

M68SXD155(D2)

SEPTEMBER 1981

EXORterm 155  
DISPLAY CONSOLE  
USER'S GUIDE

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## **SAFETY SUMMARY**

### **SAFETY DEPENDS ON YOU**

*The following general safety precautions must be observed during all phases of operation, service, and repair of this equipment. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment. Motorola Inc. assumes no liability for the customer's failure to comply with these requirements. The safety precautions listed below represent warnings of certain dangers of which we are aware. You, as the user of the product, should follow these warnings and all other safety precautions necessary for the safe operation of the equipment in your operating environment.*

#### **GROUND THE INSTRUMENT.**

To minimize shock hazard, the equipment chassis and enclosure must be connected to an electrical ground. The equipment is supplied with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter, with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

#### **DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.**

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

#### **KEEP AWAY FROM LIVE CIRCUITS.**

Operating personnel must not remove equipment covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

#### **DO NOT SERVICE OR ADJUST ALONE.**

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

#### **USE CAUTION WHEN EXPOSING OR HANDLING THE CRT.**

Breakage of the Cathode-Ray Tube (CRT) causes a high-velocity scattering of glass fragments (implosion). To prevent CRT implosion, avoid rough handling or jarring of the equipment. Handling of the CRT should be done only by qualified maintenance personnel using approved safety mask and gloves.

#### **DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT.**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of the equipment. Contact Motorola Microsystems Warranty and Repair for service and repair to ensure that safety features are maintained.

#### **DANGEROUS PROCEDURE WARNINGS.**

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed. You should also employ all other safety precautions which you deem necessary for the operation of the equipment in your operating environment.

#### **WARNING**

**Dangerous voltages, capable of causing death, are present in this equipment. Use extreme caution when handling, testing, and adjusting.**

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## CHAPTER 1

### GENERAL INFORMATION

#### 1.1 INTRODUCTION

The EXORterm 155 Display Console is a CRT-based terminal designed for use with the M6800/M6809 EXORciser and M68000 EXORmacs Development Systems. In its role as a display console, EXORterm 155 (hereinafter referred to as the terminal) facilitates the exchange of data between the user and the system by use of a high-quality video interface in combination with keyboard entry and a serial communications link.

This terminal uses the M6800 family of MOS/LSI devices. The internal terminal functions are provided by ROM-based MC6800 instructions. A shared memory utilizing Phase 1 and 2 of the clock is employed as the interface between the M6800 system and the video monitor control portion.

Two communications interfaces are provided: a 20/60 mA current loop interface and an RS-232C serial interface.

An extended communications ROM option is available to provide interface with a 103- or 202-type MODEM for remote terminal operation. This not only provides the necessary handshaking protocol, but features a display of the status of the various MODEM signals as an aid in debugging a new installation.

This manual provides general information, installation, and operating instructions for the 115V, 60 Hz or the 220V, 50 Hz terminal. The terminal is illustrated in Figure 1-1. Appendix A provides a glossary which defines the various terms and acronyms used throughout this manual.

#### 1.2 FEATURES

The features of the terminal are divided into three categories: operational, hardware, and software.

##### 1.2.1 Operational Features

The operational features include:

- Modular design concept based on the MC6800 microprocessor unit (MPU) that readily permits additional functions to be incorporated by way of optional hardware and/or software.
- Multiple display mode capability
  - Scroll mode
  - Page/edit/protect modes

- Remote entry to either internal or external device
  - Serial asynchronous communications interface
  - Keyboard entry with function keys to invoke functions unique to the development system



1-80-2353

FIGURE 1-1. EXORterm 155 Display Console

- . All commands are assigned a unique 8-bit value capable of being represented by an escape sequence to facilitate 7-bit transmission.
- . Normally transparent terminal commands can be displayed without execution to aid in program debugging and fault isolation.

### 1.2.2 Hardware Features

The hardware features include:

- . Video monitor with 12-inch diagonal display screen capable of displaying a maximum of 1920 characters, organized into 24 lines with 80 characters per line.
- . Character generator capable of producing a set of 128 characters within a 7 x 9 dot matrix: 96 upper and lower case ASCII characters, 24 lower case Greek characters, two upper case Greek characters (Omega and Sigma), and six special characters.
- . Shared memory between the video control and microprocessor system.
- . Display controls for brightness and full screen video inversion.
- . Operator switches that permit field attribute codes (FAC's) and normally transparent terminal commands to be displayed.
- . Switch selectable asynchronous serial data interfaces compatible with both EIA RS-232C and 20/60 mA current loops.
- . Switch selectable transmission word length of 7 or 8 bits.
- . Switch selectable baud rates of 110, 150, 300, 600, 1200, 1800, 2400, 4800, and 9600.
- . Switch selectable communication modes: half/full duplex, even/odd/no parity, and one or two stop bits.
- . Switch selection of optional modem controls (103 and 202).
- . Blinking inverted video cursor.
- . Audible alarm.

### 1.2.3 Software Features

The software features include:

- . Embedded FAC's for controlling blink, intensity (half-bright), video inversion, underlining, and field protection.
- . Incremental and absolute cursor positioning.
- . Display control software process module used to position the cursor, execute generic display attribute commands, control scrolling of the display area, and execute screen splitting commands.

- Keyboard control software process module used to accept encoded characters from the keyboard and queue the key value for further processing.
- Communication control software process module used to accept data for transmission and to queue input data from the communications link for the display control software process module.
- Terminal control software process module used to read the control switches and to queue commands for the display control and communication control software process modules.
- Monitor control software process modules used to execute monitor operator calls (MOC's), to facilitate queue manipulations, and to control execution of all other software process modules on a priority basis.
- CRT editor control software process module used to simplify both the initial text and source program entry, as well as subsequent program modification.

### 1.3 SPECIFICATIONS

The specifications for the terminal are identified in Table 1-1.

TABLE 1-1. EXORterm 155 Specifications

| CHARACTERISTICS                      | SPECIFICATIONS  |
|--------------------------------------|---|
| Power requirements                   | 115 Vac, 60 Hz @ 4A<br>220 Vac, 50 Hz @ 2A  |
| Word size                            |   |
| Data                                 | 8 bits  |
| Address                              | 16 bits   |
| Instructions                         | 8, 16, or 24 bits   |
| Addressing modes                     | Seven addressing modes: direct, relative, immediate, indexed, extended, implied, and accumulator.                         |
| Memory requirements used by terminal |   |
| ROM                                  | 2K bytes (executive)<br>4K bytes (display/communications)<br>2K bytes (CRT editor control)<br>2K bytes (extended display) |
| RAM                                  | 2K bytes (display)<br>1K bytes (scratchpad)   |



TABLE 1-1. EXORterm 155 Specifications cont'd)

| CHARACTERISTICS   | SPECIFICATIONS   |
|---|--|
| Current loop interface signals                                | 20 to 60 mA  |
| RS-232C interface signals                                     |  |
| Input signals   | EIA RS-232C compatible serial data/control input lines ( <u>+30</u> Vdc signal range)                  |
| Output signals  | EIA RS-232C compatible serial data/control output lines ( <u>+10</u> mA current limited)               |
| Keyboard assembly   | Standard TTY keys, plus control keys and 12 function keys  |
| Physical characteristics                                      |  |
| Width x height x depth  | Terminal: 18.54 in. x 12.13 in. x 20.29 in.<br>Keyboard: 18.54 in x 3.50 in. x 8.54 in.                |
| Weight  | Terminal: 61 lbs.<br>Keyboard: 6.5 lbs.  |
| Input/output connectors                                       |  |
| Current loop (6 pin)<br>RS-232C (25 pin)<br>Keyboard (20 pin) | AMP 1-350241-9 with pins 350037-1 or equiv.<br>CINCH DB-25P or equivalent<br>AMP 88107-1 or equivalent |
| Cable connector kit   | Includes two EIA 25-pin connectors and one 6-pin current loop connector                                |

#### 1.4 GENERAL INFORMATION

The terminal is an M6800 based system using predominantly LSI components of the M6800 family. It provides control of the display attributes, communication facility, terminal switch/indicator control, and keyboard inputs. Micro-executive firmware, in conjunction with control and application task firmware, coordinates the functions of the terminal in its development system oriented activity. The terminal consists of a Motorola M3000 video monitor for display, a CRT controller board containing all of the necessary control electronics and firmware operating routines, a CRT configuration board providing the means to manually select basic operating criteria, a chassis housing with power supply, a keyboard assembly for data entry, and the necessary resident executive firmware to control the display and communications interface. The following paragraphs provide a general description of each major assembly within the terminal. Figure 1-2 provides a block diagram of the terminal. Figure 1-3 shows the memory map of the terminal.

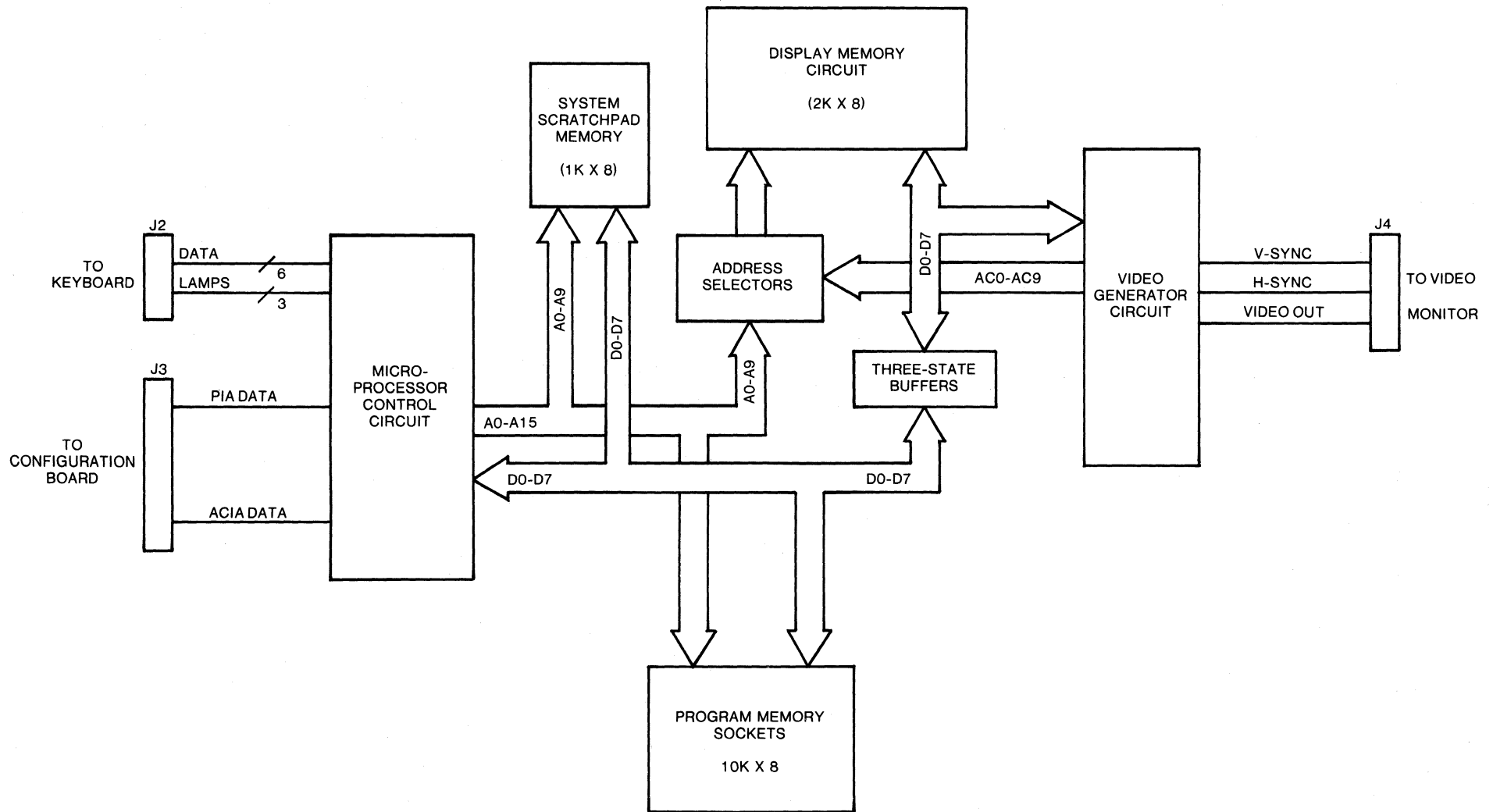


FIGURE 1-2. EXORterm 155 Block Diagram

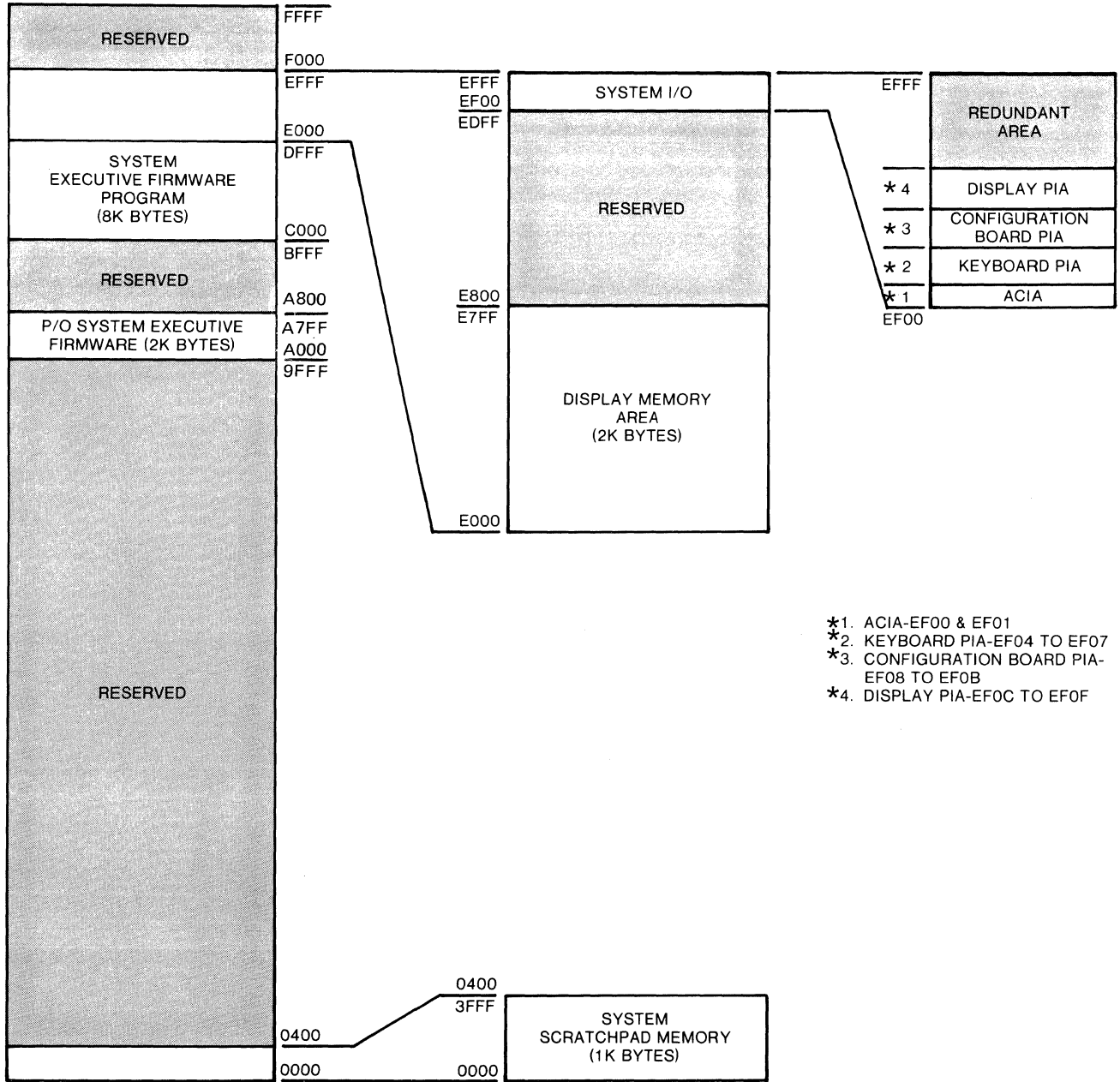


FIGURE 1-3. EXORterm 155 Memory Map

### 1.4.1 Video Monitor

The monitor is a fully transistorized (except CRT), self-contained display unit with a 12-inch diagonal CRT. This monitor has a video response range of 10 Hz to 22 MHz (within -3dB), thus enabling it to display up to 80 characters per line within a 9 x 11 dot matrix (characters use only a 7 x 9 dot matrix but are shifted for certain lower case characters (g, j, p, q, y) to produce descenders below the character baseline). Data displayed by the monitor is controlled by the CRT controller board and display control software process module through separate vertical/ horizontal sync and video inputs to the monitor.

The CRT used is a magnetic deflection type with integral implosion protection. The display screen (field) is coated with P4 phosphor (white) and is covered with a plastic anti-glare shield. An operating voltage of +70 Vdc is supplied by the regulated power supply which incorporates a universal power transformer, thus permitting the supply to operate from either 115 or 220 Vac, 50/60 Hz.

In addition to the power supply, two other printed circuit boards are used in the monitor: a vertical/video control board and a horizontal control board. Circuitry on these boards consists of two stages for video amplification, five stages for vertical sync and deflection processing, and five stages for horizontal sync and deflection processing. Dynamic focusing is also incorporated in the monitor. Except for brightness, which is located on the front panel, all standard operating and adjustment controls are located on these circuit boards.

### 1.4.2 CRT Controller Board

The CRT controller board is a single, 13-1/2 x 14 inch printed circuit board located in the base of the chassis/housing assembly. It incorporates the circuitry needed to control all functions of the terminal. The circuits contained on this board are separated into five functional groups. The function of each group is briefly described in the following paragraphs.

**1.4.2.1 Microprocessor Control Circuit.** The microprocessor control circuit contains the MC6800 MPU, three MC6821 peripheral interface adapters (PIA's), one MC6850 asynchronous communications interface adapter (ACIA), 1K byte of static RAM memory, and the necessary clock and control circuits needed to operate the MPU. The MPU executes internally stored firmware programs to control the terminal functions. These programs are more fully described in paragraph 1.4.6.

The PIA's provide parallel input/output data interface to the MPU data bus. In this system, one PIA is used to input data from the keyboard, another PIA is used to input switch position status from the CRT configuration board, and the third PIA is used to control cursor positioning on the display screen. All three of the PIA's are controlled by the resident software routines via the MPU.

The ACIA provides an asynchronous serial input/output data interface to the MPU data bus. Only one ACIA is used in this system, and it provides the means of communicating with the development system. The ACIA and associated interface circuitry is compatible with equipment having the EIA RS-232C interface or a 20/60 mA current loop.

1.4.2.2 Video Generator Circuit. The video generator circuit produces the characters displayed on the CRT screen, and controls the positioning of each character. Display characters are stored in the form of 8-bit (one-byte) words within the display memory circuit. The memory circuit is sequentially accessed by the video generator circuit to retrieve each display word. A character generator then converts each word into the proper dot pattern (within a 9 x 11 dot matrix) to produce the desired character on the screen.

In addition to generating the displayed character, the video generator circuit also produces the vertical and horizontal sync signals supplied to the monitor for positioning the characters on the screen. The sync signals and the sequentially accessed memory circuits are synchronized to display data at the proper location on the screen.

1.4.2.3 Display Memory Circuit. The display memory circuit consists of four 1K x 4 static memory devices, organized into 2048 8-bit bytes. This circuit is used to store data displayed on the screen, and is shared between the micro-processor control circuit and the video generator circuit. This shared memory technique permits the MPU to store data directly for display, while permitting the video generator circuit to control display refresh. This unburdens the MPU, permitting it to process more functions. To implement shared memory, address selectors and three-state buffers are also included within this circuit.

The data displayed within the 80 character positions of all 24 lines is a 7-bit ASCII word stored at an address within the 1920 byte positions reserved for display storage. All 7-bit characters are displayed within a 7 x 9 dot matrix on the display screen. Table 1-2 contains the 128 characters which the terminal is capable of displaying.

When used in conjunction with the keyboard assembly, the terminal can be operated in the local mode for testing both the keyboard and display operation. When operated in this mode, data cannot be exchanged between the terminal and the development system.

1.4.2.4 Program Memory Circuit. The program memory circuit contains the firmware programs used to control the terminal operation. It consists of eight 2K byte mask programmable ROM or EPROM devices. As a standard, the complete display control/executive program is contained within five 2K ROM's. These programs control all of the display and standard communications functions (see paragraph 1.4.6 for more detail). The remaining three 2K of firmware are reserved for optional programs.

### 1.4.3 CRT Configuration Board

The CRT configuration board is located on the upper portion of the back panel, and contains the switches used for manual operation selections. The connectors used to interconnect the terminal with a development system are also located on this board. In addition, this board contains the 20/60 mA current loop interface circuitry, the RS-232C interface circuitry, the baud rate generator and selection circuitry, and the audio alarm.

TABLE 1-2. Display Codes and Characters

| ASCII CODE (HEX) | CHARACTER      | ASCII CODE (HEX) | CHARACTER | ASCII CODE (HEX) | CHARACTER | ASCII CODE (HEX) | CHARACTER |
|------------------|----------------|------------------|-----------|------------------|-----------|------------------|-----------|
| 00               | $\alpha$       | 20               | (blank)   | 40               | @         | 60               |           |
| 01               | $\beta$        | 21               | !         | 41               | A         | 61               | a         |
| 02               | $\gamma$       | 22               | "         | 42               | B         | 62               | b         |
| 03               | $\delta$       | 23               | #         | 43               | C         | 63               | c         |
| 04               | $\epsilon$     | 24               | \$        | 44               | D         | 64               | d         |
| 05               | $\zeta$        | 25               | %         | 45               | E         | 65               | e         |
| 06               | $\eta$         | 26               | &         | 46               | F         | 66               | f         |
| 07               | $\theta$       | 27               | '         | 47               | G         | 67               | g         |
| 08               | $\iota$        | 28               | (         | 48               | H         | 68               | h         |
| 09               | $\kappa$       | 29               | )         | 49               | I         | 69               | i         |
| 0A               | $\lambda$      | 2A               | *         | 4A               | J         | 6A               | j         |
| 0B               | $\mu$          | 2B               | +         | 4B               | K         | 6B               | k         |
| 0C               | $\nu$          | 2C               | ,         | 4C               | L         | 6C               | l         |
| 0D               | $\xi$          | 2D               | -         | 4D               | M         | 6D               | m         |
| 0E               | $\omicron$     | 2E               | .         | 4E               | N         | 6E               | n         |
| 0F               | $\pi$          | 2F               | /         | 4F               | O         | 6F               | o         |
| 10               | $\rho$         | 30               | 0         | 50               | P         | 70               | p         |
| 11               | $\sigma$       | 31               | 1         | 51               | Q         | 71               | q         |
| 12               | $\tau$         | 32               | 2         | 52               | R         | 72               | r         |
| 13               | $\nu$          | 33               | 3         | 53               | S         | 73               | s         |
| 14               | $\phi$         | 34               | 4         | 54               | T         | 74               | t         |
| 15               | $\chi$         | 35               | 5         | 55               | U         | 75               | u         |
| 16               | $\psi$         | 36               | 6         | 56               | V         | 76               | v         |
| 17               | $\omega$       | 37               | 7         | 57               | W         | 77               | w         |
| 18               | $\Omega$       | 38               | 8         | 58               | X         | 78               | x         |
| 19               | $\sqrt{\quad}$ | 39               | 9         | 59               | Y         | 79               | y         |
| 1A               | ¢              | 3A               | :         | 5A               | Z         | 7A               | z         |
| 1B               |                | 3B               | ;         | 5B               | [         | 7B               | {         |
| 1C               | ¬              | 3C               | <         | 5C               | \         | 7C               |           |
| 1D               | ÷              | 3D               | =         | 5D               | ]         | 7D               | }         |
| 1E               | $\Sigma$       | 3E               | >         | 5E               | ˙         | 7E               | ˘         |
| 1F               | $\cong$        | 3F               | ?         | 5F               | -         | 7F               | ≡         |

#### 1.4.4 Chassis/Housing and Power Supply

The chassis/housing consists of a plastic base, bezel, and back panel, with a metal shroud and bottom plate. The base mounts the CRT controller board, video monitor, power supply, bezel, and back panel. The metal bottom plate is attached to the bottom of the base with screws. The metal shroud slips over the assembly, and attaches on the sides near the lower edge of the base.

The power supply is mounted at the rear of the assembly, with a cooling fan mounted on the back panel. The power supply provides +5 Vdc, +12 Vdc, and -12 Vdc power for the CRT controller board. The +5 Vdc is used for the logic circuits, and the +12 Vdc and -12 Vdc are used for the interface circuits. The +5 Vdc power supply voltage is also provided to the keyboard assembly.

#### 1.4.5 Keyboard Assembly

The keyboard assembly used with the terminal is electronic. The keys are solid-state memory action capacitive modules which are connected to an encoder within the assembly. The keyboard assembly is used to generate and control the display of alphanumeric data. Ninety-six displayable characters are provided.

In addition to the alphanumeric characters and symbols located on the keyboard, a number of keys are provided to promote the efficient use of the terminal (edit, cursor control, page mode, capital letters mode, etc.). To further enhance the efficiency of the terminal, 12 special function keys have been encoded to invoke functions unique to various disk-based programs (CRT editor, COBOL compiler, etc.).

#### 1.4.6 Resident Executive Firmware

The resident executive firmware controls the operation of the terminal. Six process modules have been implemented in this firmware (see Figure 1-4).

The monitor control software process module controls execution priority of all other software process modules. This process module is also used to execute MOC's, which permit a software process module or an interrupt handler to request that a function be performed on its behalf by the monitor.

The terminal control software process module queues commands to the display control and communications control software process modules. This process module is also used to read the positions of the control switches located on the CRT configuration board.

The display control software process module accepts data and commands from external devices via the interface, and interprets or executes these inputs to affect the data displayed on the screen. This process module is used to position the cursor, execute generic display attribute commands (such as video, invert, blink, etc.), control scrolling of the display area, and execute screen splitting commands.

The communications control software process module controls the flow of serial data between the basic display unit and the host computer or other device. This software process module works in conjunction with the display control software process module.

