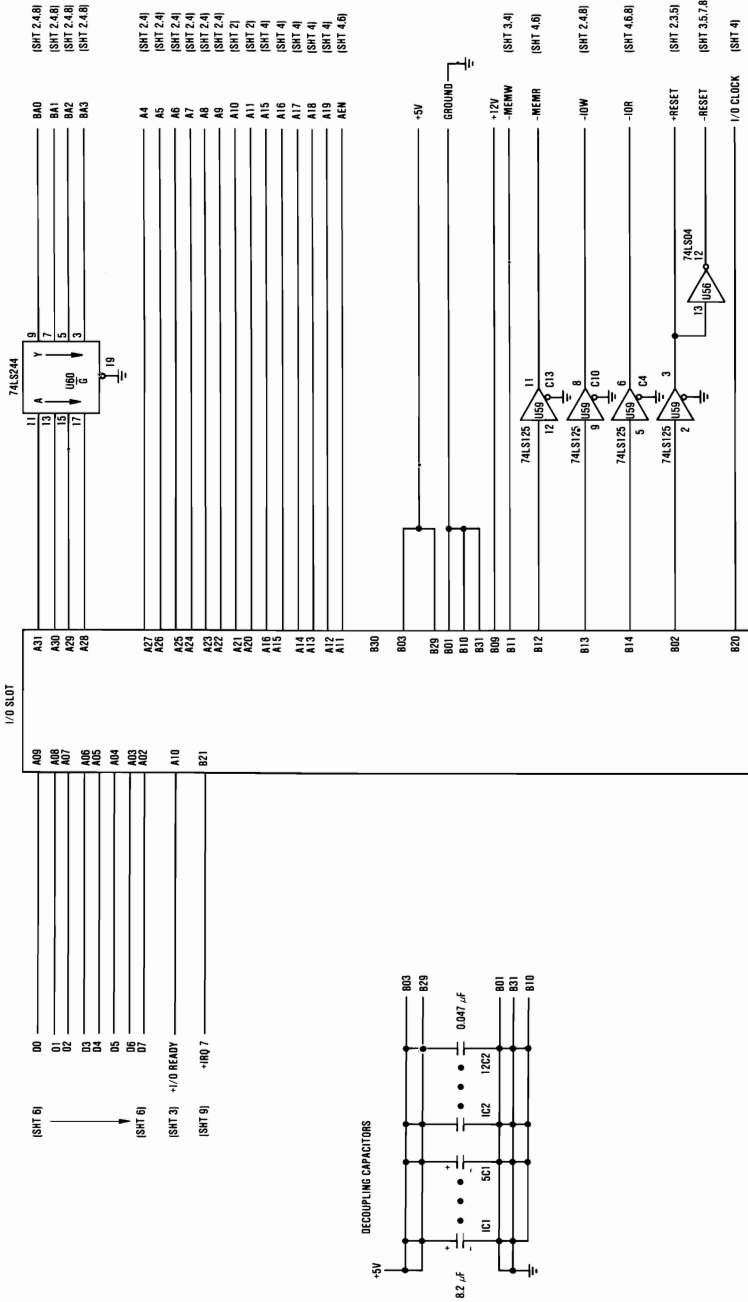
**16 Monochrome Adapter**

# Specifications



| At Standard TTL Levels | | |
|---|---|---|
| **Signal Name** | **Adapter Pin Number** | |
| − Strobe | 1 | |
| + Data Bit 0 | 2 | |
| + Data Bit 1 | 3 | |
| + Data Bit 2 | 4 | |
| + Data Bit 3 | 5 | |
| + Data Bit 4 | 6 | |
| + Data Bit 5 | 7 | IBM |
| + Data Bit 6 | 8 | Monochrome |
| + Data Bit 7 | 9 | Display and |
| − Acknowledge | 10 | Printer |
| + Busy | 11 | Adapter |
| + P. End (out of paper) | 12 | |
| + Select | 13 | |
| − Auto Feed | 14 | |
| − Error | 15 | |
| − Initialize Printer | 16 | |
| − Select Input | 17 | |
| Ground | 18-25 | |