The keyboard control software process module accepts encoded characters (normally generated by the optional keyboard), and passes the decoded results to the display control software process module for display.

The CRT editor control software process module controls the functions of the terminal that pertain to its use with the M68000 CRT editor. A description of the CRT editor is provided in Appendix B.

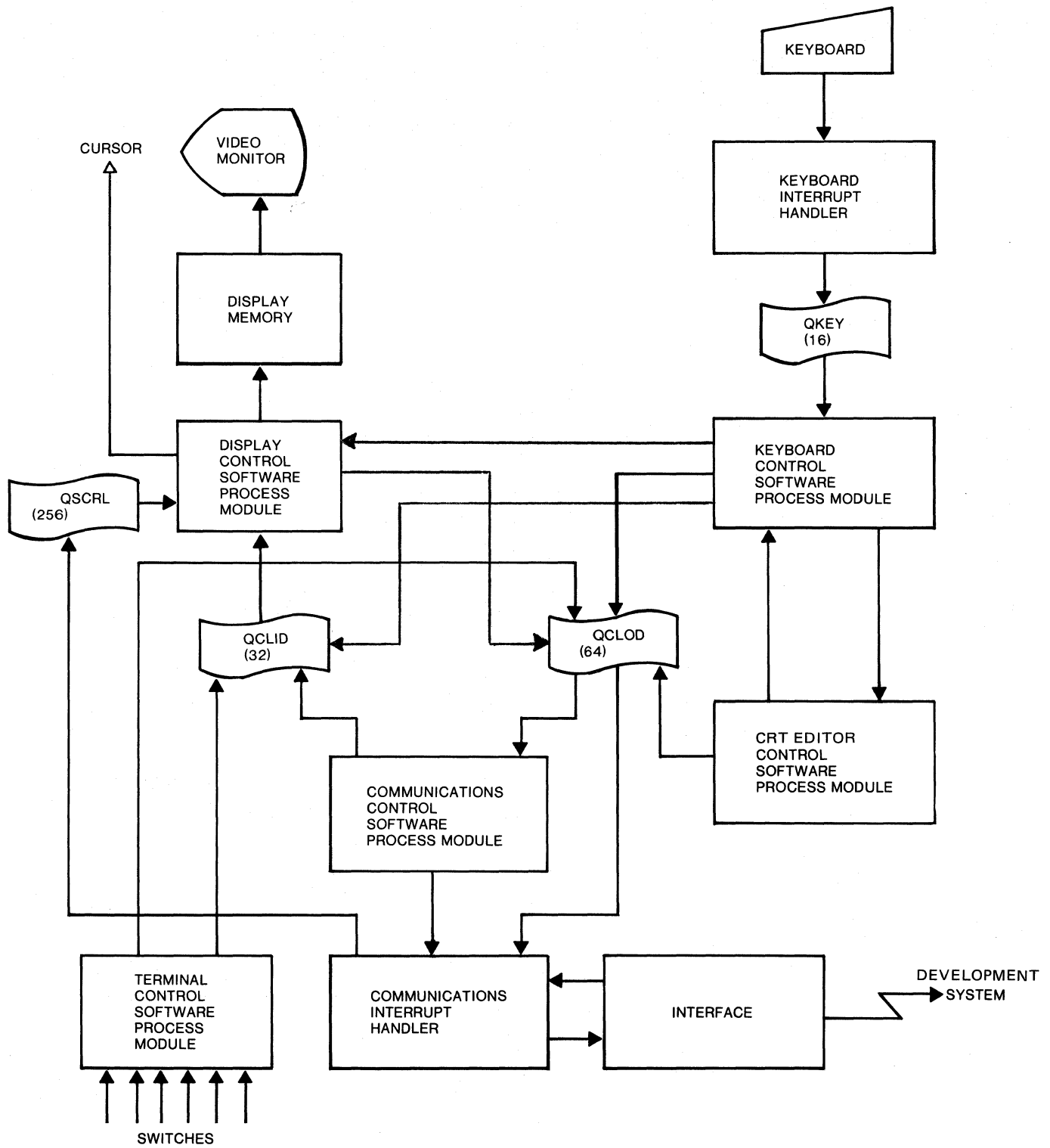


FIGURE 1-4. EXORterm 155 System Flow Chart



## CHAPTER 2

### INSTALLATION INSTRUCTIONS AND INTERCONNECTION CONSIDERATIONS

#### 2.1 INTRODUCTION

This chapter provides the unpacking, inspection, installation, and interconnection instructions for the terminal. It also discusses the interconnection signals.

#### 2.2 UNPACKING INSTRUCTIONS

##### NOTE

If the shipping carton is damaged upon receipt, request that carrier's agent be present during unpacking and inspection of the equipment.

Unpack the equipment. Refer to the packing list and verify that all items are present, including any options that may have been ordered. Save the packing material for storing and reshipping the equipment.

#### 2.3 INSPECTION

The equipment should be inspected upon receipt for broken, damaged, or missing parts, or any other physical or electrical damage.

#### 2.4 INSTALLATION INSTRUCTIONS

The terminal may be placed on any flat surface. Connect cable from host equipment to either the RS-232C or TTY connector on the rear panel.

#### 2.5 INTERCONNECTIONS

An internal connector is used for connecting the keyboard. The external connectors (current loop connector and RS-232C interface connector) are used to connect the development system or modem device to the terminal. The signals provided on these connectors are identified in Tables 2-1, 2-2, and 2-3.

TABLE 2-1. Keyboard Interface Signals (J2)

| PIN NUMBER | SIGNAL MNEMONICS              | SIGNAL NAME AND DESCRIPTION  |
|------------|-------------------------------|--|
| 1          | KB-D0                         | KEYBOARD data (bit 0) - One of 7 data lines used to output ASCII encoded characters from the keyboard.   |
| 2          | KB-D1                         | KEYBOARD data (bit 1) - Same as KB-D0 on J2-1.   |
| 3          | KB-D2                         | KEYBOARD data (bit 2) - Same as KB-D0 on J2-1.   |
| 4          | KB-D3                         | KEYBOARD data (bit 3) - Same as KB-D0 on J2-1.   |
| 5          | KB-D4                         | KEYBOARD data (bit 4) - Same as KB-D0 on J2-1.   |
| 6          | KB-D5                         | KEYBOARD data (bit 5) - Same as KB-D0 on J2-1.   |
| 7          | KB-D6                         | KEYBOARD data (bit 6) - Same as KB-D0 on J2-1.   |
| 8          | KB-D7                         | KEYBOARD data (bit 7) - The data line used to define whether the ASCII character is to be interpreted as a character (low) or control (high) word. |
| 9          | $\overline{\text{KBSTB}}$     | KEYBOARD STROBE - The low-going pulse generated by depressing any key on the keyboard, and used to initiate an interrupt request.                  |
| 10         | $\overline{\text{KBATT}}$     | KEYBOARD ATTACHED - A low level input signal used to indicate that the keyboard is electrically connected to the terminal.                         |
| 11         | $\overline{\text{ON LN DR}}$  | ON LINE DRIVER - A low level output signal used to illuminate the ON LINE key target light when in the on line mode.                               |
| 12         | $\overline{\text{AUT LF DR}}$ | AUTO LINE FEED DRIVER - A low level output signal used to illuminate the AUTO LF key target light when in the auto line feed mode.                 |
| 13-16      |                               | Not used.  |
| 17         | +5V                           | +5 Vdc - Supplied to keyboard for logic circuits.  |
| 18         |                               | Not used.  |
| 19,20      | GND                           | GROUND   |

TABLE 2-2. Current Loop (TTY) Interface Signals

| PIN NUMBER | SIGNAL MNEMONICS | SIGNAL NAME AND DESCRIPTION   |
|------------|------------------|---|
| 1          | -TRANS           | -TRANSMIT - This -12 Vdc line provides the signal return when using a current loop interface.                         |
| 2          |                  | Not used.   |
| 3          | +TRANS           | +TRANSMIT - This line transfers data to a teletypewriter or other current loop device.                                |
| 4          | GND              | GROUND - This line is connected to ground. This pin is also connected to pin 5 via a jumper connection in the cable.  |
| 5          | CLATTCHD         | CURRENT LOOP ATTACHED - This low level input signal indicates that a current loop device is attached to the terminal. |
| 6          | +RCV             | +RECEIVE - This line accepts the input from a teletypewriter terminal or other current loop device.                   |

TABLE 2-3. RS-232C Interface Signals

| PIN NUMBER | SIGNAL MNEMONICS | SIGNAL NAME AND DESCRIPTION   |
|------------|------------------|---|
| 1          |                  | Not used.   |
| 2          | TRANSMIT DATA    | TRANSMIT DATA - This line transfers data to an RS-232C compatible device.   |
| 3          | RECEIVE DATA     | RECEIVE DATA - This line accepts input data from an RS-232C compatible device.  |
| 4          | REQUEST TO SEND  | REQUEST TO SEND - This output line is used to request permission from the RS-232C device to begin sending data.             |
| 5          | CLEAR TO SEND    | CLEAR TO SEND - This line is a high level when the RS-232C device is ready to receive data.                                 |
| 6          | DATA SET READY   | DATA SET READY - This line is a high level when an RS-232C device is connected to the terminal and the device is operating. |
| 7          | SIGNAL GND       | SIGNAL GROUND - This line provides a common signal connection to the RS-232C device.  |
| 8          | CARRIER DETECT   | CARRIER DETECT - This line is a high level when the RS-232C device has detected the carrier signal.                         |

TABLE 2-3. RS-232C Interface Signals (cont'd)

| PIN NUMBER     | SIGNAL MNEMONICS          | SIGNAL NAME AND DESCRIPTION  |
|----------------|---------------------------|--|
| 9,10,<br>11,12 |                           | Not used.  |
| 13 to 19       |                           | Not used.  |
| 20             | DATA<br>TERMINAL<br>READY | DATA TERMINAL READY - This output line indicates to the RS-232C device that the terminal is ready. |
| 21 to 25       |                           | Not used.  |

## CHAPTER 3

### OPERATING INSTRUCTIONS

#### 3.1 INTRODUCTION

Information in this chapter is intended to familiarize the user with the location and function of the terminal controls. Directives to control the operation of the terminal, to display data, or to modify displayed data may be entered directly from the keyboard or via the communications interface. These directives are detailed in this chapter, along with procedures to test the terminal. Appendix C summarizes the directives.

#### 3.2 CONTROLS AND INDICATORS

There are various control knobs, switches, and lighted indicators that will aid the operator in controlling the terminal.

The front panel controls consist of the power on/off pushbutton/indicator and brightness control. These controls are shown in Figure 3-1.

The rear panel controls consist of three dip switch arrays (9 SPST), one momentary contact pushbutton switch, and a volume control. The three 9-switch, single-pole, single-throw dip arrays are located on the top left and center of the panel, and are used to manually establish various operating characteristics. All the remaining controls are located on the top right-hand side of the panel. The function of each control is described in Table 3-1. The rear panel controls are shown in Figure 3-2. Table 3-2 lists the ASCII characters and control characters supported by the terminal. The ASCII codes 00 through 1F are normally the control characters (NUL, CR, LF, etc.). However, via the rear-panel special character switch, these codes may be interpreted as special characters and displayed on the screen. Table 3-3 provides a list of the special characters. Figure 3-3 illustrates the keyboard assembly.

The following paragraphs provide a description of the commands that may be entered via the keyboard or communicated on the RS-232C communications interface. Appendix C provides a summary of all commands which may be communicated on the communications interface.

#### NOTE

Many of the characters and commands described in this chapter are applicable only to development systems working with special programs or when the terminal is used as an asynchronous editing terminal. For example, EXbug, MACSbug, and the macro assembler recognize only upper-case alphabetic characters, while the resident CRT editor recognizes upper- and lower-case alphabetic characters.

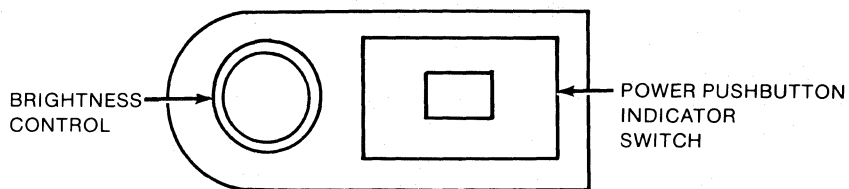
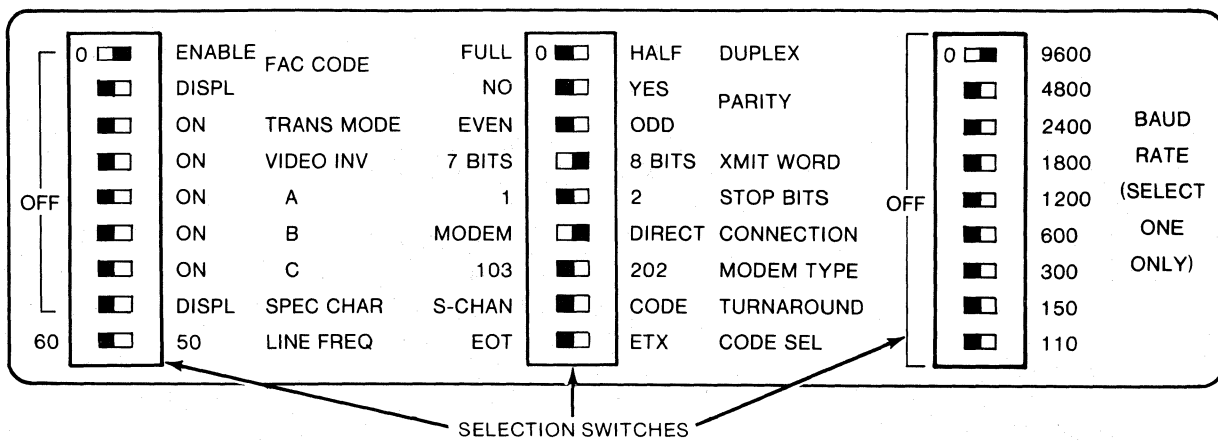


FIGURE 3-1. Front Panel Controls



NOTE: Switches are shown in the correct position for normal operation with EXORMacs or EXORciser II.

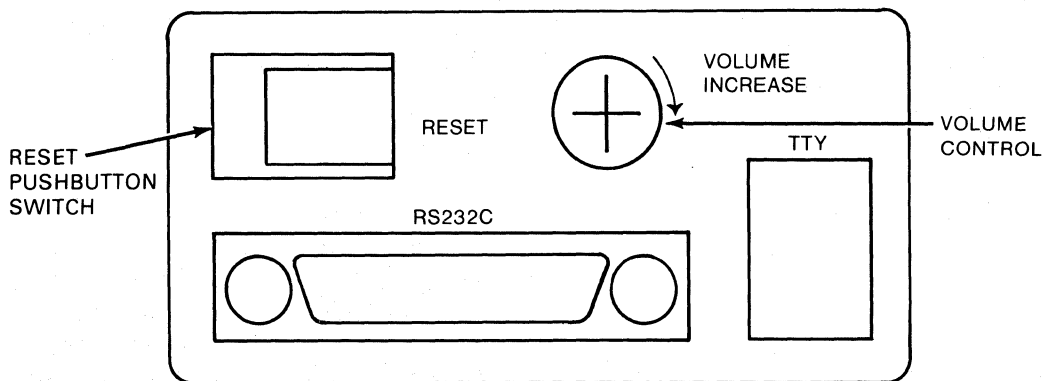


FIGURE 3-2. Rear Panel Controls

TABLE 3-1. Rear Panel Controls

| CONTROL    | FUNCTION   |
|------------|--|
| FAC CODE   | Embedded field attribute codes (FAC's) are used to control reverse video and intensity (half-bright) of data displayed on the screen (refer to paragraph 3.2.10). If the OFF/ENABLE switch is positioned to ENABLE, FAC's are permitted to perform their designated function. If the OFF/DISP switch is in the DISPL position, the FAC's are displayed. The OFF/ENABLE switch must be in the OFF position for normal operations. |
| TRANS MODE | The TRANS (transparent) MODE switch permits the user to display all characters received without recognition of commands. This mode is intended to aid in debugging programs. This switch must be OFF for normal operations.  |
| VIDEO INV  | The VIDEO INV (video invert) switch permits the user to select either a black background with white lettering (OFF) or a white background with black lettering (ON).   |
| A,B,C      | Not used.  |
| SPEC CHAR  | This switch, when in the DISPL position, permits all special characters to be displayed on the screen. The special characters are represented by the hexadecimal codes 00 through 1F, shown in Table 1-2. ASCII control commands that also fall within the range of 00 to 1F will not be executed.   |
| LINE FREQ  | This switch permits selection of a 50 Hz or 60 Hz display frequency (a screen refresh rate).   |
| DUPLEX     | This switch permits selection of a HALF or FULL duplex mode of operation. In FULL duplex, data will be displayed only if the computer or external device connected to the communication interface echoes back the data transmitted from a keyboard device. In HALF duplex, data is routed from the keyboard device to the display so that the user can see what is actually being transmitted on the communication interface.    |
| PARITY     | These switches permit the user to include a parity bit in the transmitted and received data stream. If PARITY is selected, then the user must select either EVEN or ODD parity.  |
| XMIT WORD  | This switch permits the user to select seven or eight data bits in the transmitted and received data streams.  |
| STOP BITS  | This switch permits the use of one or two stop bits in the transmitted and received data streams.  |

TABLE 3-1. Rear Panel Controls (cont'd)

| CONTROL         | FUNCTION  |
|-----------------|---|
| CONNECTION      | This switch permits the use of a MODEM or DIRECT connection via the RS-232C or current loop communication interface. The MODEM selection is used only with the optional extended communications ROM. The keyboard target lighted keys are blinked at half-second intervals when the extended communications option is not used.   |
| MODEM TYPE      | When the CONNECTION switch is in the MODEM position, the MODEM TYPE switch permits selection of the 103 or 202 modem. The 103 modem can be configured in the HALF or FULL duplex mode. The 202 modem can be configured in the HALF duplex mode, and the host system must send to the terminal first. The terminal can be forced into the transmit mode by entering the selected code (ETX or EOT) on the keyboard, after first going into the ON-LINE mode.                     |
| TURN AROUND     | When the 202 is selected as the modem type, the user has the option to select the operation which determines the receive or transmit mode. With the switch in the S-CHAN position, the transmit or receive operation is controlled by control lines connected directly to the modem device. In the CODE position, the same lines are used to control the transmit or receive operation; however, a code can be used to select the operation (refer to CODE switch description). |
| CODE SEL        | This switch permits the user to specify the code (EOT or ETX) which selects the receive or transmit operation. When transmitted data equals the selected code, the terminal will switch to receive. When received data equals the selected code, the unit will switch to transmit.  |
| BAUD RATE       | These nine switches permit the communications baud rate to be established. Either 110, 150, 300, 600, 1200, 1800, 2400, 4800, or 9600 baud can be selected.   |
| RESET           | This switch permits the terminal to be manually set and initialized. The RESET switch must be depressed whenever a rear panel configuration switch is changed.  |
| VOLUME INCREASE | This control permits the audio level of the bell to be adjusted.  |



TABLE 3-2. ASCII Character Set

| CHARACTER | COMMENTS  | KEYBOARD CHARACTER*               | 7-BIT STD CODE |             |           |
|-----------|---|-----------------------------------|----------------|-------------|-----------|
|           |   |                                   | DECIMAL VALUE  | OCTAL VALUE | HEX VALUE |
| NUL       | Null or tape feed                               | @ <sup>c</sup>                    | 0              | 000         | 00        |
| SOH       | Start of heading                                | A <sup>c</sup>                    | 1              | 001         | 01        |
| STX       | Start of text                                   | B <sup>c</sup>                    | 2              | 002         | 02        |
| ETX       | End of text                                     | C <sup>c</sup>                    | 3              | 003         | 03        |
| EOT       | End of transmission                             | D <sup>c</sup>                    | 4              | 004         | 04        |
| ENQ       | Enquire (who are you, WRU)                      | E <sup>c</sup>                    | 5              | 005         | 05        |
| ACK       | Acknowledge                                     | F <sup>c</sup>                    | 6              | 006         | 06        |
| BEL       | Bell  | G <sup>c</sup>                    | 7              | 007         | 07        |
| BS        | Backspace                                       | H <sup>c</sup>                    | 8              | 010         | 08        |
| HT        | Horizontal tab                                  | I <sup>c</sup>                    | 9              | 011         | 09        |
| LF        | Line feed                                       | LF, LFS, or J <sup>c</sup>        | 10             | 012         | 0A        |
| VT        | Vertical tab                                    | K <sup>c</sup>                    | 11             | 013         | 0B        |
| FF        | Form feed                                       | L <sup>c</sup>                    | 12             | 014         | 0C        |
| RETURN    | Carriage return                                 | RETURN, RETURNS or M <sup>c</sup> | 13             | 015         | 0D        |
| SO        | Shift out (to red ribbon)                       | N <sup>c</sup>                    | 14             | 016         | 0E        |
| SI        | Shift in (to black ribbon)                      | O <sup>c</sup>                    | 15             | 017         | 0F        |
| DLE       | Data Link Escape                                | P <sup>c</sup>                    | 16             | 020         | 10        |
| DC1       | Device Control 1                                | Q <sup>c</sup>                    | 17             | 021         | 11        |
| DC2       | Device Control 2                                | R <sup>c</sup>                    | 18             | 022         | 12        |
| DC3       | Device Control 3                                | S <sup>c</sup>                    | 19             | 023         | 13        |
| DC4       | Device Control 4                                | T <sup>c</sup>                    | 20             | 024         | 14        |
| NAK       | Negative acknowledge                            | U <sup>c</sup>                    | 21             | 025         | 15        |
| SYN       | Synchronous idle                                | V <sup>c</sup>                    | 22             | 026         | 16        |
| ETB       | End of transmission block                       | W <sup>c</sup>                    | 23             | 027         | 17        |
| CAN       | Cancel  | X <sup>c</sup>                    | 24             | 030         | 18        |
| EM        | End of medium                                   | Y <sup>c</sup>                    | 25             | 031         | 19        |
| SUB       | Substitute                                      | Z <sup>c</sup>                    | 26             | 032         | 1A        |
| ESC       | Escape, prefix                                  | ESC, ESCS, or [ <sup>c</sup>      | 27             | 033         | 1B        |
| FS        | File separator                                  | / <sup>c</sup>                    | 28             | 034         | 1C        |
| GS        | Group separator                                 | ] <sup>c</sup>                    | 29             | 035         | 1D        |
| RS        | Record separator                                | ^ <sup>c</sup>                    | 30             | 036         | 1E        |
| US        | Unit separator                                  | _ <sup>c</sup>                    | 31             | 037         | 1F        |
| SP        | Space or blank                                  | Space Bar                         | 32             | 040         | 20        |
| !         | Exclamation point                               | 1 <sup>s</sup>                    | 33             | 041         | 21        |
| "         | Quotation marks (dieresis)                      | 2 <sup>s</sup>                    | 34             | 042         | 22        |
| #         | Number sign                                     | 3 <sup>s</sup>                    | 35             | 043         | 23        |
| \$        | Dollar sign                                     | 4 <sup>s</sup>                    | 36             | 044         | 24        |
| %         | Percent sign                                    | 5 <sup>s</sup>                    | 37             | 045         | 25        |
| &         | Ampersand                                       | 6 <sup>s</sup>                    | 38             | 046         | 26        |
| '         | Apostrophe (acute accent, closing single quote) | 7 <sup>s</sup>                    | 39             | 047         | 27        |
| (         | Opening parenthesis                             | 8 <sup>s</sup>                    | 40             | 050         | 28        |
| )         | Closing parenthesis                             | 9 <sup>s</sup>                    | 41             | 051         | 29        |
| *         | Asterisk  | : <sup>s</sup>                    | 42             | 052         | 2A        |
| +         | Plus sign                                       | ; <sup>s</sup>                    | 43             | 053         | 2B        |
| ,         | Comma (cedilla)                                 | ,                                 | 44             | 054         | 2C        |
| -         | Hyphen (minus)                                  | -                                 | 45             | 055         | 2D        |

\* For implementation on keyboard, c = control; s = shift

TABLE 3-2. ASCII Character Set (cont'd)

| CHARACTER | COMMENTS               | KEYBOARD CHARACTER* | 7-BIT STD CODE |             |           |
|-----------|------------------------|---------------------|----------------|-------------|-----------|
|           |                        |                     | DECIMAL VALUE  | OCTAL VALUE | HEX VALUE |
| .         | Period (decimal point) | .                   | 46             | 056         | 2E        |
| /         | Slant                  | /                   | 47             | 057         | 2F        |
| 0         | Digit 0                | 0                   | 48             | 060         | 30        |
| 1         | Digit 1                | 1                   | 49             | 061         | 31        |
| 2         | Digit 2                | 2                   | 50             | 062         | 32        |
| 3         | Digit 3                | 3                   | 51             | 063         | 33        |
| 4         | Digit 4                | 4                   | 52             | 064         | 34        |
| 5         | Digit 5                | 5                   | 53             | 065         | 35        |
| 6         | Digit 6                | 6                   | 54             | 066         | 36        |
| 7         | Digit 7                | 7                   | 55             | 067         | 37        |
| 8         | Digit 8                | 8                   | 56             | 070         | 38        |
| 9         | Digit 9                | 9                   | 57             | 071         | 39        |
| :         | Colon                  | :                   | 58             | 072         | 3A        |
| ;         | Semicolon              | ;                   | 59             | 073         | 3B        |
| <         | Less than              | ,s                  | 60             | 074         | 3C        |
| =         | Equals                 | _s                  | 61             | 075         | 3D        |
| >         | Greater than           | .s                  | 62             | 076         | 3E        |
| ?         | Question mark          | /s                  | 63             | 077         | 3F        |
| @         | Commercial at          | @                   | 64             | 100         | 40        |
| A         | Upper case letter A    | AS                  | 65             | 101         | 41        |
| B         | Upper case letter B    | BS                  | 66             | 102         | 42        |
| C         | Upper case letter C    | CS                  | 67             | 103         | 43        |
| D         | Upper case letter D    | DS                  | 68             | 104         | 44        |
| E         | Upper case letter E    | ES                  | 69             | 105         | 45        |
| F         | Upper case letter F    | FS                  | 70             | 106         | 46        |
| G         | Upper case letter G    | GS                  | 71             | 107         | 47        |
| H         | Upper case letter H    | HS                  | 72             | 110         | 48        |
| I         | Upper case letter I    | IS                  | 73             | 111         | 49        |
| J         | Upper case letter J    | JS                  | 74             | 112         | 4A        |
| K         | Upper case letter K    | KS                  | 75             | 113         | 4B        |
| L         | Upper case letter L    | LS                  | 76             | 114         | 4C        |
| M         | Upper case letter M    | MS                  | 77             | 115         | 4D        |
| N         | Upper case letter N    | NS                  | 78             | 116         | 4E        |
| O         | Upper case letter O    | OS                  | 79             | 117         | 4F        |
| P         | Upper case letter P    | PS                  | 80             | 120         | 50        |
| Q         | Upper case letter Q    | QS                  | 81             | 121         | 51        |
| R         | Upper case letter R    | RS                  | 82             | 122         | 52        |
| S         | Upper case letter S    | SS                  | 83             | 123         | 53        |
| T         | Upper case letter T    | TS                  | 84             | 124         | 54        |
| U         | Upper case letter U    | US                  | 85             | 125         | 55        |
| V         | Upper case letter V    | VS                  | 86             | 126         | 56        |
| W         | Upper case letter W    | WS                  | 87             | 127         | 57        |
| X         | Upper case letter X    | XS                  | 88             | 130         | 58        |
| Y         | Upper case letter Y    | YS                  | 89             | 131         | 59        |
| Z         | Upper case letter Z    | ZS                  | 90             | 132         | 5A        |
| [         | Opening bracket        | [                   | 91             | 133         | 5B        |
| \         | Reverse slant          | \                   | 92             | 134         | 5C        |
| ]         | Closing bracket        | ]                   | 93             | 135         | 5D        |