Printer

**Connector Specifications**

# Logic Diagrams



Monochrome Display Adapter (Sheet 1 of 10)
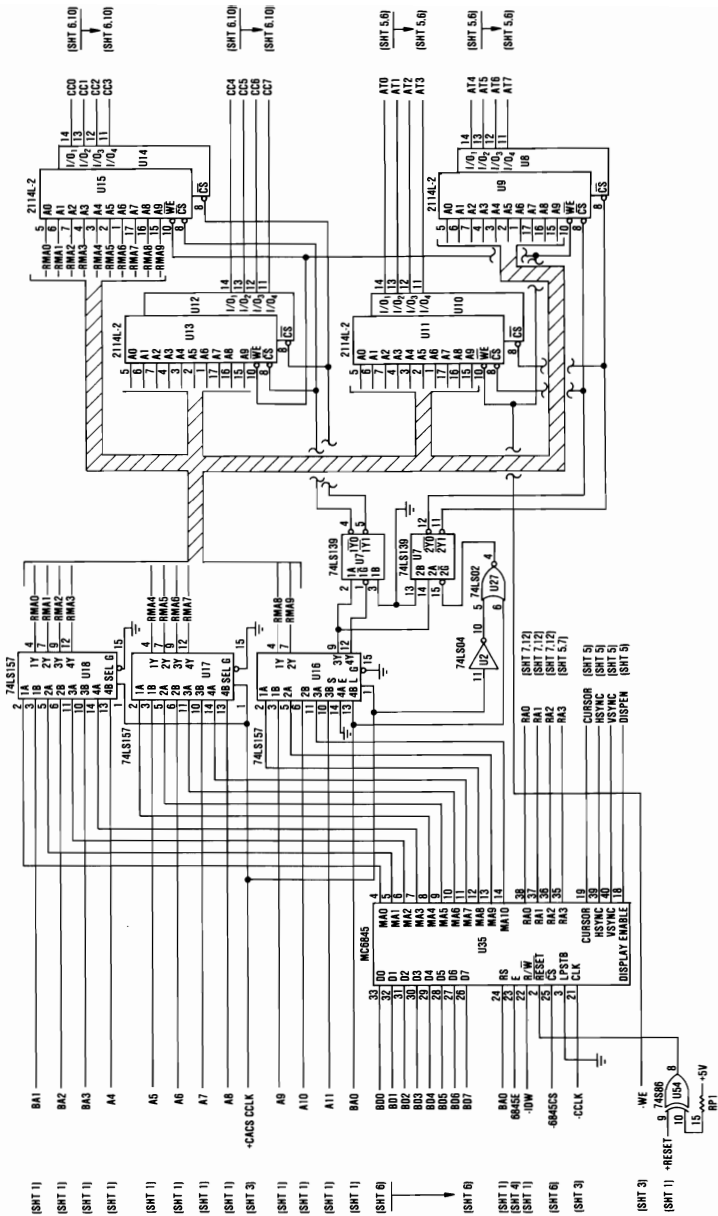
Monochrome Display Adapter (Sheet 2 of 10)