\* For implementation on keyboard, c = control; s = shift

TABLE 3-2. ASCII Character Set (cont'd)

| CHARACTER | COMMENTS            | KEYBOARD CHARACTER* | 7-BIT STD CODE |             |           |
|-----------|---------------------|---------------------|----------------|-------------|-----------|
|           |                     |                     | DECIMAL VALUE  | OCTAL VALUE | HEX VALUE |
| ^         | Circumflex          | ^                   | 94             | 136         | 5E        |
| _         | Underline           | _                   | 95             | 137         | 5F        |
| '         | Quotation mark      | @s                  | 96             | 140         | 60        |
| a         | Lower case letter a | A                   | 97             | 141         | 61        |
| b         | Lower case letter b | B                   | 98             | 142         | 62        |
| c         | Lower case letter c | C                   | 99             | 143         | 63        |
| d         | Lower case letter d | D                   | 100            | 144         | 64        |
| e         | Lower case letter e | E                   | 101            | 145         | 65        |
| f         | Lower case letter f | F                   | 102            | 146         | 66        |
| g         | Lower case letter g | G                   | 103            | 147         | 67        |
| h         | Lower case letter h | H                   | 104            | 150         | 68        |
| i         | Lower case letter i | I                   | 105            | 151         | 69        |
| j         | Lower case letter j | J                   | 106            | 152         | 6A        |
| k         | Lower case letter k | K                   | 107            | 153         | 6B        |
| l         | Lower case letter l | L                   | 108            | 154         | 6C        |
| m         | Lower case letter m | M                   | 109            | 155         | 6D        |
| n         | Lower case letter n | N                   | 110            | 156         | 6E        |
| o         | Lower case letter o | O                   | 111            | 157         | 6F        |
| p         | Lower case letter p | P                   | 112            | 160         | 70        |
| q         | Lower case letter q | Q                   | 113            | 161         | 71        |
| r         | Lower case letter r | R                   | 114            | 162         | 72        |
| s         | Lower case letter s | S                   | 115            | 163         | 73        |
| t         | Lower case letter t | T                   | 116            | 164         | 74        |
| u         | Lower case letter u | U                   | 117            | 165         | 75        |
| v         | Lower case letter v | V                   | 118            | 166         | 76        |
| w         | Lower case letter w | W                   | 119            | 167         | 77        |
| x         | Lower case letter x | X                   | 120            | 170         | 78        |
| y         | Lower case letter y | Y                   | 121            | 171         | 79        |
| z         | Lower case letter z | Z                   | 122            | 172         | 7A        |
| {         | Opening brace       | [s                  | 123            | 173         | 7B        |
|           |                     | \s                  | 124            | 174         | 7C        |
| }         | Closing brace       | ]s                  | 125            | 175         | 7D        |
| ~         | Equivalent          | ^s                  | 126            | 176         | 7E        |
| DEL       | Delete              | _s                  | 127            | 177         | 7F        |

\* For implementation on keyboard, c = control; s = shift

TABLE 3-3. Special Character Set

| ASCII<br>CODE<br>(HEX) | CHARACTER | ASCII<br>CODE<br>(HEX) | CHARACTER |
|------------------------|-----------|------------------------|-----------|
| 00                     | α         | 10                     | ρ         |
| 01                     | β         | 11                     | σ         |
| 02                     | γ         | 12                     | τ         |
| 03                     | δ         | 13                     | υ         |
| 04                     | ε         | 14                     | φ         |
| 05                     | ζ         | 15                     | ×         |
| 06                     | η         | 16                     | ψ         |
| 07                     | θ         | 17                     | ω         |
| 08                     | ι         | 18                     | Ω         |
| 09                     | κ         | 19                     | √         |
| 0A                     | λ         | 1A                     | ϕ         |
| 0B                     | μ         | 1B                     |           |
| 0C                     | ν         | 1C                     | ┐         |
| 0D                     | ξ         | 1D                     | ÷         |
| 0E                     | ο         | 1E                     | Σ         |
| 0F                     | π         | 1F                     | ≈         |



FIGURE 3-3. Keyboard Assembly Controls

1-80-2367

### 3.2.1 Mode Select Keys

The keyboard mode select keys perform the following functions:

|              |  |
|--------------|--|
| ALL<br>CAPS  | Depressing the ALL CAPS key causes the keyboard to enter the all capital letters mode (key illuminated). The only keys affected are the alphabetic keys, which will then output their shifted value. All other keys are unaffected, including shift and control functions. |
| AUTO<br>LF   | In the automatic line feed mode (key illuminated), a line feed command is automatically inserted when a carriage return is output.   |
| ON<br>LINE   | In the on line mode (key illuminated), data flow on the communications interface is permitted. When reset (local mode), data flow is not permitted. The local mode is used for demonstration and testing purposes.   |
| PAGE<br>MODE | In the page mode (key illuminated), the screen display area represents a page of information. The cursor moves about within the page and is controlled by commands. When in page mode and key is depressed, the terminal will default to the scroll mode.                  |

### 3.2.2 Character and Control Keys

This paragraph defines the effect of each keyboard key that provides a control function. Table 3-2 provides the encoded value of each keyboard key. The control keys perform the following functions:

|        |   |
|--------|---|
| SHIFT  | The SHIFT key enables keyboard generation of upper-case characters (!, &, etc.) and various control commands.   |
| CTRL   | The CTRL (control) key enables keyboard generation of ASCII control characters. If the terminal is in the special character mode, the CTRL key can be used to generate special characters ( $\theta$ , $\phi$ , $\Omega$ , etc.).                       |
| LF     | The LF (line feed) key moves the cursor below its present position. If the cursor is in the bottom line, the top line of the display will be moved up one position and the line will be blank.  |
| ESC    | The function of the ESC (escape) key is to perform escape sequences, which may be used to perform system functions that cannot be selected by a single keystroke. The format for an escape sequence is the escape code followed by an escape character. |
| BREAK  | Depressing the BREAK key forces a "space" condition on the communications interface of the terminal. Minimum space condition is 300 milliseconds.   |
| RETURN | The carriage RETURN key places the cursor at the beginning of the present line (left margin).   |

#### NOTE

The following keys are not used with EXbug or normal disk assembler or editor programs. However, they may be used with special editors.

CLEAR  
HOME

In scroll and page modes, the non-shifted function of this key (HOME) will cause the cursor to move to the left-most column in the top line. In protect mode, the cursor moves to the left-most column in the top line and then seeks non-protected column to the right; if none exists, cursor remains in left-most column of top line.

In scroll and page modes, the shifted value of the key (CLEAR) causes all positions in display to be filled with spaces. Cursor moves to home position. In protect mode, all non-protected positions in display area are filled with spaces. Cursor moves to left-most position of first non-protected field or, if no non-protected field exists, cursor moves to the home position.

LINE  
SEND  
PAGE

The non-shifted and shifted functions of this key are ignored in scroll mode. In page mode, the non-shifted function (PAGE SEND) causes all positions from home through the line where the cursor rests -- or to an end of line FAC in the line where cursor rests (whichever is found first) -- to be sent to the communications interface as a block of data. This block is framed by the start data command and the end data command. Each end of line is flagged by an end of data character (F9;ESC,y). The cursor does not change position, and any protected fields that may be sent will be bracketed by field attribute codes to indicate start and end of protected fields. In protect mode, the non-shifted function will cause all non-protected positions from home through the end of the page to be sent on the communications interface as a block of data. The data is framed as in page mode, and each end of field is flagged by an end of data character (F9;ESC,y). The cursor position will not change.

In page mode, the shifted function of this key (LINE SEND) causes all positions from the beginning of the line on which the cursor rests through the end of the line to be sent on the communications interface as a block of data. The data is framed by the start data command and end data command. The cursor does not change position. Any protected fields that may be sent will be bracketed by field attribute codes to indicate start and end of protected fields. In protect mode, the shifted function causes all non-protected positions from the beginning of the line where the cursor rests through the end of the line to be sent on the communications interface as a block of data. The data is framed as in page mode, and each end of field is flagged by an end of data character. The cursor position will not change.

INS  
CHAR

In scroll mode, the insert character (INS CHAR) command is ignored. In page mode, all columns in a line, starting with the cursor column, are moved right one column. The character in the right-most column is discarded. The character is placed at the cursor position and the cursor is advanced one column to the right with line rollover. In protect mode, the INS CHAR key performs the same function as in page mode, except movement is restricted to sequence of non-protected columns to the right of the cursor position (contiguous non-protected field).

DEL  
CHAR

In scroll mode, the DEL CHAR (delete character) command is ignored. In page mode, all columns in a line, starting with the column to the right of the cursor position, are moved left one column. The right-most column is filled with a space. The cursor does not change position. In protect mode, the DEL CHAR key performs the same function as in page mode, except the non-protected columns under and contiguous to the right within the non-protected field are moved.

SET  
TABS

In scroll, page, and protect modes, the block of data following the command defines the tab positions. The tab positions are indicated by the ASCII control character HT to set a tab, or the ASCII control character CAN to clear a tab. The commands are separated by spaces to indicate tab space (setting). The block is terminated by a line feed character. The command, followed by a line feed with no spaces, cancels, or HT's, will cause all tabs to be reset.

|←

In scroll mode, the back tab key causes the cursor to move left to previous tab position (without line rollover). In page mode, cursor moves left to previous tab position (with line and page rollover). In protect mode, cursor moves left to left-most column of previous non-protected field (with line and page rollover).

→|

In scroll mode, the forward tab key causes the cursor to move right to next tab position (without line rollover). In page mode, cursor moves right to next tab position (with line and page rollover). In protect mode, cursor moves right to right-most column of the next non-protected field (with line and page rollover).

DEL  
LINE

In scroll and protect modes, the DEL LINE (delete line) command is ignored. In page mode, the line on which cursor rests is deleted. All lines below the deleted line are moved up one line, and last line is left blank. Cursor moves to first character position of line in which it initially rested.

INS  
LINE

In scroll and protect modes, the INS LINE (insert line) command is ignored. In page mode, all lines, starting with the line on which the cursor rests, are moved down one line. The last line is discarded. The line on which cursor rests is filled with spaces. Cursor moves to first position of the blank line.

LINE  
ERAS  
PAGE

In scroll and page modes, the non-shifted function of this key (PAGE ERAS) erases all positions from the cursor position to the end of the display. These positions are filled with spaces, and the cursor does not change position. In protect mode, the non-shifted function of the key erases all non-protected positions from the cursor position to the end of the display. These positions are filled with spaces, and the cursor does not change position.

In scroll and page modes, the shifted function of this key (LINE ERAS) erases all non-protected positions from the cursor position to the end of the line. These positions are filled with space characters, and the cursor does not change position. In protect mode, the shifted function of this key erases all non-protected positions to the end of the line. The positions are filled with spaces, and the cursor does not change position.





In scroll mode, the cursor left command (←) moves the cursor left one column without line rollover. In page mode, the cursor moves left one column with line and page rollover. In protect mode, the cursor seeks the first non-protected column to the left with line and page rollover.



In scroll mode, the cursor right command (→) moves the cursor right one column without line rollover. In page mode, the cursor moves right one column with line and page rollover. In protect mode, the cursor seeks the first non-protected column to the right with line and page rollover.



In scroll mode, the cursor down command (↓) moves the cursor down one line in the same column. If already in last line, scroll is executed and last line is blanked. In page mode, the cursor moves down one line in the same column with page rollover. In protect mode, the cursor moves down one line in the same column with page rollover. If this position is protected, the cursor will seek the first non-protected column to the right.



In scroll mode, the cursor up command (↑) is ignored. In page mode, the cursor moves up one line in the same column with page rollover. In protect mode, the cursor moves up one line in the same column. If this position is protected, the cursor will seek the first non-protected column to the left.

### 3.2.3 Keyboard Commands

In the on line mode (ON LINE key illuminated), data flow on the communications interface is permitted (enabled). When reset (local mode), data flow is not permitted (disabled). The local mode is used for demonstration and testing purposes.

These two commands either enable or disable the keyboard (see Table 3-4). Obviously, the keyboard may not be enabled by the keyboard after it is disabled; however, it may be disabled and then enabled via the communications link. The command to disable the keyboard is either an 8-bit code D3 or an escape sequence of ESC S, which may be issued by depressing the ESC key followed by a capital S. If the keyboard has been disabled, the reset button on the back panel must be pressed to get started again.

TABLE 3-4. Keyboard Commands

| COMMAND          | INTERFACE VALUE |                       | KEYBOARD IMPLEMENTATION OF COMMAND |
|------------------|-----------------|-----------------------|------------------------------------|
|                  | NON-ESC.        | ESC SEQ.              |                                    |
| DISABLE KEYBOARD | D3 <i>(211)</i> | <i>21 8b</i><br>ESC S | ESC S                              |
| ENABLE KEYBOARD  | D2              | ESC R                 | N.A.                               |

### 3.2.4 Configuration Commands

These commands configure the basic display unit for the type of operation desired (see Table 3-5). The first three commands in Table 3-5 allow the display unit to be placed in the page mode, the scroll mode, or the protect mode. In the scroll mode, the cursor remains on the bottom line while the information moves up one line after each carriage return (CR). In page mode (key illuminated), the screen is treated as a page, with the cursor moving from the top line down the page. Upon completion of the bottom line, the cursor returns to the top line. In the protect mode, certain fields on the screen may be set aside as protected areas. In the protect mode (PAGE MODE key illuminated), the cursor acts as it would for the page mode, except that it can never appear in a protected area. The transparent mode command operates similarly to the rear-panel switch for transparent mode. This mode may also be reset with the reset transparent mode command. Likewise, the entire screen may be inverted, as was done with the rear-panel switch. A reset command also exists for this command. The special character display switch function is also implemented in software with set and reset commands. Finally, the terminal reset command performs the same function as the reset switch on the rear panel.

TABLE 3-5. Configuration Commands

| COMMAND                          | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND*               |
|----------------------------------|-----------------|----------|---|
|                                  | NON-ESC.        | ESC SEQ. |   |
| SET PAGE MODE                    | C7              | ESC G    | PAGE MODE, PAGE MODE <sup>s</sup> , or ESC G      |
| SET SCROLL MODE                  | C8              | ESC H    | IF IN PAGE OR PROTECT MODE, DEPRESS PAGE MODE KEY |
| SET PROTECT MODE                 | CD              | ESC M    | ESC M   |
| SET TRANSPARENT MODE             | EC              | ESC I    | ESC I   |
| RESET TRANSPARENT MODE           | ED              | ESC m    | ESC m   |
| SET VIDEO INVERT                 | EE              | ESC n    | ESC n   |
| RESET VIDEO INVERT               | EF              | ESC o    | ESC o   |
| SET DISPLAY SPECIAL              | FC              | ESC !    | ESC !   |
| RESET DISPLAY SPECIAL CHARACTERS | FD              | ESC }    | ESC }   |
| TERMINAL RESET                   | F1              | ESC q    | ESC q   |

\* For implementation on keyboard, s = Shift.

### 3.2.5 Cursor Commands

Table 3-6 shows the cursor commands. The HOME key places the cursor at the home position. The next four commands allow for cursor positioning one line up or down and one column left or right (relative to the current location). The load cursor command allows the positioning of the cursor anywhere on the screen relative to the home position in the upper left-hand corner. The command is executed by sending an ESC E, followed by the line code and column code for the desired line and column. These codes are shown in Table 3-7. For example, to position the cursor at line 5, column 20, an ESC E \$3 is sent to the display unit. The read cursor command sends the current position of the cursor over the communications interface.

TABLE 3-6. Cursor Commands

| COMMAND                     | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND* |
|-----------------------------|-----------------|----------|-------------------------------------|
|                             | NON-ESC.        | ESC SEQ. |                                     |
| HOME                        | C0              | ESC @    | HOME or ESC @                       |
| CURSOR UP ONE LINE (↑)      | C1**            | ESC A    | ↑ or ↑ <sup>S</sup> or ESC A        |
| CURSOR DOWN ONE LINE (↓)    | C2**            | ESC B    | ↓ or ↓ <sup>S</sup> or ESC B        |
| CURSOR LEFT ONE COLUMN (←)  | C3**            | ESC C    | ← or ← <sup>S</sup> or ESC C        |
| CURSOR RIGHT ONE COLUMN (→) | C4**            | ESC D    | → or → <sup>S</sup> or ESC D        |
| LOAD CURSOR                 | C5              | ESC E    | ESC E                               |
| READ CURSOR                 | C6              | ESC F    | ESC F                               |
| AUTO LINE FEED              | F7              | N.A.     | AUTO LF                             |

\* For implementation on keyboard, s = shift.

\*\* Page mode value only. In scroll mode, C1,C2,C3, and C4 are translated to 0B,0A,08, and 0C, respectively, for transmission on the communications interface.

TABLE 3-7. Cursor Position Code

| LINE/COLUMN | ASCII CODE | LINE/COLUMN | ASCII CODE | LINE/COLUMN | ASCII CODE |
|-------------|------------|-------------|------------|-------------|------------|
| 1           | SPACE      | 28          | ;          | 55          | V          |
| 2           | !          | 29          | <          | 56          | W          |
| 3           | "          | 30          | =          | 57          | X          |
| 4           | #          | 31          | >          | 58          | Y          |
| 5           | \$         | 32          | ?          | 59          | Z          |
| 6           | %          | 33          | @          | 60          | [          |
| 7           | &          | 34          | A          | 61          | \          |
| 8           | '          | 35          | B          | 62          | ]          |
| 9           | (          | 36          | C          | 63          | ^          |
| 10          | )          | 37          | D          | 64          | _          |
| 11          | *          | 38          | E          | 65          | `          |
| 12          | +          | 39          | F          | 66          | a          |
| 13          | ,          | 40          | G          | 67          | b          |
| 14          | -          | 41          | H          | 68          | c          |
| 15          | .          | 42          | I          | 69          | d          |
| 16          | /          | 43          | J          | 70          | e          |
| 17          | 0          | 44          | K          | 71          | f          |
| 18          | 1          | 45          | L          | 72          | g          |
| 19          | 2          | 46          | M          | 73          | h          |
| 20          | 3          | 47          | N          | 74          | i          |
| 21          | 4          | 48          | O          | 75          | j          |
| 22          | 5          | 49          | P          | 76          | k          |
| 23          | 6          | 50          | Q          | 77          | l          |
| 24          | 7          | 51          | R          | 78          | m          |
| 25          | 8          | 52          | S          | 79          | n          |
| 26          | 9          | 53          | T          | 80          | o          |
| 27          | :          | 54          | U          |             |            |

NOTE: CURSOR POSITION = COMMAND BYTE(S), LINE CODE, COLUMN CODE

### 3.2.6 Tab Commands

Table 3-8 lists the tab commands. Tab's are initialized every ten columns but may be changed, if desired, with the tab set command. In the protect mode, tabbing will move the cursor to the beginning of the next unprotected field. An example of this function will be given later in this chapter.

TABLE 3-8. Tab Commands

| COMMAND     | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND*        |
|-------------|-----------------|----------|--|
|             | NON-ESC.        | ESC SEQ. |  |
| FORWARD TAB | DA              | ESC Z    | SET TAB, SET TABS <sup>s</sup> , or ESC Z  |
| BACK TAB    | DB              | ESC [    | ←,  ← <sup>s</sup> , or ESC [              |
| SET TABS    | DC              | ESC \    | SET TABS, SET TABS <sup>s</sup> , or ESC \ |

\* For implementation on keyboard, s = Shift.

### 3.2.7 ASCII Commands

ASCII commands recognized by the display unit are given in Table 3-2. FF (form feed) moves the cursor position to the right one character space without changing the character position contents.

### 3.2.8 Screen Edit Commands

Screen edit commands consist of both inserting and deleting characters or lines. The screen edit commands are given in Table 3-9. Also, the entire screen may be erased by the clear command.

TABLE 3-9. Screen Edit Commands

| COMMAND             | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND*        |
|---------------------|-----------------|----------|--|
|                     | NON-ESC.        | ESC SEQ. |  |
| CHARACTER DELETE ** | D1              | ESC Q    | DEL CHAR, DEL CHAR <sup>s</sup> , or ESC Q |
| PAGE ERASE **       | D4              | ESC T    | ERAS or ESC T                              |
| LINE ERASE **       | D5              | ESC U    | ERAS <sup>s</sup> or ESC U                 |
| LINE INSERT **      | D6              | ESC V    | INS LINE, INS LINE <sup>s</sup> , or ESC V |
| CHARACTER INSERT ** | D0              | ESC P    | INS CHAR, INS CHAR <sup>s</sup> , or ESC P |
| LINE DELETE **      | D7              | ESC W    | DEL LINE, DEL LINE <sup>s</sup> , or ESC W |
| CLEAR **            | D8              | ESC X    | HOME, HOME <sup>s</sup> , or ESC X         |

\* For implementation on keyboard, s = Shift.

\*\* = Page/Protect Mode only.

### 3.2.9 Screen Configuration Commands

The screen configuration may be changed from the maximum character display of 24 lines x 80 columns to any lesser number of lines and columns. For instance, if the desired top line to be displayed is line 5, an ESC I (see Table 3-10) and the cursor positioning code for line 5 (\$) would be sent to the display unit. In this manner, the display may be configured in any character size. Figure 3-4 shows an example of this technique. The commands sent to the display unit are ESC I +, ESC J ., ESC K B, and ESC L G. Then the display area is filled with K's by depressing the K key. By holding the K key down, the character will automatically repeat itself. The area inside the box is called the virtual screen area, while outside of the box is the absolute area. Read absolute and write absolute commands permit information to be read or written into the absolute area. Only FAC's may be written into the absolute area. While displayed characters and FAC's may be read from the absolute area, the displayed characters must be placed on the screen before the screen configuration is reduced. The reading and writing on the screen is performed through the communications interface.

TABLE 3-10. Screen Configuration Commands

| COMMAND                | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND |
|------------------------|-----------------|----------|------------------------------------|
|                        | NON-ESC.        | ESC SEQ. |                                    |
| TOP DISPLAY LINE *     | C9              | ESC I    | ESC I                              |
| BOTTOM DISPLAY LINE    | CA              | ESC J    | ESC J                              |
| LEFT DISPLAY COLUMN *  | CB              | ESC K    | ESC K                              |
| RIGHT DISPLAY COLUMN * | CC              | ESC L    | ESC L                              |
| WRITE ABSOLUTE *       | CE              | ESC N    | ESC N                              |
| READ ABSOLUTE *        | CF              | ESC O    | ESC O                              |

\* = Page/Protect Mode only.

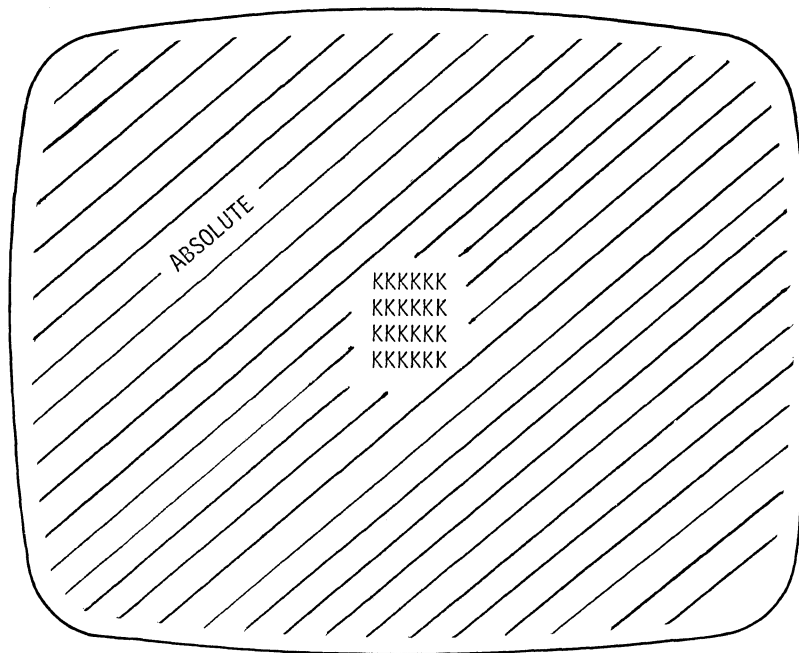


FIGURE 3-4. Example Defining Virtual Display Area

### 3.2.10 Field Attribute Codes (FAC's)

Table 3-11 describes the FAC's, which allow for various portions of the screen to be blinked on and off, inverted, underlined, etc. FAC's occupy one screen location, and several may be combined into a single screen location. FAC's are displayed as blanks on the screen. Refer to Figure 3-5 for an example of these codes.