20  Monochrome Adapter
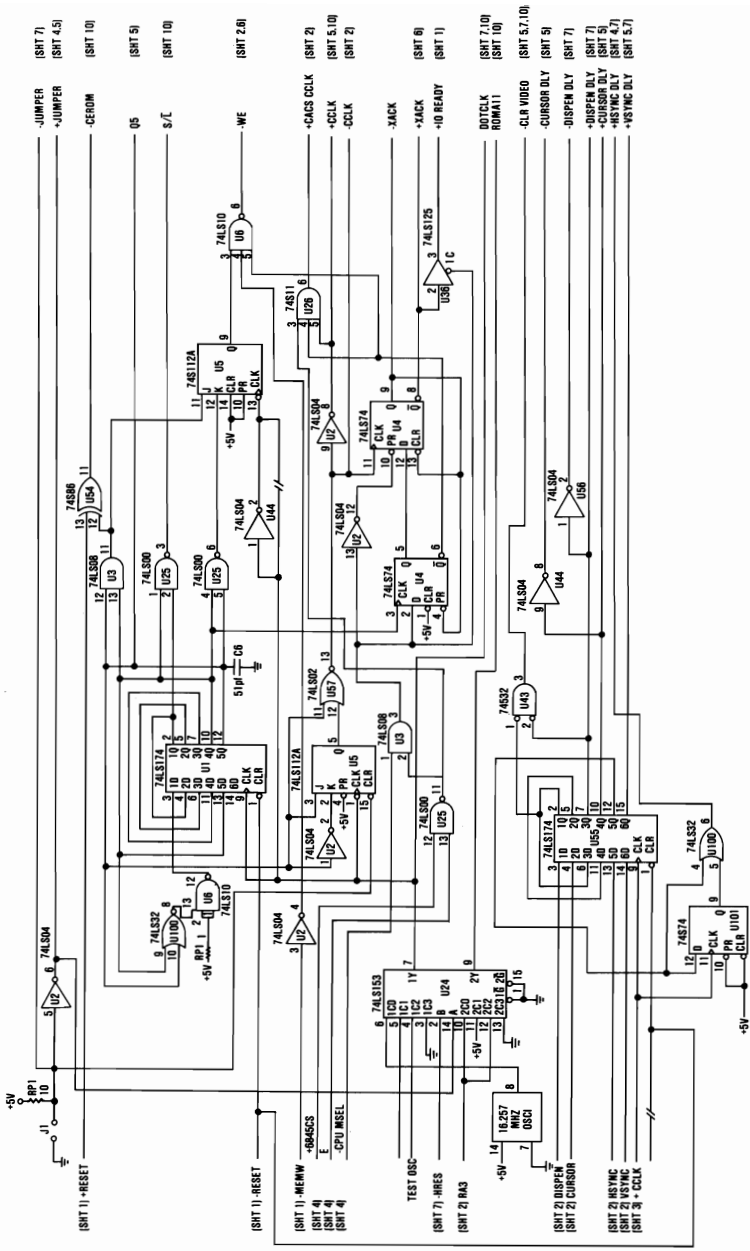
**Monochrome Display Adapter (Sheet 3 of 10)**
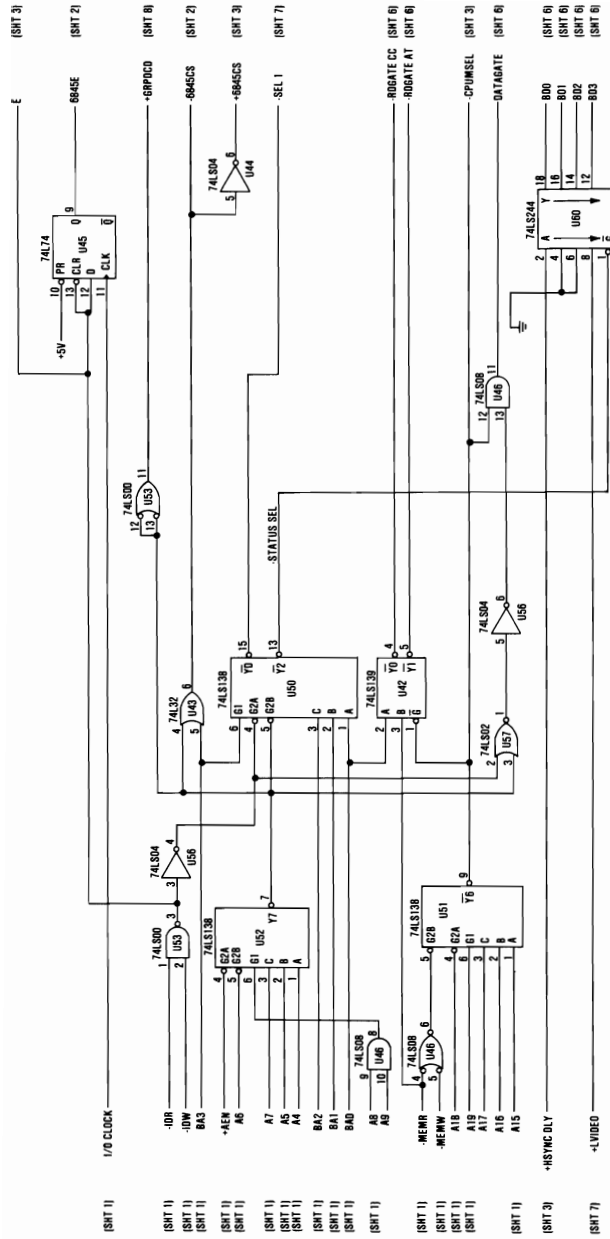
**Monochrome Display Adapter (Sheet 4 of 