Assume that we wish to display the message "MOTOROLA EXORTERM 155" on the first line of the screen, with "MOTOROLA" in reverse blinking video, "EXORTERM" underlined, and "155" at half brightness. The following hex code sequence does this.

|            |                              |
|------------|------------------------------|
| 1B,49,20   | Set top display line = 1     |
| 1B,58      | Clear screen                 |
| 1B,62      | Set video invert             |
| 1B,60      | Set blink                    |
| 1B,44      | Move cursor right one column |
| "MOTOROLA" | ASCII text string            |
| 1B,63      | Reset video invert           |
| 1B,61      | Reset blink                  |
| 1B,66      | Set underline                |
| 1B,44      | Move cursor right one column |
| "EXORTERM" | ASCII text string            |
| 1B,67      | Reset underline              |
| 1B,64      | Set half bright              |
| 1B,44      | Move cursor right one column |
| "155"      | ASCII text string            |
| 0D,0A      | CR,LF                        |

Note that the cursor does not change position when one or more FAC's are sent. Text characters can never be put in column one if FAC's are to be used at the beginning of the line. A move-the-cursor-right-one-column FAC must be included (not a space) in order not to overwrite and destroy the FAC's. Any combination of FAC's can be combined into a single character location so that a subsequent character string may be blinked, inverted, made half bright, and underlined at the same time. Also, the end of the line command automatically resets all FAC's. To underline an entire line, one merely places the set underline FAC in the first character position, followed by a move-the-cursor-right-one-column command.

TABLE 3-11. Field Attribute Codes

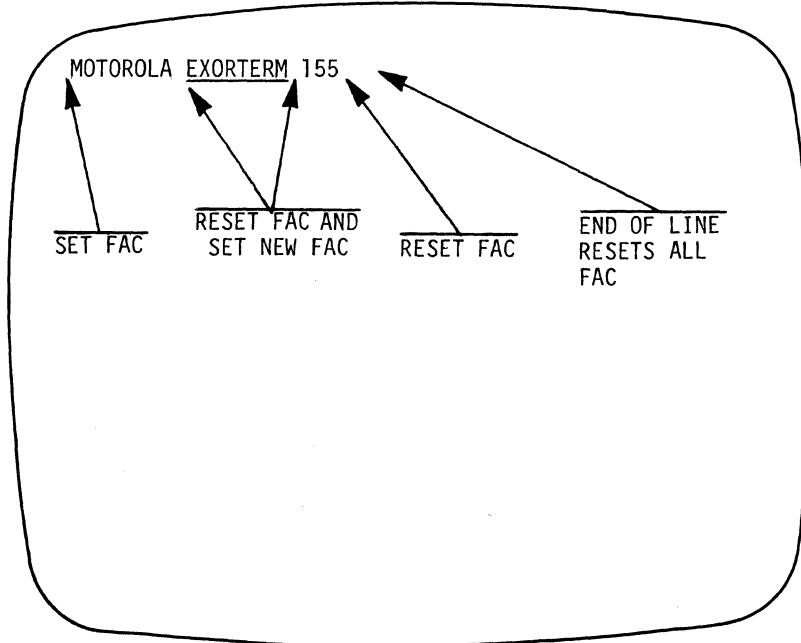
| COMMAND               | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND |
|-----------------------|-----------------|----------|------------------------------------|
|                       | NON-ESC.        | ESC SEQ. |                                    |
| SET BLINK *           | E0              | ESC `    | ESC `                              |
| RESET BLINK *         | E1              | ESC a    | ESC a                              |
| SET VIDEO INVERT *    | E2              | ESC b    | ESC b                              |
| RESET VIDEO INVERT *  | E3              | ESC c    | ESC c                              |
| SET HALF BRIGHT *     | E4              | ESC d    | ESC d                              |
| RESET HALF BRIGHT *   | E5              | ESC e    | ESC e                              |
| SET UNDERLINE *       | E6              | ESC f    | ESC f                              |
| RESET UNDERLINE *     | E7              | ESC g    | ESC g                              |
| SET NON-DISPLAY *     | E8              | ESC h    | ESC h                              |
| SET DISPLAY *         | E9              | ESC i    | ESC i                              |
| SET FIELD PROTECT *   | EA              | ESC j    | ESC j                              |
| RESET FIELD PROTECT * | EB              | ESC k    | ESC k                              |

\* = Extended Display Feature supported command.

The last two FAC's in Table 3-11 are set and reset field protect. In order to use the field protect FAC's the terminal must be in page mode. Secondly, the set and reset commands are placed on the screen along with the character string to be protected. The terminal is then placed in the protect mode by the ESC M command. Now the protected fields are prevented from being changed -- the cursor cannot be positioned into these protected fields. For an example, refer to Figure 3-6, which shows how to build a form consisting of NAME, ADDRESS, CITY, STATE, and ZIP. An underline area should follow each of the prompt words, and the prompt words should be protected. A field protect FAC is placed in the first character position of the first line, then an N in the next character position, followed by AME. The next character position is a reset field protect FAC and set underline. The cursor is moved over several positions, and a reset



underline is inserted, followed by a CR and LF. Here, the first position gets a set field protect FAC; then ADDRESS, with the A in the second cursor position; and a reset field protect FAC and set underline after the second S. After the prompt characters and FAC's are inserted, a set protect mode command is entered, and the cursor will seek the first unprotected character position --in this case, the second space after NAME. Now a name may be entered and, if the forward tab key is depressed, the cursor will seek the first character position of the next unprotected field. In this case, an address may be entered and, again, the forward tab key is depressed.



NOTE: FAC CODES OCCUPY ONE CHARACTER LOCATION

FIGURE 3-5. Example of FAC's

The diagram shows a rounded rectangular box containing a form with the following fields:

- NAME \_\_\_\_\_
- ADDRESS \_\_\_\_\_
- CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

FIGURE 3-6. Example of How to Build a Display Using Protected Fields

### 3.2.11 Communication Commands

Table 3-12 gives the communication commands. Some are commands issued to the terminal, while others are characters issued by the communication interface. The information will be framed with the start data and end data commands. The end of data indicators follow the transmission of the entire block of data (see to Figure 3-7).

TABLE 3-12. Communication Commands

| COMMAND                  | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND* |
|--------------------------|-----------------|----------|-------------------------------------|
|                          | NON-ESC.        | ESC SEQ. |                                     |
| SEND LINE **             | DF              | ESC _    | SENDS <sup>s</sup> or ESC _         |
| SEND PAGE **             | D9              | ESC Y    | SEND, ESC Y                         |
| START DATA **            | DD              | ESC ]    | ESC ]                               |
| END DATA **              | DE              | ESC ^    | ESC ^                               |
| END-OF-DATA INDICATOR ** | F9              | ESC y    | ESC y                               |
| DISPLAY STATUS ON        | F2              | ESC r    | ESC r                               |
| DISPLAY STATUS OFF       | F3              | ESC s    | ESC s                               |
| ENABLE LOAD **           | FA              | ESC z    | ESC z                               |
| DISABLE LOAD **          | FB              | ESC {    | ESC {                               |
| END-OF-LINE FAC **       | FE              | ESC ~    | ESC ~                               |
| BREAK                    | 8C              | N.A.     | BREAK                               |

\* For implementation on keyboard, s = Shift.

\*\* = Extended Display Feature supported command.

Recall the NAME, ADDRESS, CITY, STATE, and ZIP page example. In this form, the information JOHN DOE ROUTE 1 BOX 1 ANYWHERE ARIZONA 00000 has been entered. Now the page send command has been issued to the terminal, with the information as shown having been sent over the communication interface. First sent is a start of data character, followed by the first block of information consisting of JOHN DOE and the remaining unused field. This is followed by an end data character to indicate the end of that data field. The next data field is transmitted, followed by an end data character. This continues until all data is transmitted and the end of data indicator is sent. In this example, the cursor was the first character position of the line following the CITY, STATE, ZIP line; thus, the extra space and end data character preceded the end of data indicator. The prompt characters were not transmitted due to being in protected fields. Figure 3-8 shows the same transmission except in the page mode. Notice that the prompt characters are transmitted, plus a set of FAC's for setting and resetting the appropriate operations. The FAC's are represented by the lower case letters. Compare these letters with the escape sequences for the FAC's.

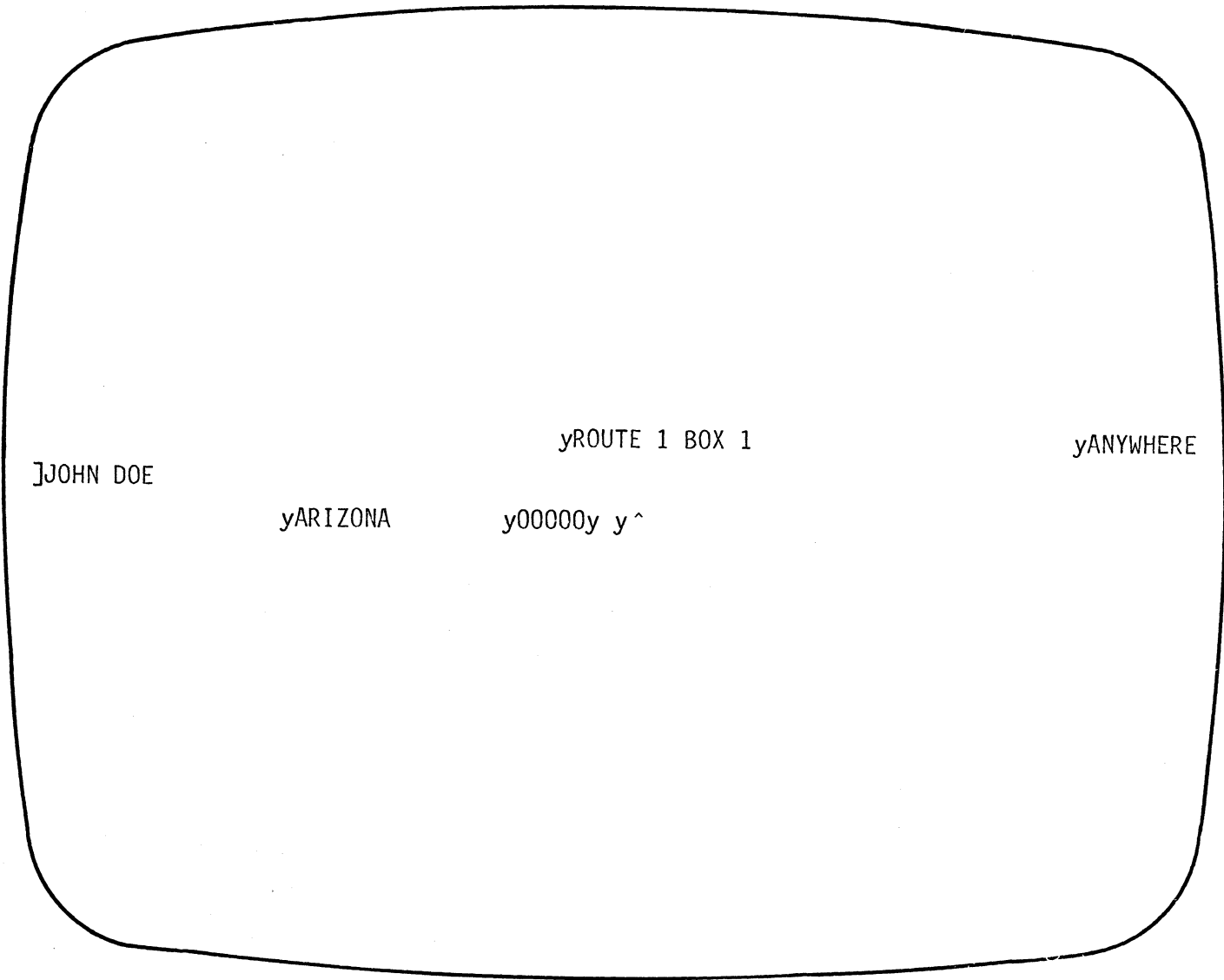


FIGURE 3-7. Example of Communication Commands (Protect Mode)

```
]jgiceaNAMEkficeaJOHN DOE                kgiceayjgiceaADDRESSkficeaROUTE 1  
BOX 1                kgiceayjgiceaCITYkficeaANYWHERE  
ceaSTATEkficeaARIZONA    jgiceaZIPkficea00000kgiceay y ^
```

FIGURE 3-8. Example of Communication Commands (Page Mode)

The display status on and off commands allow communication error conditions to be displayed on the screen. The error conditions are parity error, receiver overrun, and framing error. The error condition is indicated by a blinking display in the lower right hand corner of the screen.

The enable load and disable load commands are used to download data into the terminal memory. Downloading means to place data directly into memory locations of actual terminal RAM through the communication port. This data block must be preceded by the enable load command, an ASCII DC2 to indicate start of data, and the block of data. After the block of data is sent, it is followed by a DC4 to indicate end of data, and a disable load command.

Depressing the BREAK key forces a "space" condition on the communication interface of the terminal. Minimum space condition is 300 milliseconds.

### 3.2.12 Function Key Commands

Keyboard function keys F1 through F12 and their shifted values are used to select operations at a specific command level. The key functions are defined by user firmware or software programs. Table 3-13 gives the function key command codes.

TABLE 3-13. Function Key Commands

| COMMAND | INTERFACE VALUE |          | KEYBOARD IMPLEMENTATION OF COMMAND* |
|---------|-----------------|----------|-------------------------------------|
|         | NON-ESC.        | ESC SEQ. |                                     |
| FKEY01  | A0              | N.A.     | F1                                  |
| FKEY02  | A1              | N.A.     | F2                                  |
| FKEY03  | A2              | N.A.     | F3                                  |
| FKEY04  | A3              | N.A.     | F4                                  |
| FKEY05  | A4              | N.A.     | F5                                  |
| FKEY06  | A5              | N.A.     | F6                                  |
| FKEY07  | A6              | N.A.     | F7                                  |
| FKEY08  | A7              | N.A.     | F8                                  |
| FKEY09  | A8              | N.A.     | F9                                  |
| FKEY10  | A9              | N.A.     | F10                                 |
| FKEY11  | AA              | N.A.     | F11                                 |
| FKEY12  | AB              | N.A.     | F12                                 |
| SKEY01  | B0              | N.A.     | F1 <sup>S</sup>                     |
| SKEY02  | B1              | N.A.     | F2 <sup>S</sup>                     |
| SKEY03  | B2              | N.A.     | F3 <sup>S</sup>                     |
| SKEY04  | B3              | N.A.     | F4 <sup>S</sup>                     |
| SKEY05  | B4              | N.A.     | F5 <sup>S</sup>                     |
| SKEY06  | B5              | N.A.     | F6 <sup>S</sup>                     |
| SKEY07  | B6              | N.A.     | F7 <sup>S</sup>                     |
| SKEY08  | B7              | N.A.     | F8 <sup>S</sup>                     |
| SKEY09  | B8              | N.A.     | F9 <sup>S</sup>                     |
| SKEY10  | B9              | N.A.     | F10 <sup>S</sup>                    |
| SKEY11  | BA              | N.A.     | F11 <sup>S</sup>                    |
| SKEY12  | BB              | N.A.     | F12 <sup>S</sup>                    |

\*For implementation on keyboard, s = shift

### 3.3 INITIALIZATION

The first step performed when initializing the terminal is to verify that the LINE FREQ switch, located on the rear panel, is set to the proper frequency (50 Hz or 60 Hz). The next step is to set the following switches for normal development system operations (see Figure 3-2 for switch locations):

- a. FAC CODE OFF/ENABLE switch to ENABLE
- b. FAC CODE OFF/DISPL switch to OFF
- c. TRANS MODE to OFF
- d. VIDEO INVERT switch to desired position
- e. A, B, and C to OFF
- f. SPEC CHAR OFF/DISPL switch to OFF
- g. DUPLEX switch to FULL
- h. PARITY switch to NO
- i. XMIT WORD switch to 8 BITS
- j. STOP BITS switch to 1
- k. CONNECTION switch to DIRECT
- l. BAUD RATE switch to 9600

When the operation of the unit has been established, power can be applied by pressing the power switch located on the front panel. The software and hardware are brought to the following state when power is applied to the unit:

- a. Screen display area equals 1 through 22 lines and columns 1 through 80
- b. Display is "blanked"
- c. Cursor is in the home position (upper left hand corner of screen)
- d. Scroll mode is set
- e. Transparent mode is reset
- f. Normal video is set
- g. On line mode is set
- h. Auto line feed mode is reset

After a one-minute warmup, adjust the brightness control to produce a well-defined cursor. The terminal is now ready for data transmission.

#### NOTE

The rear panel single-pole, single-throw switch DIP arrays used to establish the operation are read only when power is applied to the terminal, or the RESET switch is set.

### 3.4 OPERATOR TEST PROCEDURE

The basic operation of the terminal can be validated (exclusive of the serial communication interface) by an operator-monitored series of checks when the unit is first powered up. These checks can also be made if a unit mal-function is suspected during daily operation. Note that all of the logic functions of the "power on check" can be simulated using the RESET switch on the rear panel.

#### 3.4.1 Power On Check

When the terminal is powered on, the keyboard ON LINE target lighted key should not be illuminated. After about one-quarter to one-half second, the ON LINE key should illuminate.

After a one-minute warmup, the screen should be blank, with the cursor block blinking in the upper left-hand corner of the screen. No other characters should be visible on the screen at this point. If the cursor is not visible, turn the brightness control until the raster is faintly visible. The cursor should now be visible. Adjust the brightness control to produce a well-defined cursor.

#### 3.4.2 Off Line Checks

When the power-on check has been successfully completed, the following off line checks can be made. Place the unit in off line mode by depressing the ON LINE key.

##### Character Entry Checks

- a. Depress 'a' key and enter a number of the characters in memory and on the display.
- b. Depress SHIFT key and enter more characters. Note that any letters entered are now capitalized.
- c. Depress RETURN key and notice that the cursor moves to the first location of that line.
- d. Depress LINE FEED key and note that the cursor moves to the same column in the line directly below its previous location.
- e. Depress ESCAPE key, followed by the '@' key, and note that the cursor returns to the home position (the first column on the first line).
- f. Depress LINE FEED key several times, followed by several 'a' keys. This should move the cursor toward the center of the screen.
- g. Depress ESCAPE key, followed by a lower case 'q'. Note that the display completely erases and the cursor returns to the home position.



### Cursor Control Checks

Before performing the checkout, depress the ESCAPE key, followed by a lower case 'q' to reset the unit. Ensure that the unit is in a loopback mode (local or half duplex), the cursor is in the home position, and the display is blank. Perform the checkout as follows:

- a. Depress ESCAPE key, followed by upper-case "B" key, repeating this sequence until the cursor reaches the bottom line of the display.
- b. Depress ESCAPE key, followed by upper-case "D" key, repeating this sequence until the cursor nears the last position on the line.
- c. Depress ESCAPE key, followed by upper case "C" key, repeating this sequence to cause the cursor to wrap around to the last position of the line above.
- d. Depress ESCAPE key, followed by '@' key, to move the cursor to the first character position of the first line.

This completes the operator self-test of the terminal.

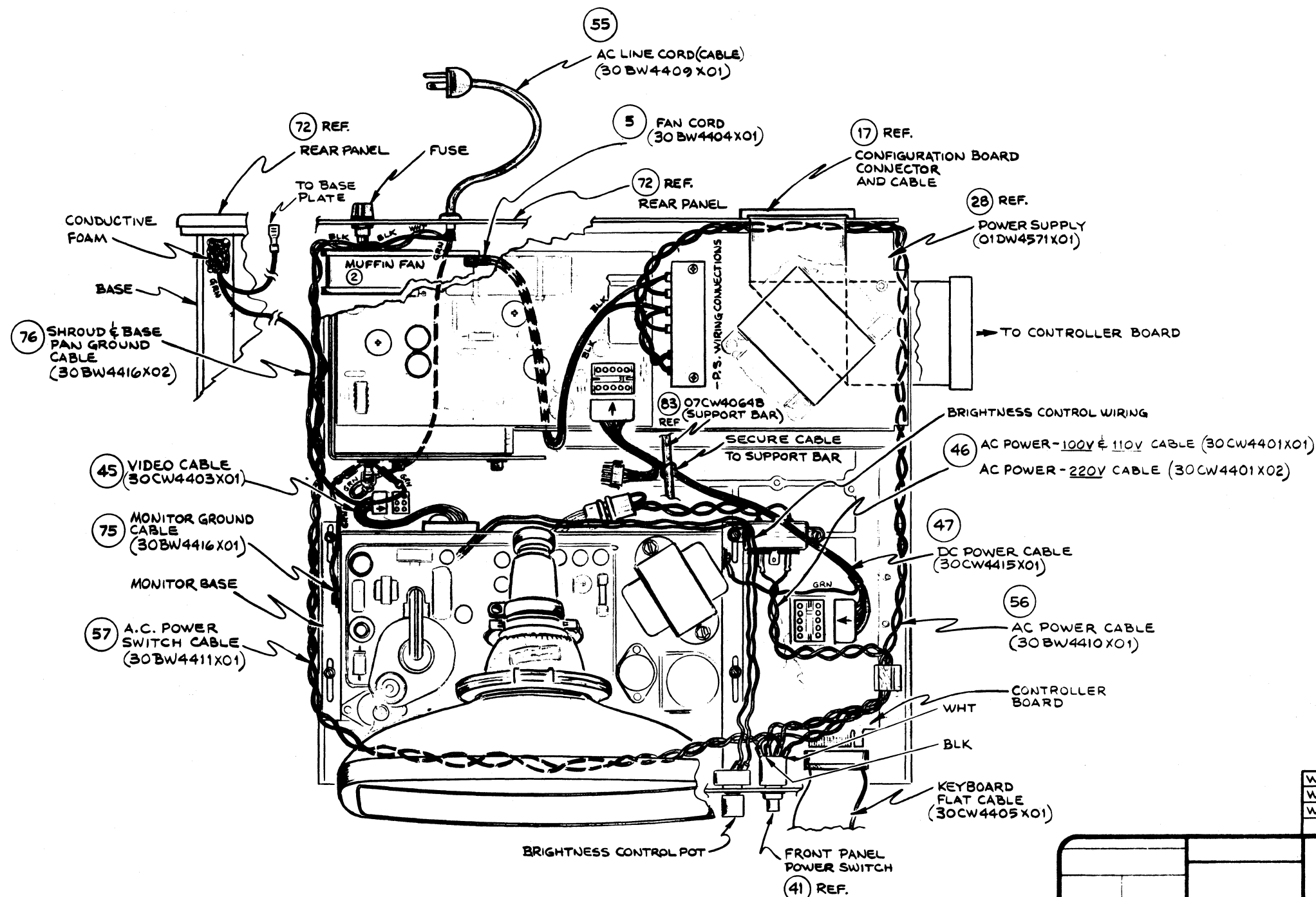
## CHAPTER 4

### DIAGRAMS

#### 4.1 SCHEMATIC AND INTERCONNECTION DIAGRAMS

This chapter contains the interconnection diagram for the terminal. Also, the schematics are provided for the CRT Controller Board, CRT Memory Devices and Locations, CRT Configuration Board, and Power Supply Assembly. The service manual for the Video Monitor Assembly is supplied at the end of this chapter.

| REVISION |             |          |       |  |  |
|----------|-------------|----------|-------|--|--|
| ISSUE    | REL. OR NO. | DATE     | APPD. | DESCRIPTION                                  |  |
| K        | B136        | 9/14/77  |       | RELEASED TO PRODUCTION                       |  |
| L        | H355        | 11/29/77 |       | ADDED FIND NO'S - AND SHEET 2                |  |
| M        | H-759       | 10/1/78  |       | UPDATED DWGS TO CORRESPOND TO CHANGES        |  |
| N        | H1251       | 9/17/79  |       | ON SHEET 2, 30CW4415X01 WAS 30CW4402 (L.P.S) |  |
| P        | H2581       | 2/14/82  |       | COMPLETE REDRAW                              |  |



|                   |             |
|-------------------|-------------|
| WIRING DIA., 100V | 69DW4000X03 |
| WIRING DIA., 220V | 69DW4000X02 |
| WIRING DIA., 110V | 69DW4000X01 |
| DESCRIPTION       | PART NO.    |

**WIRING DIAGRAM  
CRT CHASSIS  
100V/110V/220V**

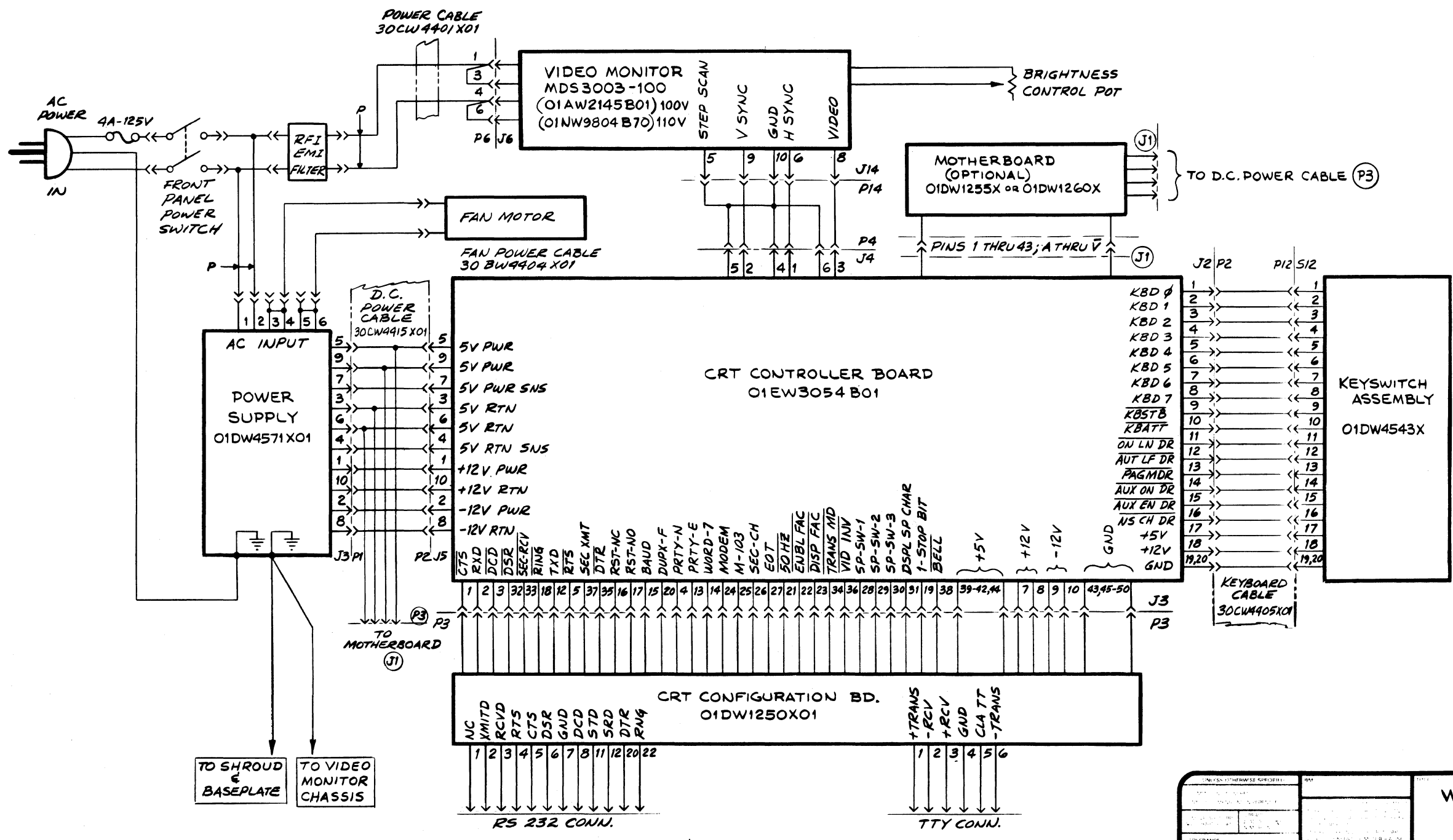
MOTOROLA microsystems  
Integrated Circuits Division