10)**
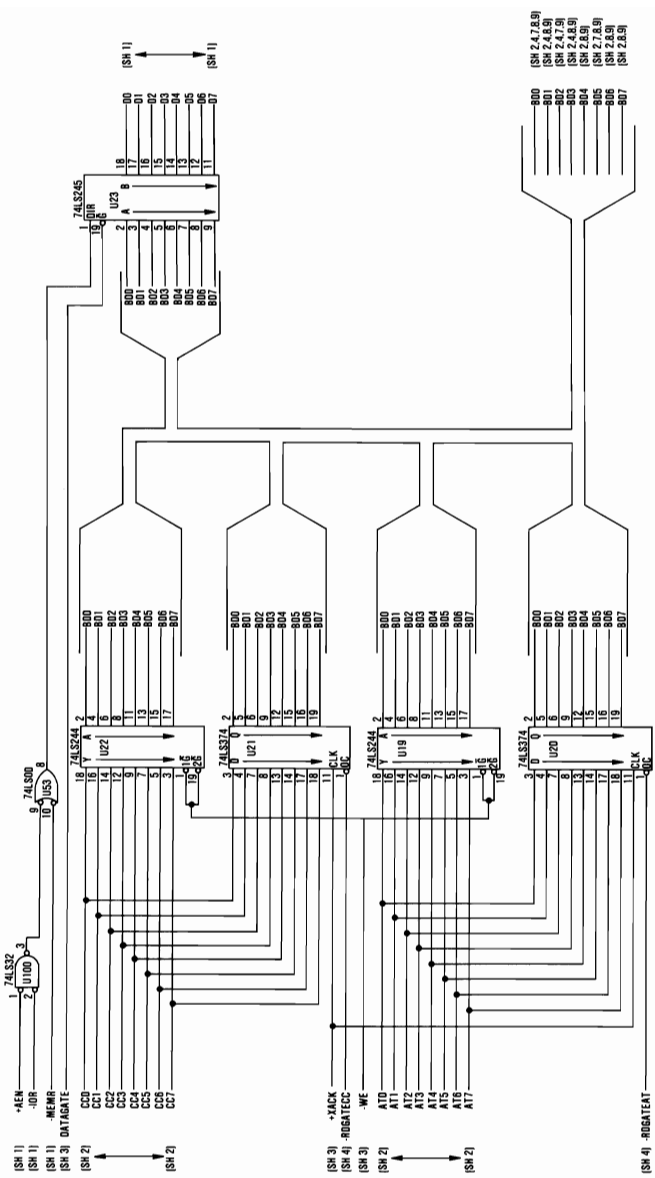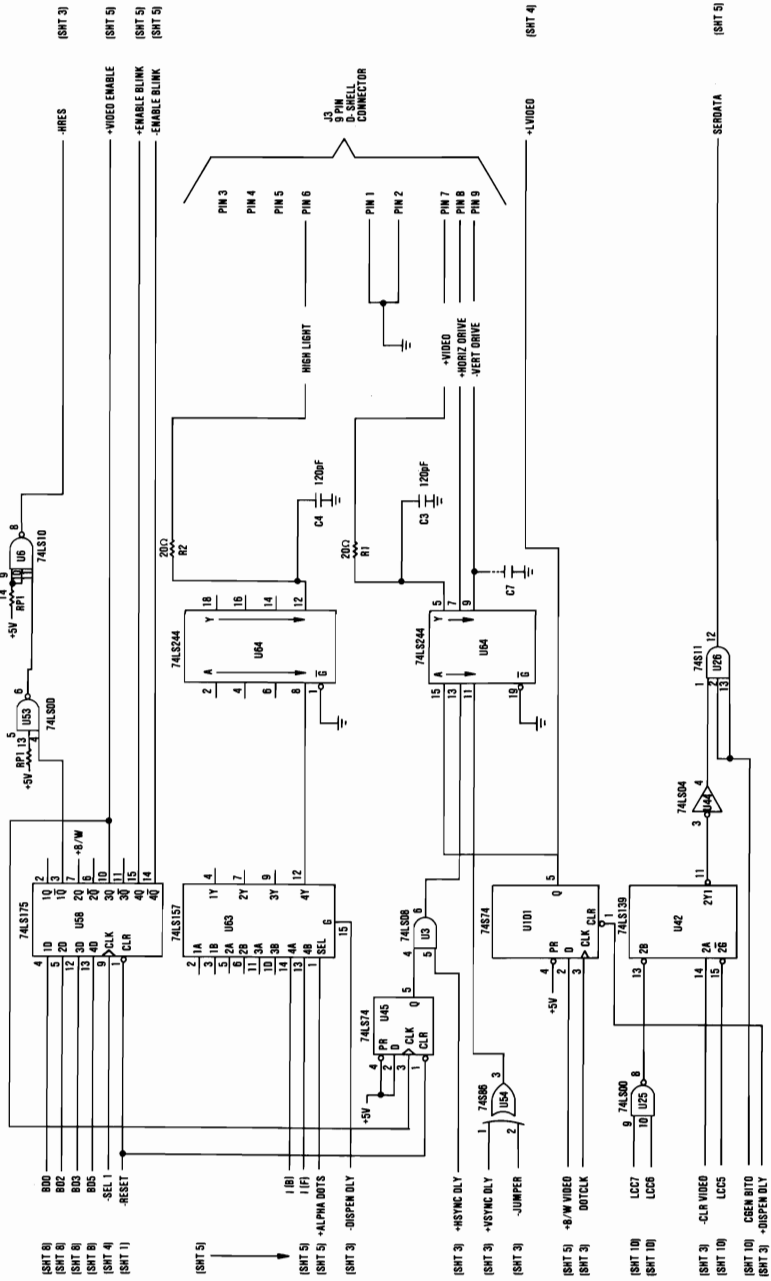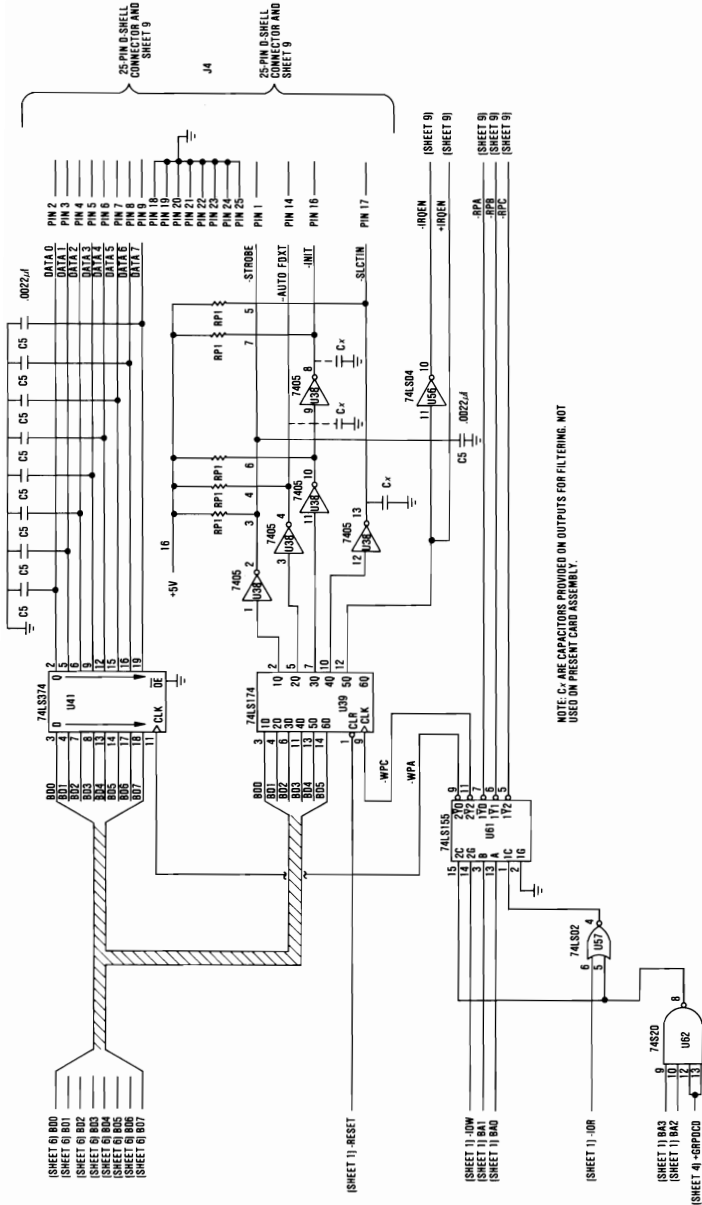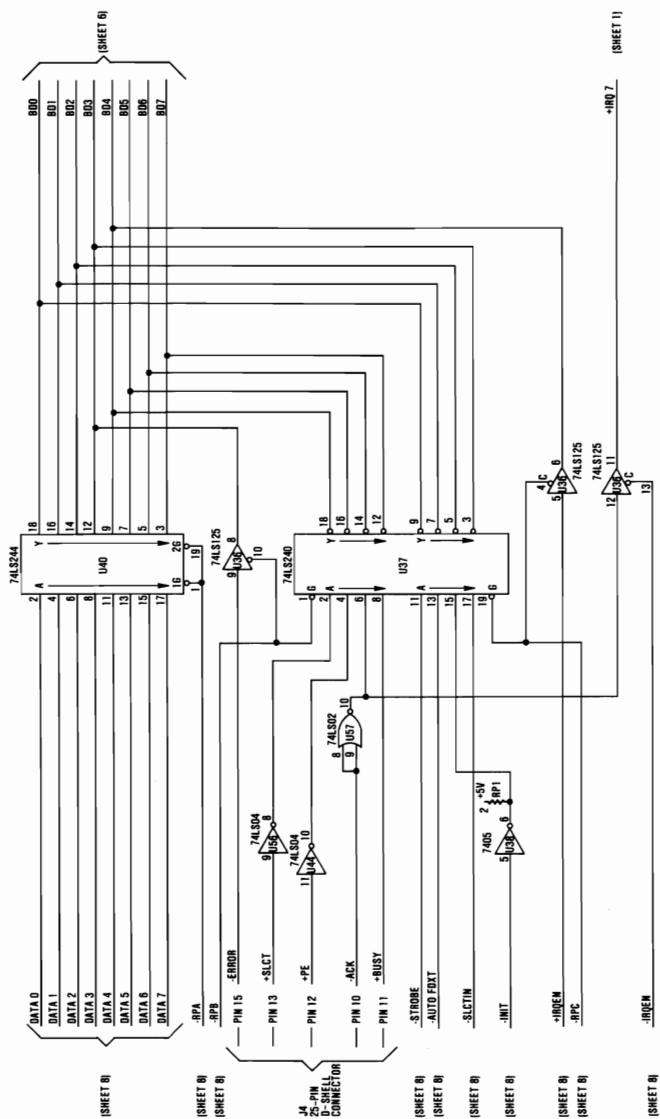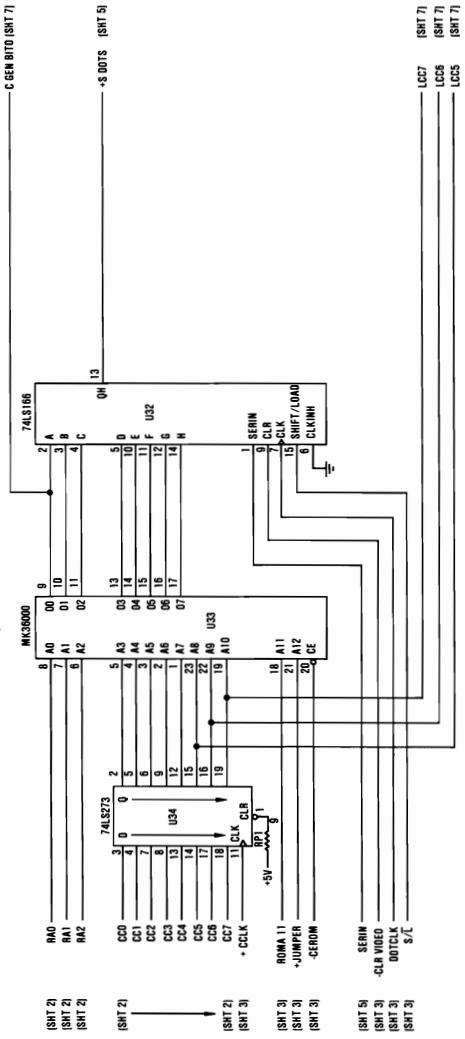
22 **Monochrome Adapter**
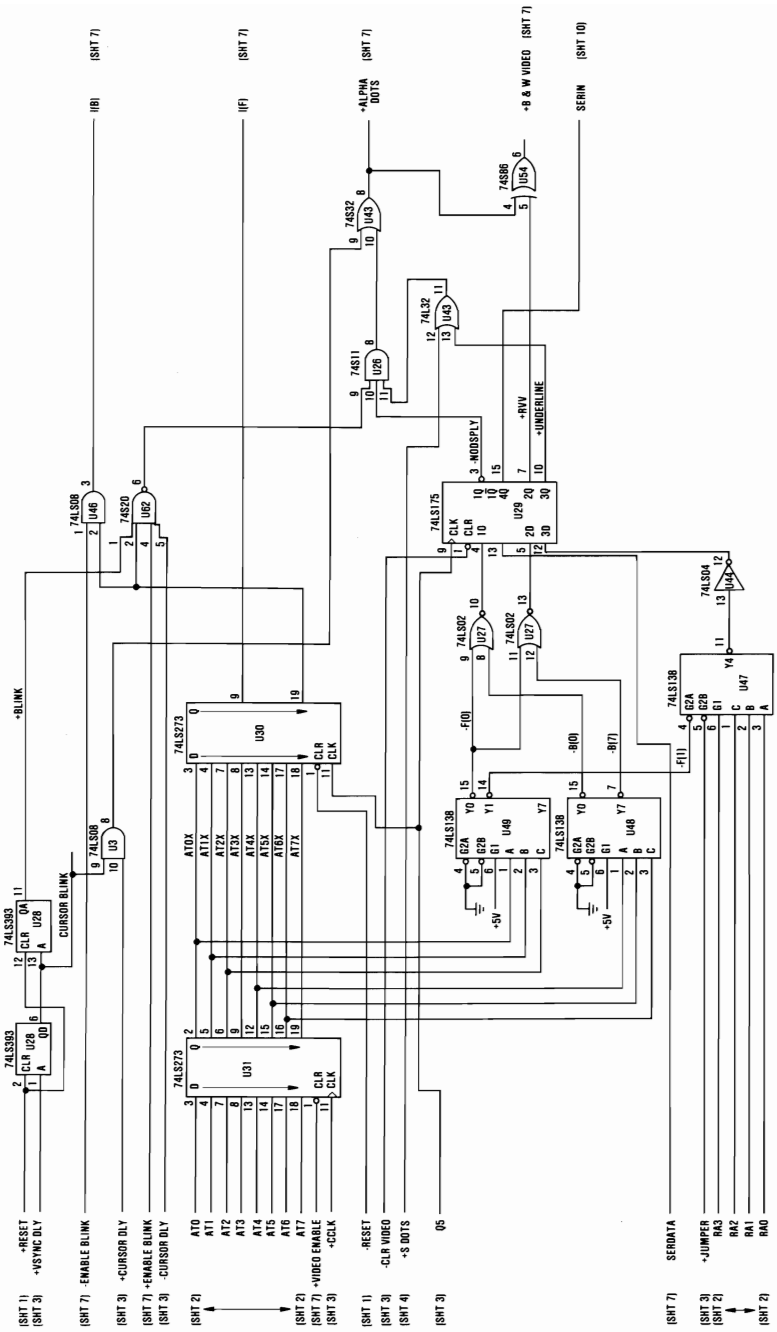
**Monochrome Display Adapter (Sheet 5 of 10)**

**Monochrome Display Adapter (Sheet 6 of 10)**

Monochrome Display Adapter (Sheet 7 of 10)

**Monochrome Adapter  25**

Monochrome Display Adapter (Sheet 8 of 10)

NOTE: Cx ARE CAPACITORS PROVIDED ON OUTPUTS FOR FILTERING. NOT USED ON PRESENT CARD ASSEMBLY.

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Monochrome Display Adapter (Sheet 9 of 10)

Monochrome Display Adapter (Sheet 10 of 10)

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