DRAWING NO. **69DW4000X**

1/3

FIGURE 4-1. CRT Chassis Wiring Diagram  
(Sheet 1 of 3)

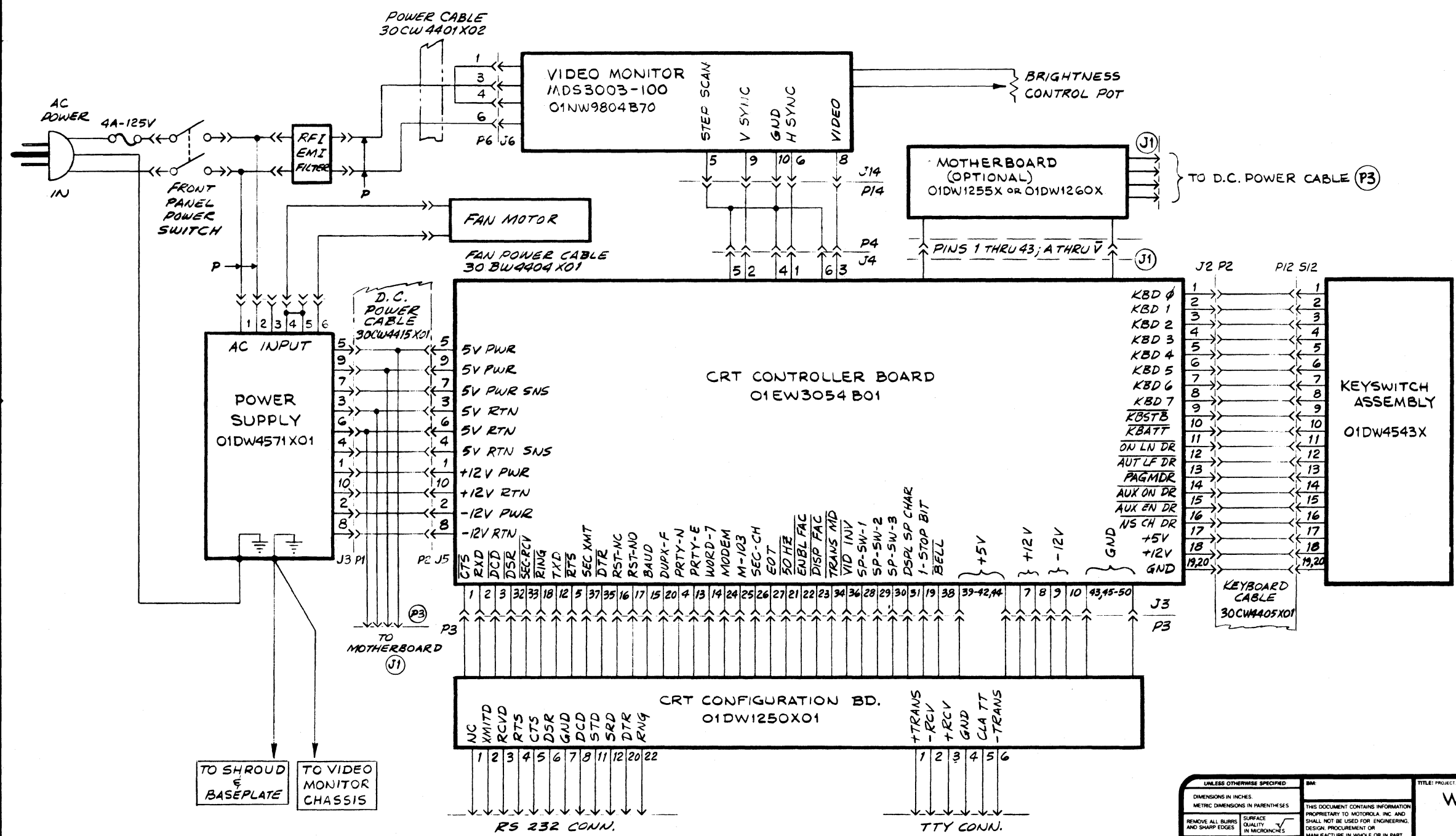
| REVISION |             |         |        |                 |
|----------|-------------|---------|--------|-----------------|
| ISSUE    | REF. IN NO. | DATE    | APP'D. | DESCRIPTION     |
| P        | H2581       | 9/16/82 | JPA    | COMPLETE REDRAW |



|  |                         |   |
|--|-------------------------|---|
| WIRING DIAGRAM<br>CRT CHASSIS<br>100V & 110V |                         | MOTOROLA microsystems<br>Integrated Circuits Division   |
| DRAWING NO.<br><b>69DW4000X</b>              | SHEET NO.<br><b>2/3</b> | APPROVED: <i>R. Martin</i> 2/16/82<br>CHECKED: <i>J. Summers</i> 2/18/82<br>DESIGNED: <i>W. H. ...</i> 2/15/82<br>DRAWN: <i>...</i> 2/16/82 |

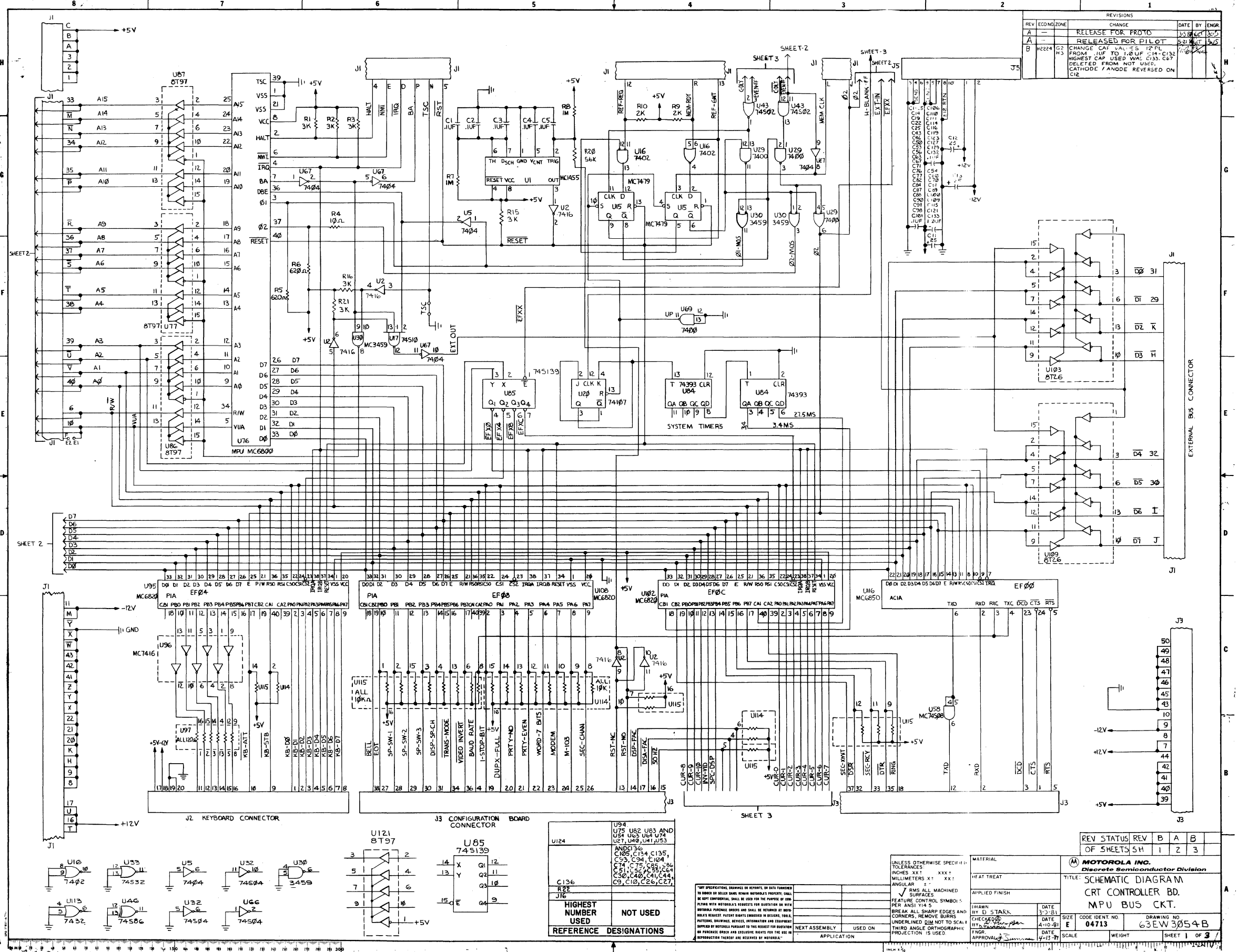
FIGURE 4-1. CRT Chassis Wiring Diagram (Sheet 2 of 3) 4-5/4-6

| REVISION |            |         |      |                 |
|----------|------------|---------|------|-----------------|
| ISSUE    | REL/CH NO. | DATE    | APPD | DESCRIPTION     |
| P        | H.581      | 2/16/82 | JPS  | COMPLETE REDRAW |



|                                  |  |                              |  |   |  |
|----------------------------------|--|------------------------------|--|---|--|
| UNLESS OTHERWISE SPECIFIED:      |  | DIMENSIONS IN INCHES         |  | METRIC DIMENSIONS IN PARENTHESES                      |  |
| REMOVE ALL BURRS AND SHARP EDGES |  | SURFACE QUALITY              |  | IN MICRONS  |  |
| TOLERANCE:                       |  | 2 PLACE DEC = ±              |  | 3 PLACE DEC = ±                                       |  |
| HOLES ±                          |  | ANGLES ±                     |  | SCALE:  |  |
| DO NOT SCALE DRAWING             |  | DATE                         |  | DATE  |  |
| DRAWN BY                         |  | DATE                         |  | DATE  |  |
| CHECKED BY                       |  | DATE                         |  | DATE  |  |
| APPROVED BY                      |  | DATE                         |  | DATE  |  |
| TITLE: PROJECT PART USE          |  | WIRING DIAGRAM               |  | CRT CHASSIS   |  |
|                                  |  | 220V                         |  |   |  |
| MOTOROLA microsystems            |  | Integrated Circuits Division |  | 3102 NORTH 56TH STREET PHOENIX, ARIZONA 85018, U.S.A. |  |
| DRAWING NO.                      |  | 69DW4000X                    |  | SHEET 3/3   |  |

FIGURE 4-1. CRT Chassis Wiring Diagram (Sheet 3 of 3) 4-7/4-8



| REVISIONS |         |   |                 |
|-----------|---------|---|-----------------|
| REV       | ECOZONE | CHANGE  | DATE BY ENGR    |
| A         |         | RELEASE FOR PROTO   | 3/5/81 GAT 30/5 |
| B         |         | RELEASE FOR PILOT   | 5/21/81 GAT 1/5 |
| B         | W2224   | G2<br>CHANGE CAP VALUES 12 PL<br>FROM .1UF TO 1.0UF C14-C132<br>HIGHEST CAP USED WAC C133, C67<br>DELETED FROM NOT USED<br>CATHODE / ANODE REVERSED ON<br>C12 | 11/6/81 GAT 1/5 |

| U124 | U29 | U82 | U83 | AND |
|------|-----|-----|-----|-----|
| C136 | U29 | U82 | U83 | AND |
| R22  | U83 | U84 | U74 | AND |
| J16  | U27 | U42 | U41 | AND |
|      | U53 |     |     |     |

| HIGHEST NUMBER USED | NOT USED |
|---------------------|----------|
| U124                | U29      |
| R22                 | U83      |
| J16                 | U42      |
|                     | U41      |
|                     | U53      |

UNLESS OTHERWISE SPECIFIED:  
TOLERANCES:  
INCHES .XX  
MILLIMETERS .X  
ANGULAR .5°  
RMS ALL MACHINED SURFACES  
FEATURE CONTROL SYMBOLS:  
PER ANSI Y14.5  
BREAK ALL SHARP EDGES AND CORNERS. REMOVE BURRS.  
UNDERLINED DIM NOT TO SCALE  
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED

| REV | STATUS | REV | B | A | B |
|-----|--------|-----|---|---|---|
|     |        |     |   |   |   |

|            |  |                |  |               |  |
|------------|--|----------------|--|---------------|--|
| MATERIAL   |  | APPLIED FINISH |  | DATE          |  |
| HEAT TREAT |  | PER ANSI Y14.5 |  | BY D STARK    |  |
| CHECKED    |  | DATE           |  | CODE IDENT NO |  |
| APPROVAL   |  | 4-11-81        |  | 04713         |  |
| SCALE      |  | WEIGHT         |  | DRAWING NO    |  |
|            |  |                |  | 635E 3054B    |  |
|            |  |                |  | SHEET 1 OF 3  |  |

FIGURE 4-2. CRT Controller Board Schematic Diagram (Sheet 1 of 3) 4-9/4-10









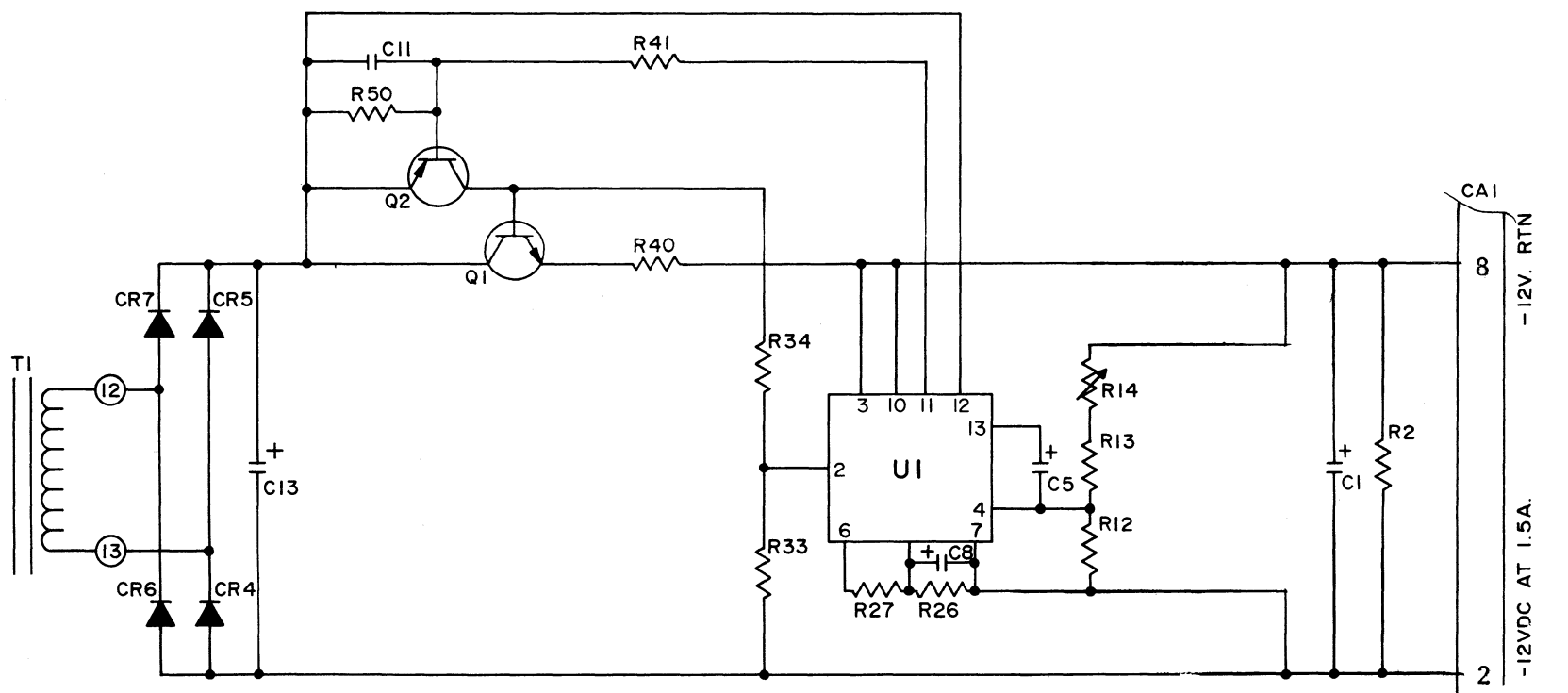
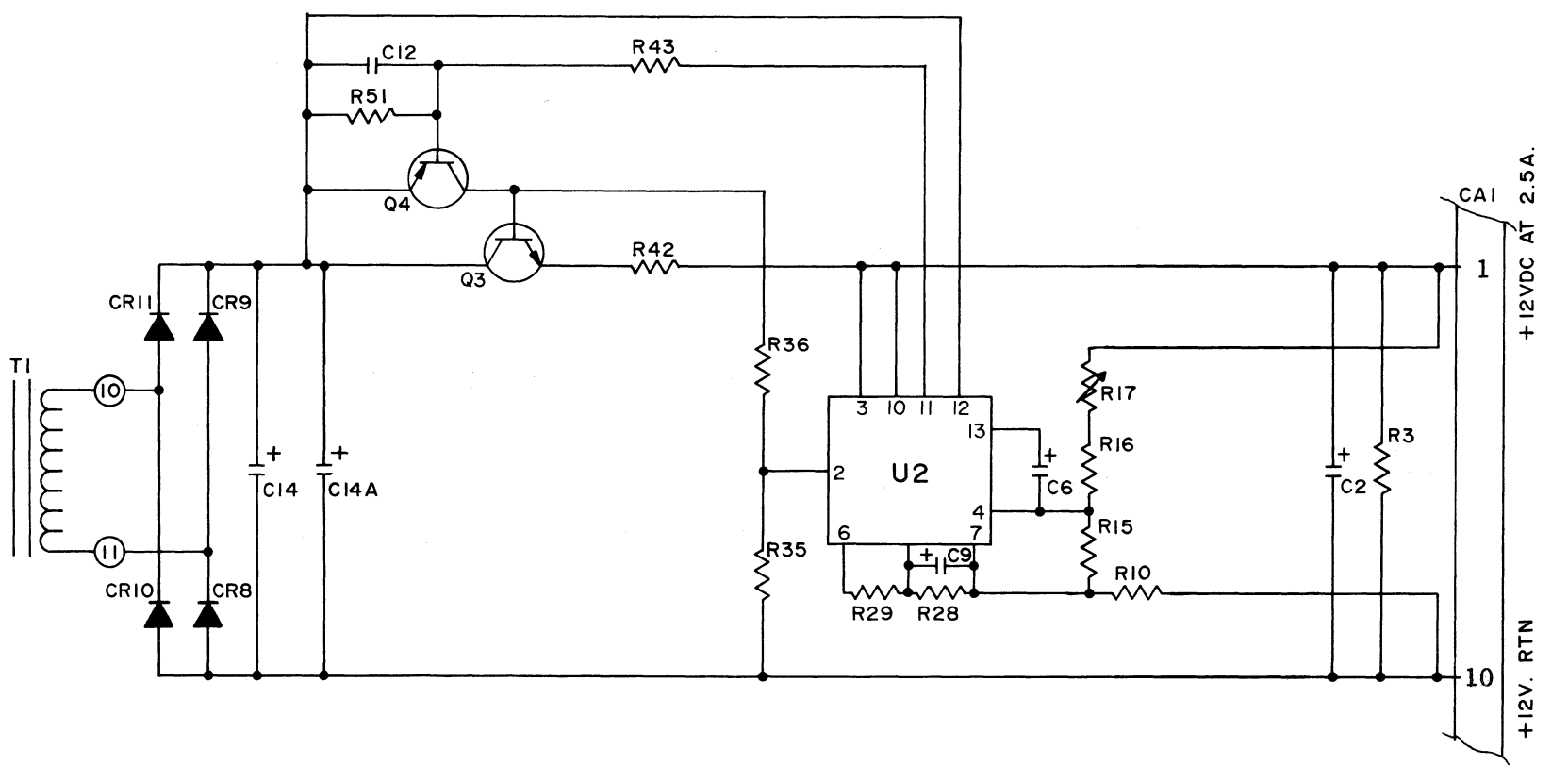
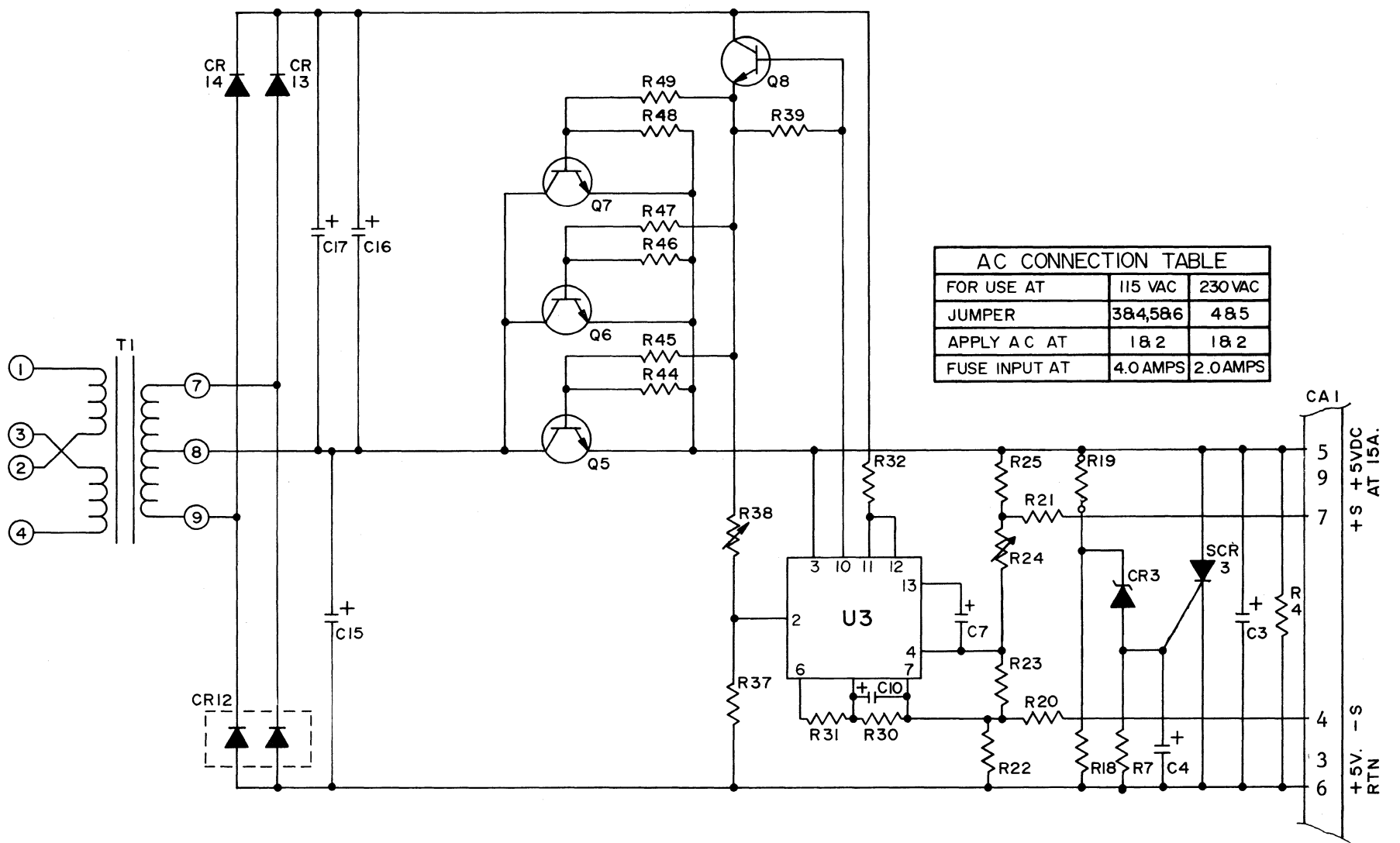
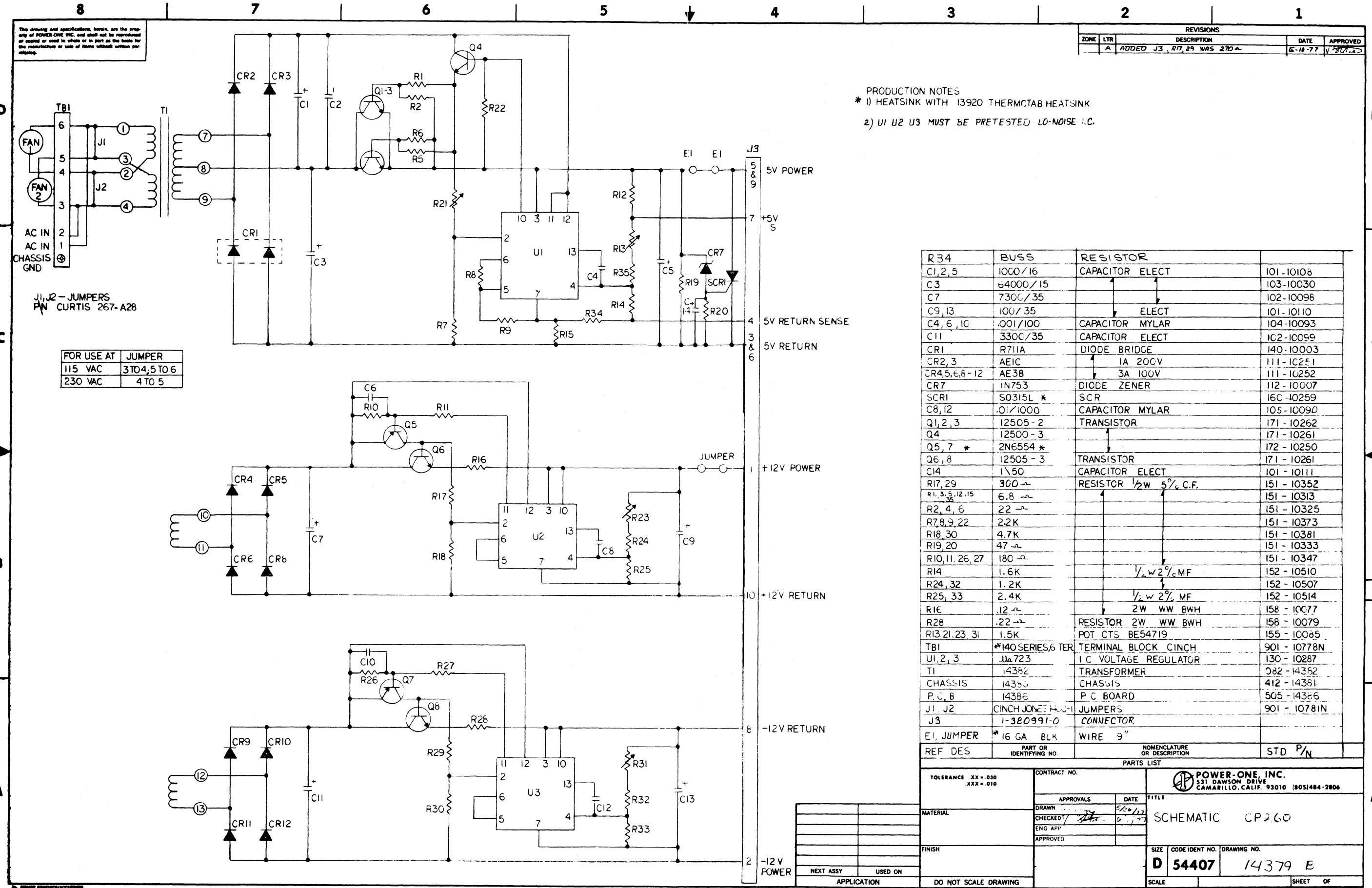


FIGURE 4-4. Condor CP559 Power Supply Schematic Diagram

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| REVISIONS |     |                           |         |               |
|-----------|-----|---------------------------|---------|---------------|
| ZONE      | LTR | DESCRIPTION               | DATE    | APPROVED      |
|           | A   | ADDED J3, R17, 29 WAS 270 | 6-18-77 | V. SUTHERLAND |



PRODUCTION NOTES  
 \* 1) HEATSINK WITH 13920 THERMOTAB HEATSINK  
 2) U1 U2 U3 MUST BE PRETESTED LO-NOISE I.C.

J1, J2 - JUMPERS  
 PN CURTIS 267-A28

| FOR USE AT | JUMPER         |
|------------|----------------|
| 115 VAC    | 3 TO 4, 5 TO 6 |
| 230 VAC    | 4 TO 5         |

| REF DES          | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | STD P/N    |
|------------------|-------------------------|-----------------------------|------------|
| R34              | BUSS                    | RESISTOR                    |            |
| C1, 2, 5         | 1000/16                 | CAPACITOR ELECT             | 101-10108  |
| C3               | 64000/15                |                             | 103-10030  |
| C7               | 730C/35                 |                             | 102-10098  |
| C9, 13           | 100/35                  | ELECT                       | 101-10110  |
| C4, 6, 10        | .001/100                | CAPACITOR MYLAR             | 104-10093  |
| C11              | 330C/35                 | CAPACITOR ELECT             | 102-10099  |
| CR1              | R711A                   | DIODE BRIDGE                | 140-10003  |
| CR2, 3           | AE1C                    | 1A 200V                     | 111-10251  |
| CR4, 5, 6, 8-12  | AE3B                    | 3A 100V                     | 111-10252  |
| CR7              | 1N753                   | DIODE ZENER                 | 112-10007  |
| SCR1             | S0315L *                | SCR                         | 160-10259  |
| C8, 12           | .01/1000                | CAPACITOR MYLAR             | 105-10090  |
| Q1, 2, 3         | 12505-2                 | TRANSISTOR                  | 171-10262  |
| Q4               | 12500-3                 |                             | 171-10261  |
| Q5, 7 *          | 2N6554 *                |                             | 172-10250  |
| Q6, 8            | 12505-3                 | TRANSISTOR                  | 171-10261  |
| C14              | 1/50                    | CAPACITOR ELECT             | 101-10111  |
| R17, 29          | 300                     | RESISTOR 1/2W 5% C.F.       | 151-10352  |
| R1, 3, 5, 12, 15 | 6.8                     |                             | 151-10313  |
| R2, 4, 6         | 22                      |                             | 151-10325  |
| R7, 8, 9, 22     | 2.2K                    |                             | 151-10373  |
| R18, 30          | 4.7K                    |                             | 151-10381  |
| R19, 20          | 47                      |                             | 151-10333  |
| R10, 11, 26, 27  | 180                     |                             | 151-10347  |
| R14              | 1.6K                    | 1/2W 2% MF                  | 152-10510  |
| R24, 32          | 1.2K                    |                             | 152-10507  |
| R25, 33          | 2.4K                    | 1/2W 2% MF                  | 152-10514  |
| R16              | .12                     | 2W WW BWH                   | 158-10077  |
| R28              | .22                     | RESISTOR 2W WW BWH          | 158-10079  |
| R13, 21, 23, 31  | 1.5K                    | POT CTS BE54719             | 155-10085  |
| TB1              | *140 SERIES 6 TER       | TERMINAL BLOCK CINCH        | 901-10778N |
| U1, 2, 3         | LM723                   | I.C. VOLTAGE REGULATOR      | 130-10287  |
| T1               | 14352                   | TRANSFORMER                 | 082-14352  |
| CHASSIS          | 14350                   | CHASSIS                     | 412-14381  |
| P.C.B            | 14386                   | P.C. BOARD                  | 505-14386  |
| J1, J2           | CINCH JONES HO-1        | JUMPERS                     | 901-10781N |
| J3               | 1-380991-0              | CONNECTOR                   |            |
| E1, JUMPER       | *16 GA BLK              | WIRE 9"                     |            |

| PARTS LIST                        |                | CONTRACT NO. |                 |
|-----------------------------------|----------------|--------------|-----------------|
| TOLERANCE XX = .030<br>XXX = .010 |                |              |                 |
| MATERIAL                          | APPROVALS      | DATE         | TITLE           |
|                                   | DRAWN          | 5/24/77      | SCHEMATIC CP260 |
|                                   | CHECKED        |              |                 |
|                                   | ENG APP        |              |                 |
|                                   | APPROVED       |              |                 |
| FINISH                            |                |              |                 |
| SIZE                              | CODE IDENT NO. | DRAWING NO.  |                 |
| D                                 | 54407          | 14379 E      |                 |
| SCALE                             |                |              |                 |
| SHEET                             |                |              |                 |

FIGURE 4-5. Power-One CP260 Power Supply Schematic Diagram 4-19/4-20



# MOTOROLA

## GENERAL INFORMATION

The monitors described herein are fully transistorized (except CRT) and applicable for displaying alphanumeric characters. The MDS3000, MDS3003 series monitors use a 12-inch CRT and the MDS4000, MDS4003 series monitors use a 15-inch CRT. Each monitor accepts a TTL non-composite video, with separate TTL horizontal and vertical sync pulses. Additional inputs include optional TTL StepScan, and/or optional +24VDC to operate the monitor.

A universal power transformer permits operating the monitor from 120, 220 or 240 volts AC, 50/60 Hz. A built-in regulated power supply provides operating voltages of +24V, +13V and +5V.

Input and output connections for the monitor are made through a standard 10-pin edge connector, (or optional 20-pin connector) on the circuit card. Inputs consist of non-composite video, horizontal sync, vertical sync, and signal ground. The optional TTL level StepScan and +24VDC are also connected to the monitor via the 10-pin edge connector. Three pins on the edge connector are also provided for alternate interconnecting of the remote brightness control.

Circuitry consists of two stages for non-composite video amplification, one integrated circuit for vertical sync and deflection processing, five stages for horizontal sync and deflection processing, and a three stage regulated power

## SERVICE MANUAL

### MDS3000, 3003 SERIES (12-INCH)

### MDS4000, 4003 SERIES (15-INCH)

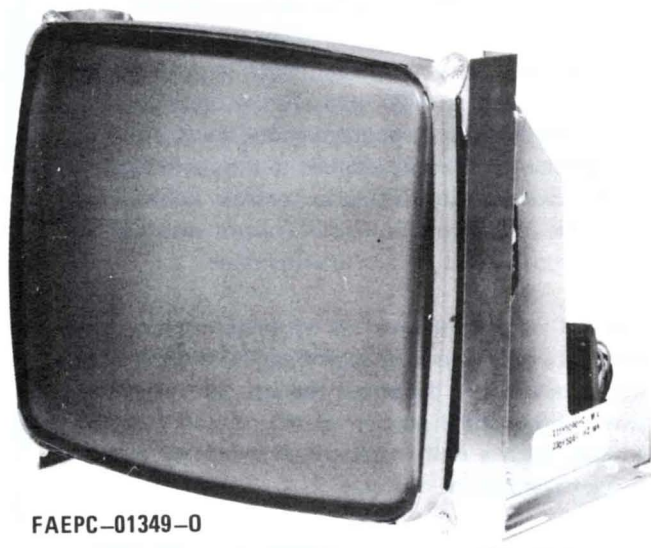
## CRT DISPLAY MONITORS

### StepScan™



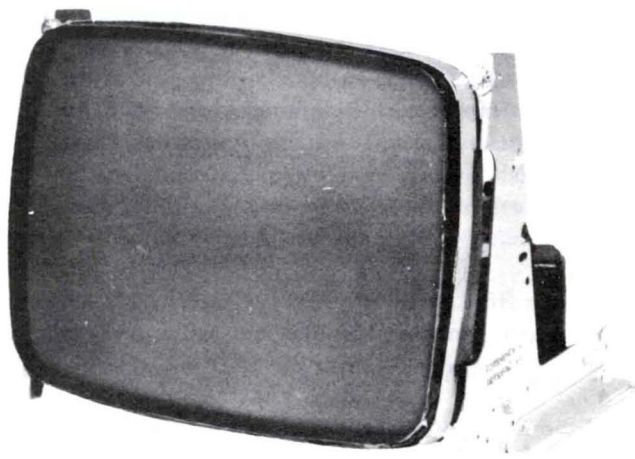
supply. All models also contain dynamic focusing and spot kill circuitry.

One etched circuit card is utilized, which contains all necessary circuitry. Components are mounted on the top of the circuit card and plated copper foil on the bottom. Schematic reference numbers are printed on the top and bottom of each circuit card to aid in the location and identification of components for servicing. All standard operating/adjustment controls are mounted in a convenient manner on the circuit card.



FAEPC-01349-0

Model MDS4000, MDS4003 Series (15" CRT)



Model MDS3000, MDS3003 Series (12" CRT)



**MOTOROLA INC.**  
Display Systems

4-21

MANUAL VP38  
1/81

PART NO. 68P25253A82  
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1299 E. Algonquin Road, Schaumburg, IL. 60196 (312) 397-8000

## SAFETY WARNING

**CAUTION: NO WORK SHOULD BE ATTEMPTED ON AN EXPOSED MONITOR CHASSIS BY ANYONE NOT FAMILIAR WITH SERVICING PROCEDURES AND PRECAUTIONS.**

1. **SAFETY PROCEDURES** should be developed by habit so that when the technician is rushed with repair work, he automatically takes precautions.

2. A **GOOD PRACTICE**, when working on any unit, is to first ground the chassis and to use only one hand when testing circuitry. This will avoid the possibility of carelessly putting one hand on chassis or ground and the other on an electrical connection which could cause a severe electrical shock.

3. Extreme care should be used in **HANDLING THE PICTURE TUBE** as rough handling may cause it to implode due to atmospheric pressure (14.7 lbs. per sq. in.). Do not nick or scratch glass or subject it to any undue pressure in removal or installation. When handling, safety goggles and heavy gloves should be worn for protection. Discharge picture tube by shorting the anode connection to chassis ground (not cabinet or other mounting parts). When discharging, go from ground to anode or use a well insulated piece of wire. When servicing or repairing the monitor, if the cathode ray tube is replaced by a type of tube other than that specified under the Motorola Part Number as original equipment in this Service Manual, then avoid prolonged exposure at close range to unshielded areas of the cathode ray tube. Possible danger of personal injury from unnecessary exposure to X-ray radiation may result.

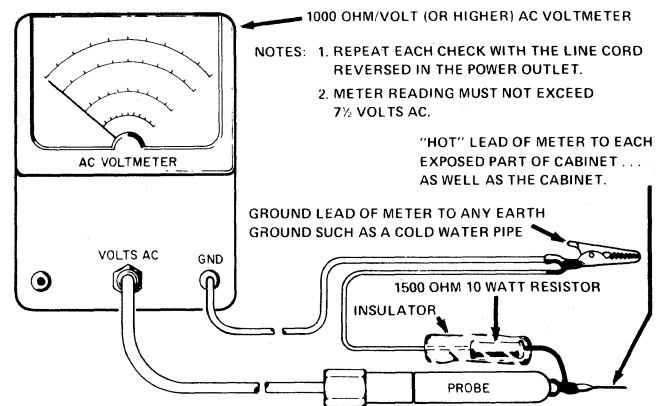
4. An **ISOLATION TRANSFORMER** should always be used during the servicing of a unit whose chassis is connected to one side of the power line. Use a transformer of adequate power rating as this protects the serviceman from accidents resulting in personal injury from electrical shocks. It will also protect the chassis and its components from being damaged by accidental shorts of the circuitry that may be inadvertently introduced during the service operation.

5. Always **REPLACE PROTECTIVE DEVICES**, such as fishpaper, isolation resistors and capacitors and shields after working on the unit.

6. If the **HIGH VOLTAGE** is adjustable, it should always be **ADJUSTED** to the level recommended by the manufacturer. If the voltage is increased above the normal setting, exposure to unnecessary X-ray radiation could result. High voltage can accurately be measured with a high voltage meter connected from the anode lead to chassis.

7. **BEFORE RETURNING A SERVICED UNIT**, the service technician must thoroughly test the unit to be certain that it is completely safe to operate without danger of electrical shock. **DO NOT USE A LINE ISOLATION TRANSFORMER WHEN MAKING THIS TEST.**

In addition to practicing the basic and fundamental electrical safety rules, the following test, which is related to the minimum safety requirements of the Underwriters Laboratories should be performed by the service technician before any unit which has been serviced is returned.



Voltmeter Hook-up for Safety Check

A 1000 ohm per volt AC voltmeter is prepared by shunting it with a 1500 ohm, 10 watt resistor. The safety test is made by contacting one meter probe to any portion of the unit exposed to the operator such as the cabinet trim, hardware, controls, knobs, etc., while the other probe is held in contact with a good "earth" ground such as a cold water pipe.

The AC voltage indicated by the meter may not exceed 7½ volts. A reading exceeding 7½ volts indicates that a potentially dangerous leakage path exists between the exposed portion of the unit and "earth" ground. Such a unit represents a potentially serious shock hazard to the operator.

The above test should be repeated with the power plug reversed, when applicable.

**NEVER RETURN A MONITOR** which does not pass the safety test until the fault has been located and corrected.

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| CIRCUIT CARD LAYOUT - SOLDER SIDE.....                    | 23 |

**\* NOTE:** A service schematic diagram and electrical/mechanical parts list for the basic MDS-Series CRT monitors is not included in this manual; instead, it accompanies this manual as a separate sheet, Motorola Part No. 68P25253A84.

For users of unique variations of the MDS-Series CRT monitors, however, order the schematic diagram by its complete model number.

## SPECIFICATIONS

### DISPLAY

- **MDS3000** — 12" diagonal measure
- **MDS4000** — 15" measured diagonally, 14" diagonal viewable area
- 110° deflection angle
- 3 x 4 aspect ratio
- P4 phosphor standard (other EIA phosphors available)
- T band U.L. implosion protection
- Direct etch and PPG optional
- **Standard Display Size:** (MDS3000) 8.5 x 6.0, (MDS4000) 10.0 x 7.5
- Capable of displaying over 3400 characters.

### VIDEO PERFORMANCE

- **Resolution:** 1200 lines center, 950 lines corners (P4 phosphor)
- **Bandwidth:** within 3 dB, 10 Hz to 30 MHz is typical.

### PERFORMANCE FEATURES

- **StepScan™:** Stepped vertical scanning option provides an increased capacity display at any horizontal frequency, thus conserving bandwidth and in many cases, eliminating the need for a higher frequency clock for increased performance.
- **Dynamic Focus:** Excellent corner focus is achieved by supplying dynamic voltage to the focus element of the cathode ray tube.

### SYNCHRONIZATION

- **Horizontal:** 15.7 kHz  $\pm$  500 Standard; 18.7 kHz  $\pm$  500 optional
- **Vertical:** 47 to 63 Hz
- **Horizontal Blanking:** 11 uSec minimum (for scanning frequency of 15.7 kHz). 10 uSec minimum (at 18.7 kHz). Time includes retrace and delay.
- **Vertical Blanking:** 800 uSec (includes retrace and video delay)

### INPUT SIGNALS

- **Horizontal:** 4 to 32 uSec, input TTL compatible, positive-going (negative optional), 4.0V PP  $\pm$  1.5
  - **Vertical:** 50 to 1400 uSec, input TTL compatible, positive (negative optional), 4.0V PP  $\pm$  1.5
  - **Video:** positive white, input termination 470 ohms  $\pm$  5%, 2.5 - 5.0V PP
- Composite video input with DHHS protection circuit optionally available.

### POWER INPUT

- 120/240V AC (105-135), 50/60 Hz, 65VA max.
- 24V DC optional

### INTERCONNECT TO CUSTOMER SYSTEM

- 10 pin edge connector standard
- 20 pin ribbon cable optional

### CONTROLS

- **Internal:** Horizontal size, horizontal video centering, brightness, focus, vertical hold, vertical size, vertical linearity. (All controls adjustable from top or back of unit).
- **External:** Brightness (as an operator control).
- Optional contrast control available.

### GEOMETRY (Pin & Barrel)

- Sides equal less than 1% of height.
- Top and bottom equal less than 1% of width.

### LINEARITY

- Character height or width will not vary  $\pm$  7% from the average character size.
- Adjacent characters will not vary more than 5%.

### ENVIRONMENT

- **Operating Temperature:** 0° to +55°C
  - **Storage Temperature:** -40°C to +65°C
- Note:** CRT's with bonded etched panels should not be subjected to storage or operating temperatures above 50°C
- **Operating Altitude:** 10,000 ft. max.

Designed to comply with DHHS Radiation Performance Standards and U.L. specifications.

\*In a continual effort to upgrade our standard products as new technological advances are made, specifications are subject to change without notice.

— NOTE —

This manual is up-to-date and correct as of the printing date.

— CAUTION —  
NO WORK SHOULD BE ATTEMPTED ON ANY EXPOSED  
MONITOR CHASSIS BY ANYONE NOT FAMILIAR WITH  
SERVICING PROCEDURES AND PRECAUTIONS.

# SERVICE NOTES

## BLOCK/SCHEMATIC DIAGRAMS

Refer to Figure 1 for a functional view of an MDS-Series Display Monitor in block form. It will help in becoming familiar with the overall schematic diagram, which accompanies this manual as a separate service sheet (Motorola Part No. 68P25253A84).

## ELECTRICAL/MECHANICAL PARTS LISTS

A complete listing of field replaceable parts in alphanumeric sequence is included on the back of the accompanying schematic diagram.

## CIRCUIT TRACING

Component reference numbers are printed on the top and bottom of the circuit card to facilitate circuit tracing. In addition, top (component) and bottom (solder) view drawings are included for convenient viewing of the circuit card. Transistor elements are identified as follows:

E – emitter, B – base, and C – collector

## COMPONENT REMOVAL

On the circuit card, component removal requires the use of a "desoldering" iron, carefully applied to pre-

vent lifting of the foil from the circuit card. An iron with a temperature controlled heating element is recommended to reduce the possibility of card damage. Use latest recommended desoldering procedures. The nozzle of the solder extracting gun should be inserted directly over the component lead which is heated only long enough to melt the solder and draw it away. This should leave the component lead free of the circuit card.

## POWER TRANSISTOR REPLACEMENT

When replacing transistors Q101 (+24V Reg.) or Q402 (Horiz. Output), use the following information and observe all precautions:

1. There are no plug-in sockets; instead, two (2) screws are soldered from the bottom of the circuit card to protrude up through the circuit card and its bracket. The transistors are secured with two (2) nuts each on the top of the circuit card bracket, which also serves as a heat sink.
2. When replacing a transistor, silicone grease (Motorola Part No. 11M490487) should be applied evenly to the top of the heat sink (circuit card bracket) and bottom of the transistor. In addition, be sure a mica insulator is positioned properly between the transistor and heat sink.

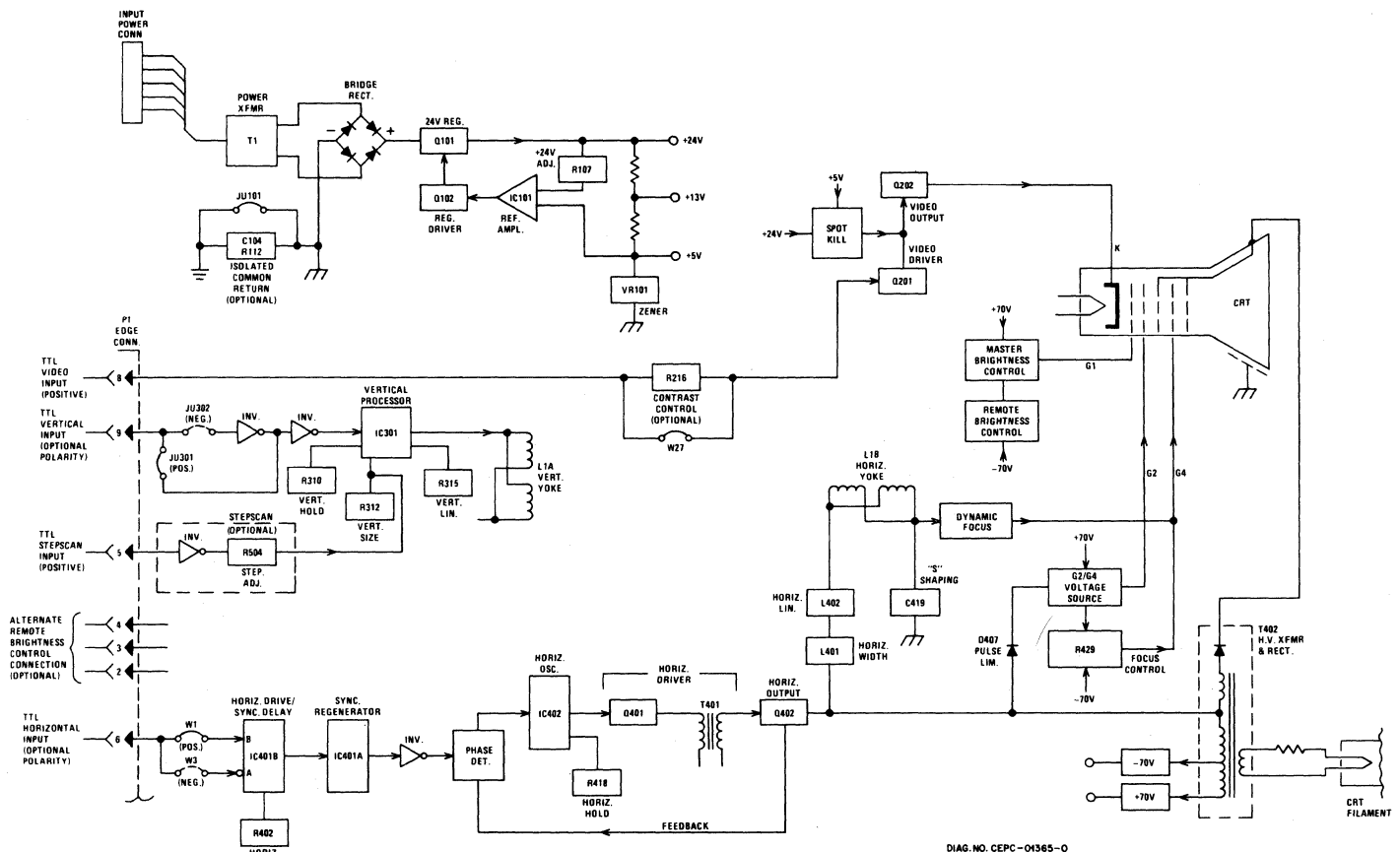


Figure 1. MDS-Series Display Monitor – Functional Block Diagram



- The transistor mounting nuts must be tight before applying power to the monitor. This insures proper cooling and electrical connections. **NON-COMPLIANCE WITH THESE INSTRUCTIONS CAN RESULT IN FAILURE OF THE TRANSISTOR AND/OR ITS RELATED COMPONENTS.**

— NOTE —

Use caution when tightening transistor mounting nuts. If the screw or nut threads are stripped by excessive pressure, a poor electrical and mechanical connection will result.

### INSTALLATION—MOUNTING SLOT HOLE DIMENSIONS

Figure 2 is a bottom view drawing that clearly illustrates mounting slot hole dimensions. Use it to identify mounting clearances in the final installation.

### CRT REPLACEMENT

#### General

Use extreme care in handling the CRT as rough handling may cause it to implode due to high vacuum pressure.

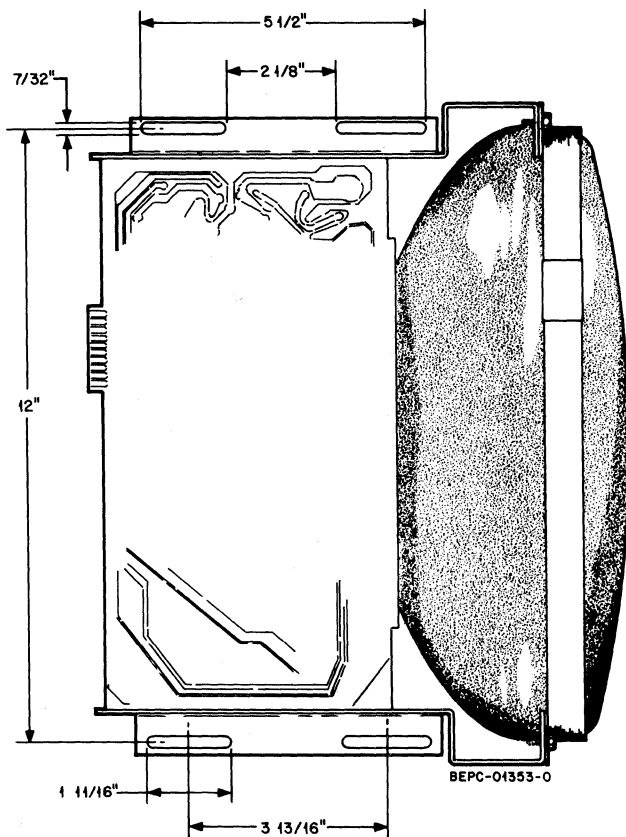


Figure 2. Mounting Slot Hole Dimensions

Do not nick or scratch glass or subject it to any undue pressure in removal or installation. Use goggles and heavy gloves for protection. Also, be sure to disconnect the monitor from all external voltage sources. Refer to Figure 5 for location of the CRT identification label. Information on the label is essential for ordering the correct replacement CRT!

#### Procedure

- Step 1. Connect a grounding strap (first) to the metal chassis for a good earth ground; then discharge CRT by shorting the H.V. 2nd anode to ground.
- Step 2. Remove the CRT socket, deflection yoke (loosen clamp screw) and 2nd anode lead.
- Step 3. Remove CRT from the front of the chassis by loosening and removing four screws, one at each corner of CRT.
- Step 4. Reverse the above steps to re-install the new CRT.
- Step 5. After installation perform operational check/adjustment procedures.

### SERVICE PHOTOGRAPHS

#### Figure 3:

Figure 3 shows the rear view of a typical MDS-Series display monitor. Callouts identify the circuit card edge connector (P1) for signal inputs, a six (6) pin power input connector, and a remote brightness control (R213) soldered to the circuit card. Variations to the aforementioned will include a different type of power connector, and the remote brightness control can be interconnected via the circuit card edge connector.

#### Figure 4:

For convenient access to the component (top) side of the circuit card, reference Figure 4. Callouts accompanying the illustration are self-explanatory.

#### Figure 5:

For convenient unobstructed troubleshooting of the circuit card, stand the monitor on its side as shown in Figure 5. Notice also in this illustration the location of the CRT identification label. The information on this label is essential for ordering the correct replacement CRT.

#### Figure 6:

Reference Figure 6 for quick identification and location of adjustable controls, transistors, integrated circuits, etc.

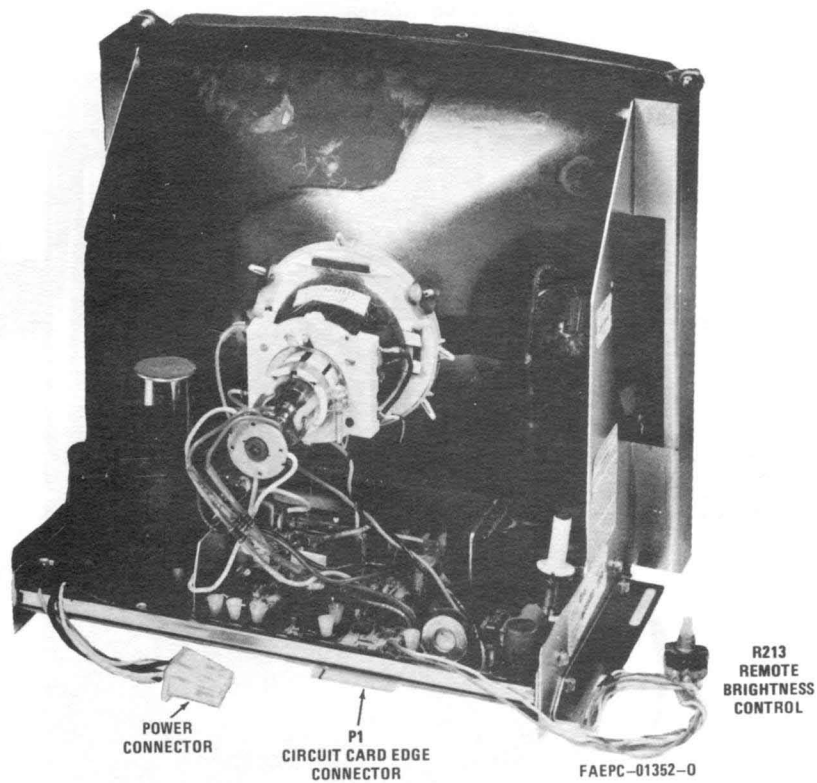


Figure 3. Typical MDS-Series Display Monitor – Rear View

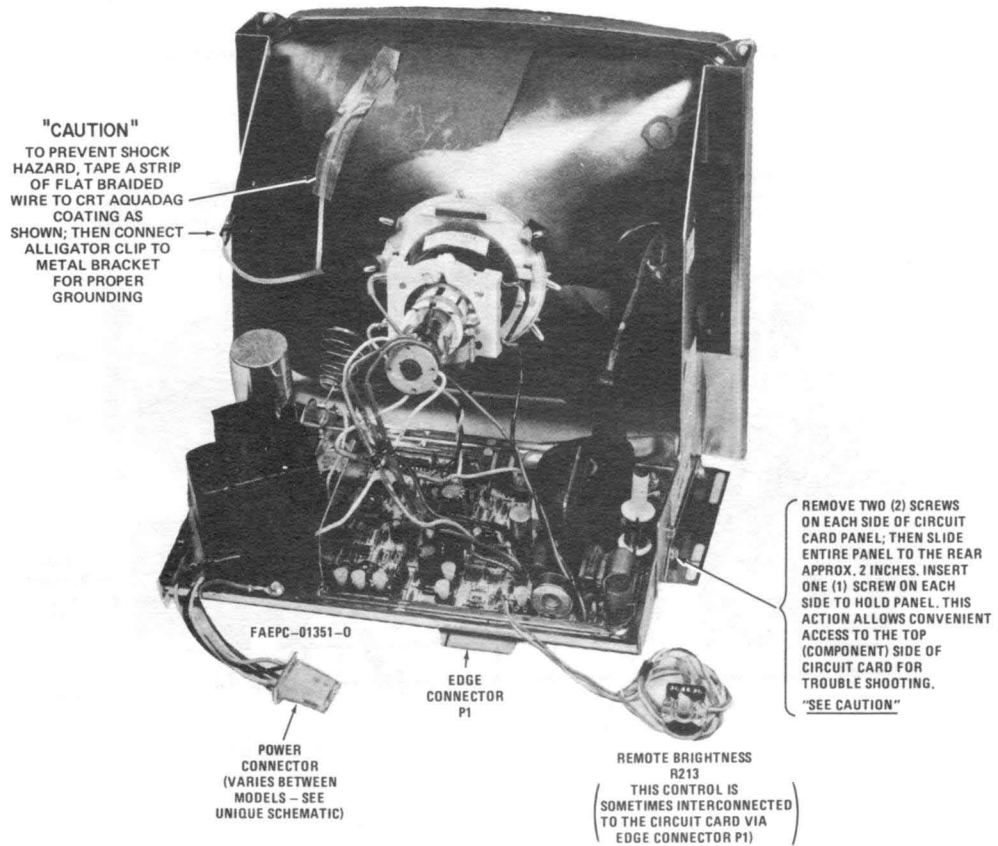


Figure 4. Circuit Card Troubleshooting from Component Side

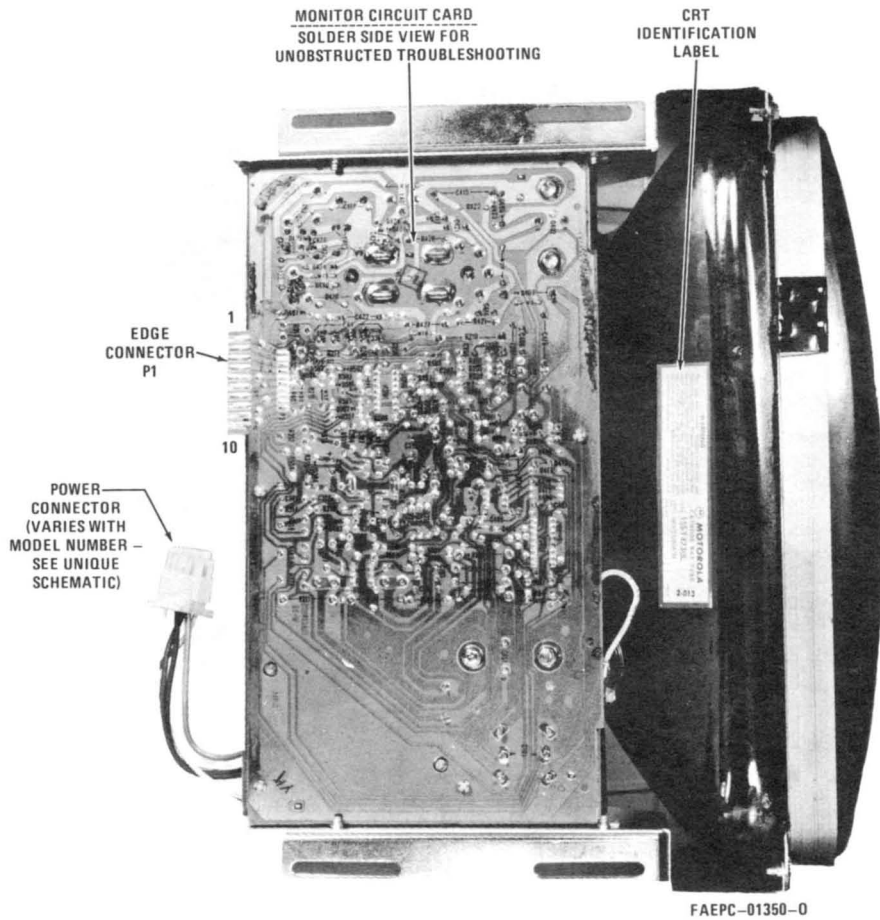


Figure 5. Circuit Card Troubleshooting from Component Side

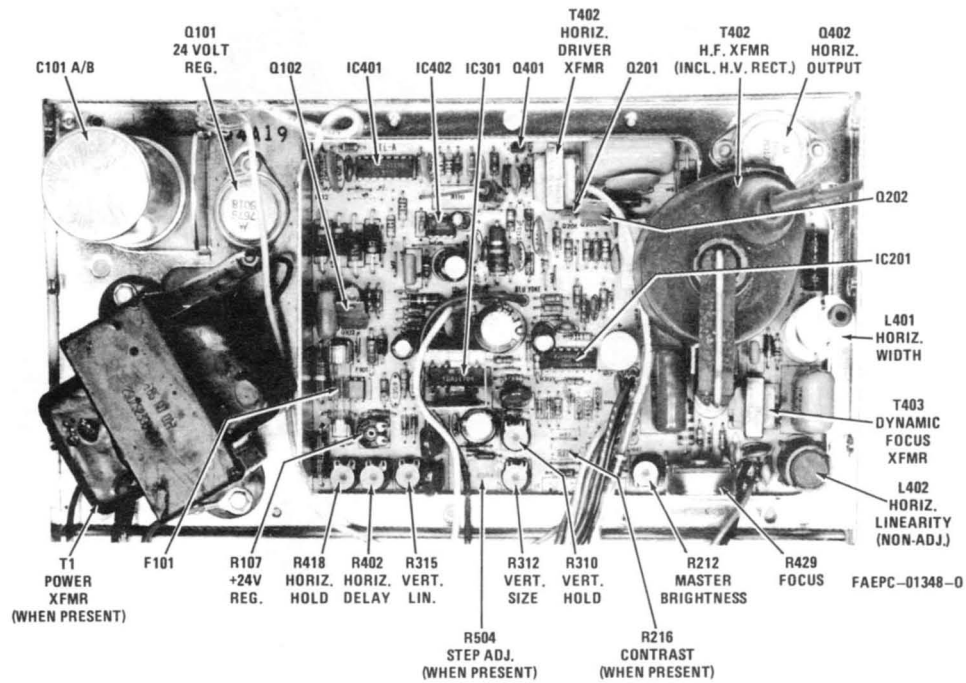


Figure 6. Identification and Location of Circuit Card Components – Adjustable Controls, Transistors, Integrated Circuits, Etc.

## OPERATIONAL CHECK/ADJUSTMENT PROCEDURES

### GENERAL

The following procedures are provided to check the operation of the monitor and perform simple preinstallation adjustments (if required), or readjust after servicing and component replacement.

When reference is made to adjust to a specific size display (vertically and horizontally), refer to original model specifications for correct dimensions by the monitor model number. This also applies to minimum and maximum tolerances when adjusting for correct CRT geometry, linearity, focus, etc.

#### – NOTE –

To assist in understanding more of the preceding terminology, refer to a separate Motorola Manual, "Incoming Inspection Guide" (Motorola part number 68P25253A71).

Perform the procedures in the sequence presented, and allow at least five (5) minutes warm-up before adjusting the monitor. In addition, when instructed to disconnect an input signal, do not ground the signal at the circuit card edge connector (P1). This action could damage the signal source generator. Instead, disconnect the signal at its source.

CCW = Counter Clockwise Rotation, CW = Clockwise Rotation. (As viewed from rear of circuit card.)

### EQUIPMENT REQUIRED

Variac (0-150 Volts AC)

Precision Digital Voltmeter

Non-Metallic Alignment Tool

Test Signals (Bench test signals must be same amplitude, polarity, and frequency as final installed operating signal source. Refer to original specifications for values by monitor model number.)

The following Motorola gauges are required for performing complete and accurate CRT geometry and linearity alignment. Refer to original model specifications for correct gauges to use.

Linearity Gauge

Slot Gauge

Parallelogram Gauge

### ISOLATED GROUND/COMMON RETURN CHECK

#### – CAUTION –

Do not connect power or signals to monitor.

**Procedure No. 1.** For monitors with circuit card common return foil isolated from metallic chassis/earth ground. Isolating components are R112 (22K resistor) and C104 (0.1 $\mu$ F capacitor); jumper JU101 is out.

Step 1. Connect ohmmeter leads between edge connector P1, pin 1, and chassis (earth) ground. Resistance reading should be 22K ohms,  $\pm$  5%.

Step 2. Connect ohmmeter leads between edge connector P1, pin 10, and chassis (earth) ground. Resistance reading should be 22k ohms,  $\pm$  5%.

#### – NOTE –

Step 3 is only for monitors that have their Remote Brightness control (R213) interconnected to the circuit card via edge connector P1, pins 2, 3 and 4.

Step 3. Connect ohmmeter leads between edge connector P1, pin 2, and chassis (earth) ground. Resistance reading should be 22K ohms,  $\pm$  5%.

**Procedure No. 2.** For monitors with non-isolated circuit card common return foil; whereby, the foil is connected direct to the metallic chassis/earth ground via a (white) wire. (Jumper JU101 is in, while components R112 and C104 are out.)

Step 1. Measure between edge connector pins and chassis (earth) ground as described in Procedure No. 1. Resistance readings should be 0.2 ohms or less.

### +24V VOLTAGE REGULATOR CONTROL ADJUSTMENT

#### Procedure

Step 1. Connect monitor to AC line supply. Adjust supply to 120 volts.

Step 2. Apply signal connector to circuit card edge connector, P1.

Step 3. Adjust Vertical (R310) and Horizontal (R418) Hold controls until display is synced.

Step 4. Connect a DC digital voltmeter or other precision accuracy voltmeter to the collector (case) of the regulator output transistor, Q101.

Step 5. Adjust the +24V Voltage Regulator control, R107, for output of +24 volts  $\pm$  0.5 volts.

Step 6. When adjustment is complete, vary the AC line supply voltage between 105 and 135 volts to check for proper regulator operation. If regulator is operating properly there should be no change in display size.

## BRIGHTNESS/CONTRAST ADJUSTMENT

### Procedure

Step 1A. Disconnect video signal input (only) at pin 8 of edge connector P1 . . .

or

Step 1B. If monitor is equipped with a Contrast control (R216 on monitor circuit card or customer supplied off-circuit card), rotate to the position that cuts off the video input signal.

Step 2. Rotate Master Brightness control (R212) fully CCW (raster off).

Step 3. Rotate Remote Brightness control (R213) fully CCW (raster off).

Step 4. Rotate Master Brightness control (R212) until the raster just begins to appear on the CRT; then back off slightly to the threshold of raster cutoff.

Step 5A. Reconnect video signal . . .

or

Step 5B. Adjust Contrast control (if present) for desired video display level on CRT.

Step 6. Adjust Remote Brightness control (R213) for desired (overall) brightness level.

## HORIZONTAL OSCILLATOR ADJUSTMENT

### Procedure

Step 1. Disconnect horizontal sync input (only) at pin 6 of edge connector P1.

Step 2. Adjust Horizontal Hold control (R418) until video display approaches best horizontal sync condition. (Without the horizontal sync input connected, however, the display will never quite lock in.)

– NOTE –

It may be necessary to temporarily increase the raster brightness with the Remote Brightness control (R213) to view the raster edges.

Step 3. Reconnect the horizontal sync signal. (At this point the video display should be in sync.)

Step 4. Adjust the Horizontal Delay control (R402) until the video display is centered horizontally within the raster (as viewed from the left side to the right side of the raster).

## HORIZONTAL SIZE ADJUSTMENT

### Procedure

Adjust Horizontal Width coil (L401) for specified video width (horizontally).

– NOTE –

To increase width, rotate coil slug CCW (away from circuit card); to decrease width, rotate coil slug CW (toward circuit card).

## VERTICAL HOLD ADJUSTMENT

### Procedure

If video display is rolling, adjust the Vertical Hold control (R310) until the video display remains locked in.

## VERTICAL SIZE/LINEARITY ADJUSTMENT

### Procedure No. 1 (Monitors without StepScan)

Step 1. Adjust the Vertical Size control (R312) until the specified size display (vertically) is obtained.

Step 2. (Refer to Figure 7.) Adjust the Vertical Linearity control (R315) until the extreme top and bottom characters (designated "A" and "B") are equal in height to the center characters (designated "C").

Step 3. Readjust the Vertical Size control (R312), if necessary, for specified size display (vertically).

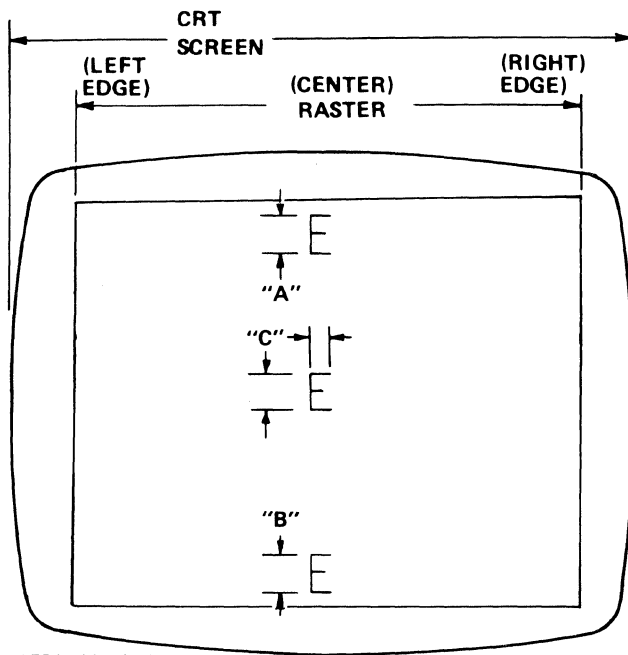
### Procedure No. 2 (Monitors with StepScan)

Step 1. With specified StepScan input connected to pin 5 of edge connector P1, rotate the Step Adjust control (R504) for minimum vertical size. (This control will be final adjusted later.)

Step 2. Adjust Vertical Size control (R312) for specified vertical size display – before StepScan is actively applied with Step Adjust control, R504.

Step 3. (Refer to Figure 7.) Adjust the Vertical Linearity control (R315) until the extreme top and bottom characters (designated "A" and "B") are equal in height to the center characters (designated "C").

Step 4. Readjust the Vertical Size control (R312), if necessary, for specified size display (vertically) as described in Step 2.



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Figure 7. Partial CRT Display of Characters for Vertical Linearity Adjustment

### STEPSCAN ADJUSTMENT (Applicable to monitors with StepScan only)

#### General

StepScan is a unique input signal that is accounted for, and incorporated, when the original video signal format is being developed. As a result, it cannot be connected to just any monitor, even if the monitor has the necessary StepScan circuitry. Check original video signal format specification.

#### Procedure:

- Step 1. Be sure specified positive-going TTL Level Step-Scan signal is connected to pin 5 of edge connector P1.
- Step 2. Rotate the Step Adjust control (R504) through its entire range slowly, and observe that the display size increases vertically.
- Step 3A. Adjust the Step Adjust control (R504) for correct vertical size per original model specifications  
...
- or
- Step 3B. If the StepScan is not required in the final installed application, rotate the Step Adjust control (R504) for minimum vertical size. (See following NOTE.)

#### – NOTE –

In Step 3B this is applicable only if the StepScan input remains connected to the edge connector from its source. However, if the StepScan source is physically disconnected from pin 5 of the edge connector, pin 5 must be grounded to pin 1 or 10. In either of these conditions, proceed to Step 4.

- Step 4. Readjust Vertical Size control (R312) to desired height vertically.

### RASTER CENTERING ADJUSTMENT (Applicable only if the CRT and/or deflection yoke have been changed.)

#### – NOTE –

Depending on the input signal format, the video display on some monitors will be down-centered more than normal within the raster. As a result, an up-centering resistor (R325) is added, which shifts the entire raster (and video display) up. (The shift will vary between 0.1 – 0.4 inches.) This action is necessary to minimize over-adjusting the Centering Magnets to recenter the video display. (Excessive adjustment of the Centering Magnets could cause geometric distortion.)

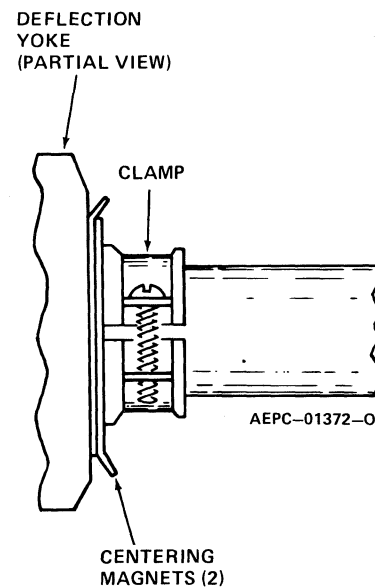


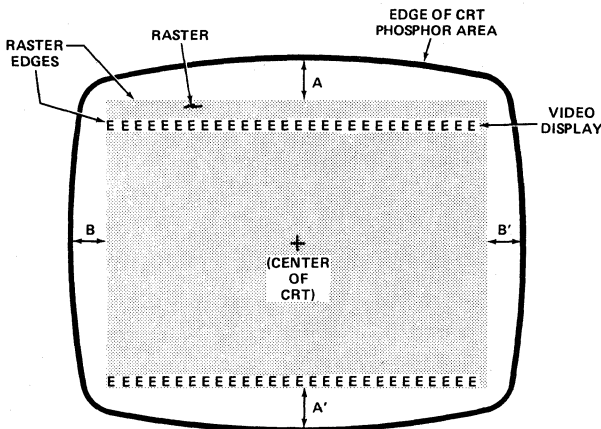
Figure 8. Partial View of CRT Neck/Deflection Yoke - Centering Magnets

**General**

This procedure should be performed while the monitor is free-standing on a bench, and in the correct sequence (preceding the Raster Geometry Adjustment procedure). Do not readjust after the monitor has been installed in a cabinet or terminal.

**Procedure No. 1 (For monitors without up-centering resistor R325.)**

- Step 1. Turn up the Remote Brightness control (R213) until the four (4) edges of the raster are visible.
- Step 2. (Reference Figure 8.) Rotate the two (2) centering magnets (simultaneously) until the raster is centered (horizontally and vertically) within the active phosphor area of the CRT. (Reference Figure 9.)
- Step 3. Readjust the Remote Brightness control (R213) for desired (overall) brightness level.



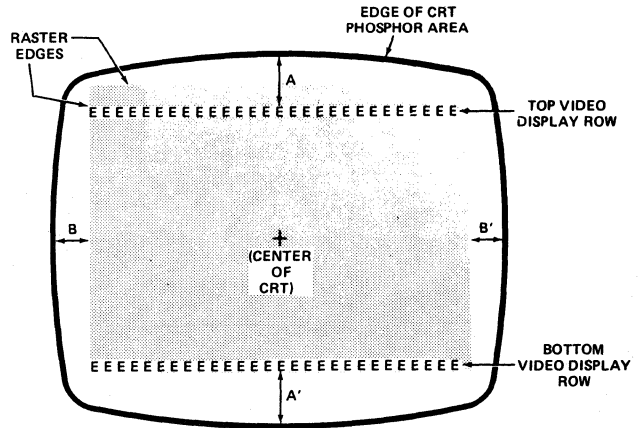
RASTER CENTERING (WITHOUT UP-CENTERING RESISTOR, R325)  
 VERTICAL: A = A' (TOP AND BOTTOM RASTER EDGES)  
 HORIZONTAL: B = B' (LEFT AND RIGHT RASTER EDGES)

AEPC-01374-0

*Figure 9. Raster Centering Without Up-Centering Resistor, R325*

**Procedure No.2 (For monitors with up-centering resistor R325.)**

- Step 1. Turn up the Remote Brightness control (R213) until the four (4) edges of the raster are visible.
- Step 2. (Reference Figure 8.) Rotate the two (2) centering magnets (simultaneously) until the left and right edges of the raster are centered horizontally, and the top and bottom edges of the video display are centered vertically within the active phosphor area of the CRT. (Reference Figure 10.)



RASTER CENTERING (WITH UP-CENTERING RESISTOR, R325)  
 VERTICAL: A = A' (TOP AND BOTTOM VIDEO DISPLAY ROWS)  
 HORIZONTAL: B = B' (LEFT AND RIGHT RASTER EDGES)

AEPC-01375-0

*Figure 10. Raster Centering With Up-Centering Resistor, R325*

- Step 3. Readjust the Remote Brightness control (R213) for desired (overall) brightness level.

**– CAUTION –**

Remember, do not readjust the centering magnets after performing the CRT Raster Geometry Adjustment procedure that follows, or after final installation. CRT raster geometry will be affected.

**RASTER GEOMETRY ADJUSTMENTS**

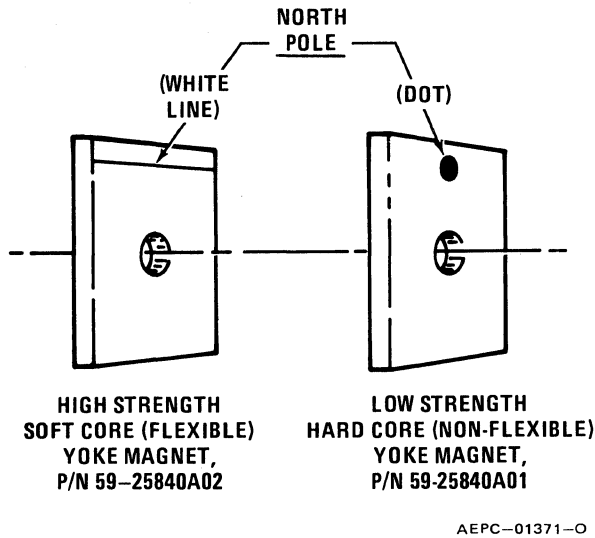
**General**

This adjustment is normally required only if the yoke and/or CRT have been replaced. Upon completion of the geometry adjustments, there may not be a yoke magnet installed on every yoke mounting pin. Normal installation ranges from one to four yoke magnets per deflection yoke. In addition, keep in mind that there will be some interaction between yoke magnets on the deflection yoke mounting pins. Whereby, as the geometry adjustment proceeds, it may be necessary to remove an earlier positioned magnet from one pin when a new magnet is positioned (or added) on a different pin.

There are two (2) different strength yoke magnets available for correcting CRT geometry. The soft core (or flexible) magnet is the stronger of the two magnets. (Reference Figure 11 to identify their north poles.) Pincushion and trapezoidal correction generally require high strength magnets, and barrel correction requires a lower strength magnet for correction.

**— WARNING —**

High voltages are present at the deflection yoke and are a potential shock hazard. Exercise caution when performing the following adjustment procedures.

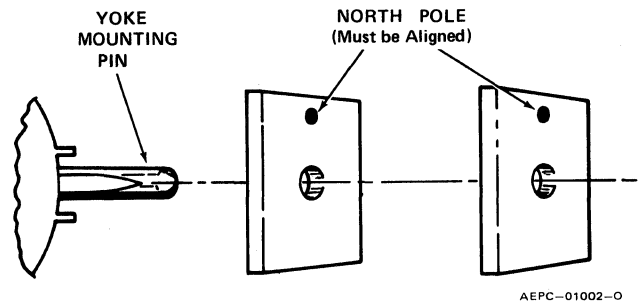


*Figure 11. Yoke Magnet North Pole Identification*

**Pincushion/Barrel Correction (top, bottom and sides) Procedure**

Perform this adjustment if the raster exhibits the abnormal effects shown in Figure 13.

- Step 1. Push a magnet on the yoke mounting pin as shown in Figure 13. A magnet should be placed only on the pin that corresponds to the affected area.
- Step 2. Rotate the magnet to obtain the desired raster, labeled "NORMAL" on Figure 13.
- Step 3. If the desired raster cannot be obtained, add a second magnet to the yoke mounting pin. Both magnets must be aligned as shown in Figure 12; then rotated simultaneously.



*Figure 12. Installing a Second Yoke Magnet*

**Trapezoidal Correction (corners) Procedure**

Perform this adjustment if the raster exhibits the abnormal effects shown in Figure 14.

- Step 1. Push a magnet onto the yoke mounting pin as shown in Figure 14. Magnet should be placed only on the pin that corresponds to the affected area.
- Step 2. Rotate the magnet to obtain the desired raster, labeled "NORMAL" in Figure 14.
- Step 3. If the desired raster cannot be obtained, add a second magnet to the yoke mounting pin. Both magnets must be aligned as shown in Figure 12; then rotated simultaneously.

**FOCUS ADJUSTMENT**

**Procedure**

The optimum focus of the display is obtained by adjusting the focus control, R429, for best focus at a point which is near the center and approximately one-third (1/3) down from the top of the display.



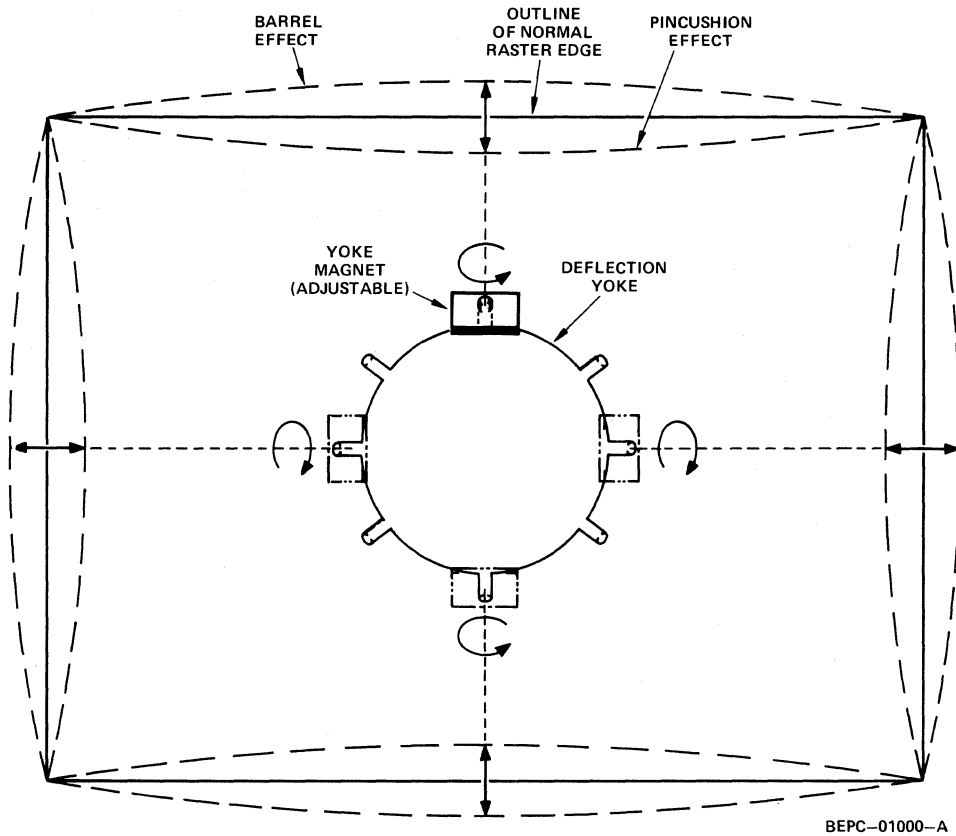


Figure 13. Pincushion/Barrel Effects and Adjustment

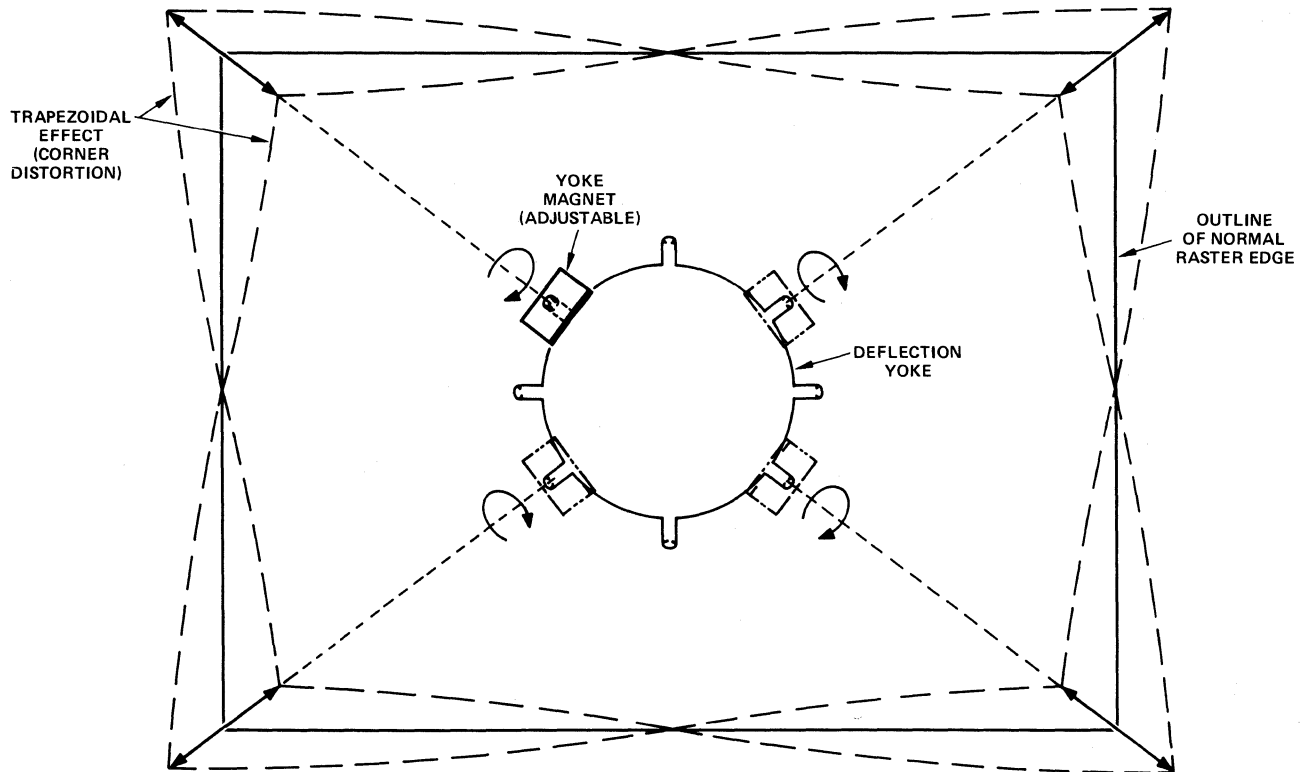


Figure 14. Trapezoidal Effect and Adjustment



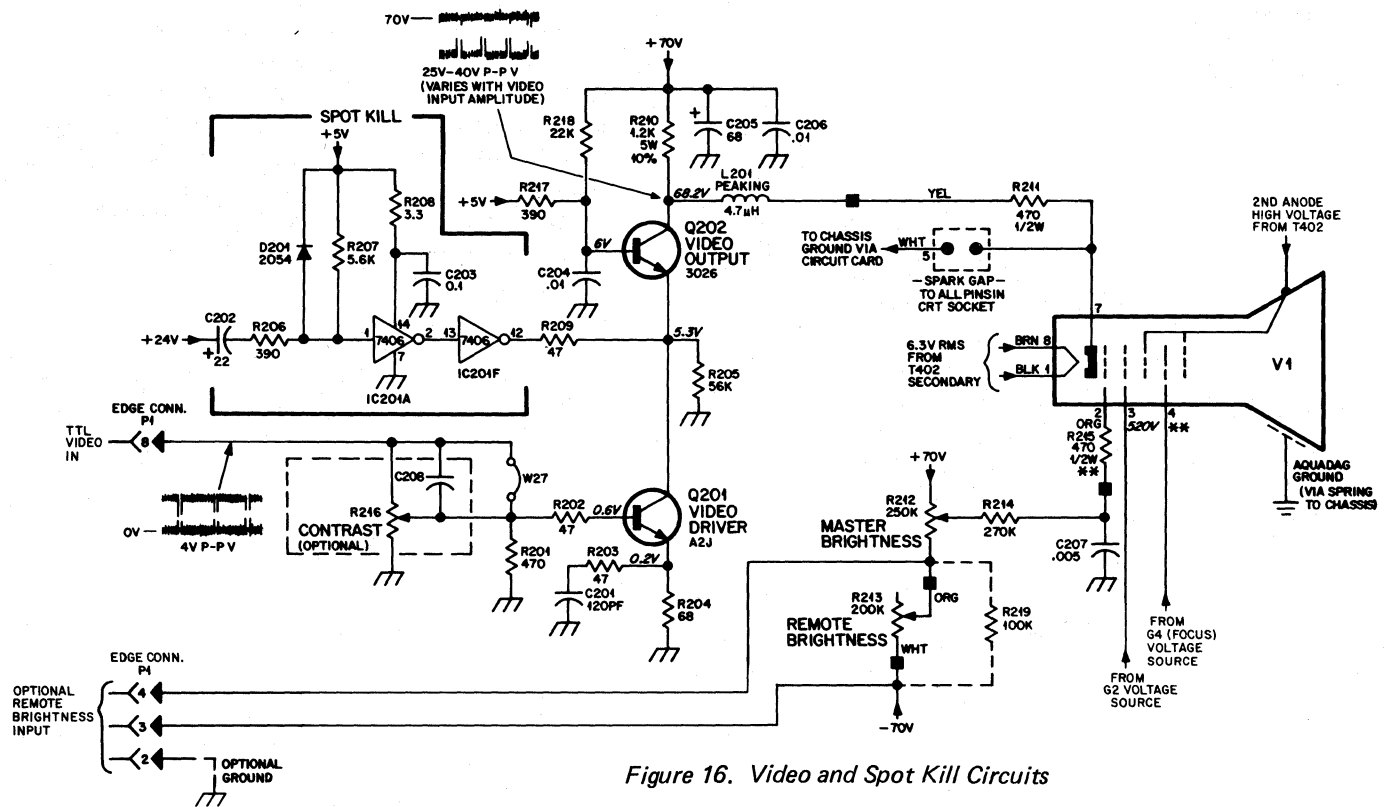


Figure 16. Video and Spot Kill Circuits

biased at 6.0V by R217 and R218. When a video signal is applied to the base of Q201, it turns on, allowing Q202 to conduct. The resultant output is developed across collector load resistor R210 and DC coupled to the CRT cathode via peaking coil L201 and resistor R211. Q202 is protected from CRT arcing by a spark gap built into the CRT socket, and R211 further isolates Q202 from transients. Capacitor C204 shorts video frequency signals from the base of Q202 to ground. Peaking coil L201 increases the high frequency response of the video amplifier. Capacitor C205 provides filtering of the +70V supply, while C206 is a high frequency AC bypass capacitor to ground.

#### SPOT KILL (Refer to Figure 16)

When power is removed from the monitor, the horizontal and vertical scans collapse and a bright spot is left that will burn a spot in the phosphor screen unless prevented from doing so.

When the monitor is turned off, the decrease in the 24V supply voltage is coupled through capacitor C202 and resistor R206 to pin 1 of IC201A. This TTL input is normally held in the high state by resistor R207. The falling 24V supply switches IC201A to the low state at pin 1, which is inverted to a high at pin 2 of IC201A; then inverted to a low again by IC201F at pin 12. The open collector output of IC201F, now in the low state (conducting), pulls R209 to ground to become the emitter resistor of Q202. With 6.0 volts on its base, Q202 saturates. The resulting low collector voltage on Q202 is coupled to the CRT cathode causing it to conduct heavily. The large cathode current in the CRT discharges the second anode during scan collapse. The second anode is completely discharged before the scan currents collapse completely so that a spot can not form.

#### STEPSCAN FUNCTION (Reference Figure 17)

StepScan is useful when it is desired to display more rows of data characters than the existing "alphanumeric video" signal format will permit. A typical display consists of 240 horizontal scan lines which form character rows of data. Between each character row is a desired amount of blank spacing which is made up of horizontal scan lines without video information. By accelerating the vertical deflection between character rows, one (1) horizontal scan line could provide the spacing between rows that would normally be occupied by three (3) horizontal scan lines (see Figure 17). This would reduce the number of blank horizontal scan lines between character rows from three (3) down to one (1). However, the physical spacing between the character rows would not change. Since two (2) horizontal lines are saved between each row, a 24 row format will accumulate 48 unused scan lines. These 48 extra scan lines will reside at the bottom of the display since the CRT still scans a total of 240 horizontal lines. Therefore, the 48 additional lines at the bottom can also be used to display data. This means an additional six (6) rows of characters can be displayed. (For example, 7 lines for char. height plus 1 line for spacing = 8 lines per char. block. 48 unused lines divided by 8 char. block lines = 6 additional rows.)

#### — NOTE —

StepScan does not actually produce the six (6) additional rows; instead, it simply provides space (and horizontal lines) for them. The six (6) additional rows of video must be designed into the original video signal format during its development.

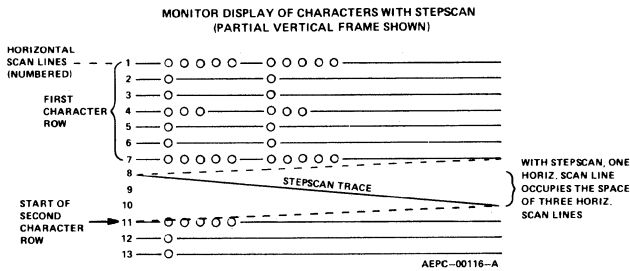


Figure 17. Displaying Characters on a Monitor with StepScan

### STEPSCAN CIRCUIT (Refer to Figure 18)

The StepScan circuit requires an external TTL positive-going pulse of approximately 4.0 volts P-P. These pulses are applied to pin 5 of IC201C through the protective network R501, D501 and D502. These pulses switch the TTL input of IC201C from the low state, normally maintained by resistor R502, to the high state. The open collector output of IC201C, pin 6, conducts during these pulses. These current pulses, regulated by control R504, are applied to the height control pin of the vertical processor, IC301. The slope of the output sawtooth current is increased during these pulses to "step" the vertical position to the next character.

The rate at which the vertical processor steps is determined by the repetition rate of the incoming StepScan pulses. The slope (charge rate) of the stepped portion of the sawtooth is adjustable with the STEP ADJ. control, R504, which varies the spacing between the character rows. With the vertical sawtooth thus modified, the yoke vertical deflection current will be "stepped" during the line between character rows chosen. One additional component associated

with StepScan operation is capacitor C307. It increases the response of IC301 internal amplifier output (pin 4) by coupling the leading edge of the StepScan pulses into the amplifier input of IC301 (pin 10).

### VERTICAL SCAN (Refer to Figure 18)

Input TTL level pulses pass through resistor R301 and protective diodes D301 and D302 to IC201B or IC201E inputs. The input to IC201B accepts, through jumper JU302, negative vertical sync and the input to IC201E accepts, through jumper JU301, positive vertical sync. R303 holds the input of IC201B low to prevent its output, an open collector, from shorting the input to IC201E when negative sync is not selected.

Output pulses from IC201E (pin 10) are differentiated by capacitor C301 and resistor R306. Diode D303 couples only the negative-going spikes from the differentiator circuit to the sync input of IC301 (pin 8). R307 and R308 provide input current limiting. The sync input (pin 8) performs several functions. It strips away any random noise that may be present on the input line and conditions the vertical pulses for processing. It also converts the input voltage pulses to current to control the internal oscillator. The oscillator generates a non-symmetrical square wave with a short duty cycle at the vertical scan frequency (50 to 60 Hz). Components R310, R311 and C304 determine the frequency. This square wave signal is applied to a ramp generator whose slope and amplitude is determined by R312, R313, C305 and C306. The ramp voltage signal is applied to a buffer stage which isolates the ramp generator from the output stages and reduces any loading effect on the previous stages. Components R314, R316 and R315 reshape the ramp voltage to make it extremely linear.

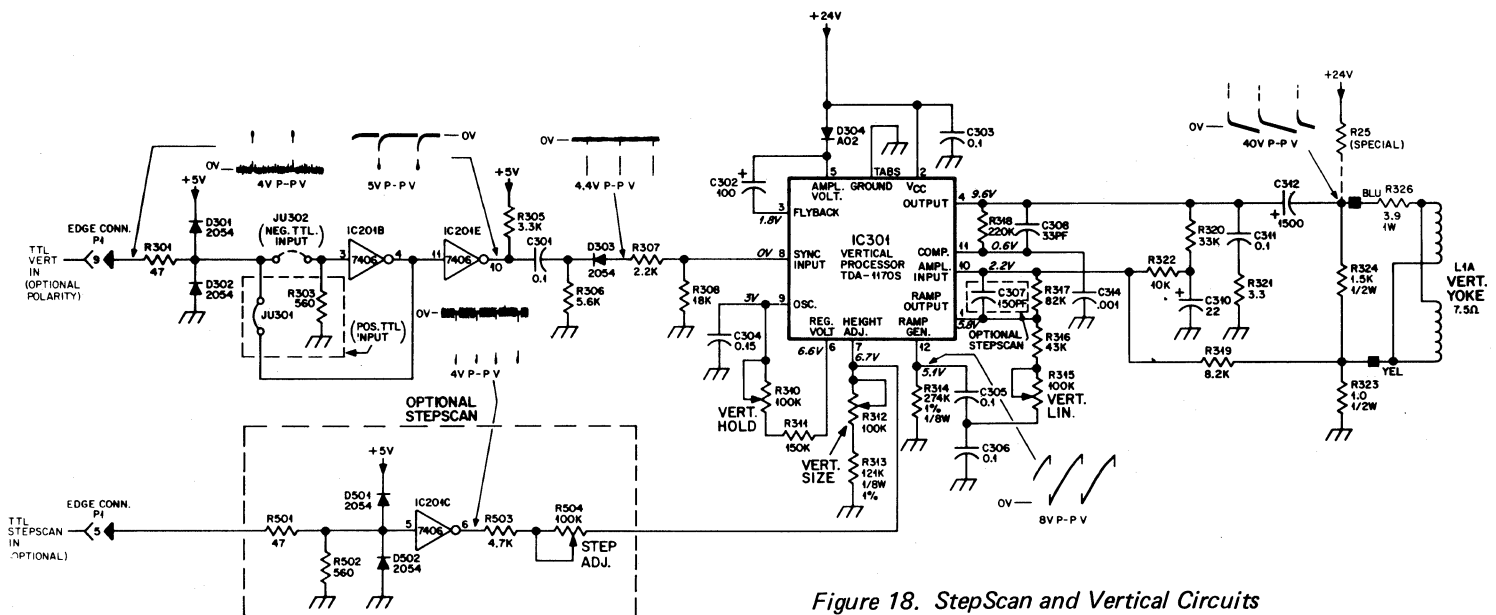


Figure 18. StepScan and Vertical Circuits

The output signal from pin 4 (IC301) drives the vertical deflection coils directly via coupling capacitor C312. Components R321 and C311 provide damping to prevent any oscillations in the output circuit. R320, R322, R319, R318, R323, C310 and C308 provide AC and DC feedback for the output stage to maintain proper gain and linearity. When the scan reaches the bottom of the screen a sync pulse initiates retrace. To insure a quick return to the top of the screen the voltage across the yoke is doubled during retrace to quickly discharge the yoke inductance. This voltage doubling circuit consists of diode D304, capacitor C302 and a transistor network in IC301. Capacitor C314 provides additional (external) compensation for IC301, pin 11. Resistor R325 (when present) is used to up-center the raster and video display.

### HORIZONTAL DRIVE/SYNC DELAY AND REGENERATOR (Refer to Figure 19)

TTL horizontal rate sync is coupled to the input of IC401B through the protective network consisting of resistor R401 and diodes D401 and D402. Jumpers W1 or W2 and W3 select positive or negative sync respectively. IC401B is a monostable multivibrator with its time constant being established by resistor R403, HORIZ. DELAY control R402, and capacitor C401. A positive pulse appears at pin 13 of IC401B, the leading edge coincident with the selected leading edge of horizontal sync and the trailing edge determined by the HORIZ. DELAY control, R402.

The falling edge of this pulse triggers IC401A, another monostable multivibrator, whose time constant (established by R406 and C403) regenerate a positive pulse at pin 5 of IC401A. Pulse width at this point is approximately equal to the input sync pulse. This pulse is inverted and increased in amplitude to 24V P-P by IC201D.

### PHASE DETECTOR (Refer to Figure 19)

The phase detector consists of two diodes D403 and

D404 in a keyed clamp circuit. Its function is to develop a control voltage for synchronizing the horizontal oscillator with the incoming sync pulses. Two inputs are required to generate the required output; one from the horizontal sync regenerator IC401A, and one from the horizontal output circuit, Q402. The required output must be of the proper polarity and amplitude to correct phase differences between the input horizontal sync pulses and the horizontal time base. Each pulse from the collector of the horizontal output, Q402, is integrated into a sawtooth by R411 and C405. Capacitor C406 blocks DC from the collector of Q402. The output transistor of IC201D is normally at cut-off and its collector voltage rests at approximately 24 volts. Since C404 is connected to the output of IC201D, it will charge up to the collector voltage. When a pulse turns on and saturates the output of IC201D, its collector voltage drops to near ground potential. C404 will now discharge, coupling a negative-going sync pulse to the cathodes of D403 and D404. This negative potential is sufficient to forward bias both diodes to conduct and discharge any positive or negative charge on C405 to ground. In other words, it clamps the voltage on capacitor C405 during sync pulse time to approximately zero volts.

Without considering the sync pulses, the sawtooth wave would cause current flow into capacitor C405 when it is negative, and out of C405 when it is positive. Since the sawtooth is symmetrical about its AC axis, the charge and discharge currents of C405 are equal. C405 would therefore average a zero voltage level. A sync pulse (waveform A, Figure 20) clamping the sawtooth as it passes through its AC axis (waveform B, Figure 20), will not affect its positive and negative symmetry. Therefore, the average voltage on C405 would remain zero. However, if the horizontal time base begins to lag, the sync pulse will clamp the sawtooth to ground at a point below its AC axis, resulting in a non-symmetrical charge on C405. This clamping action will cause the sawtooth's AC axis to shift to a point above the

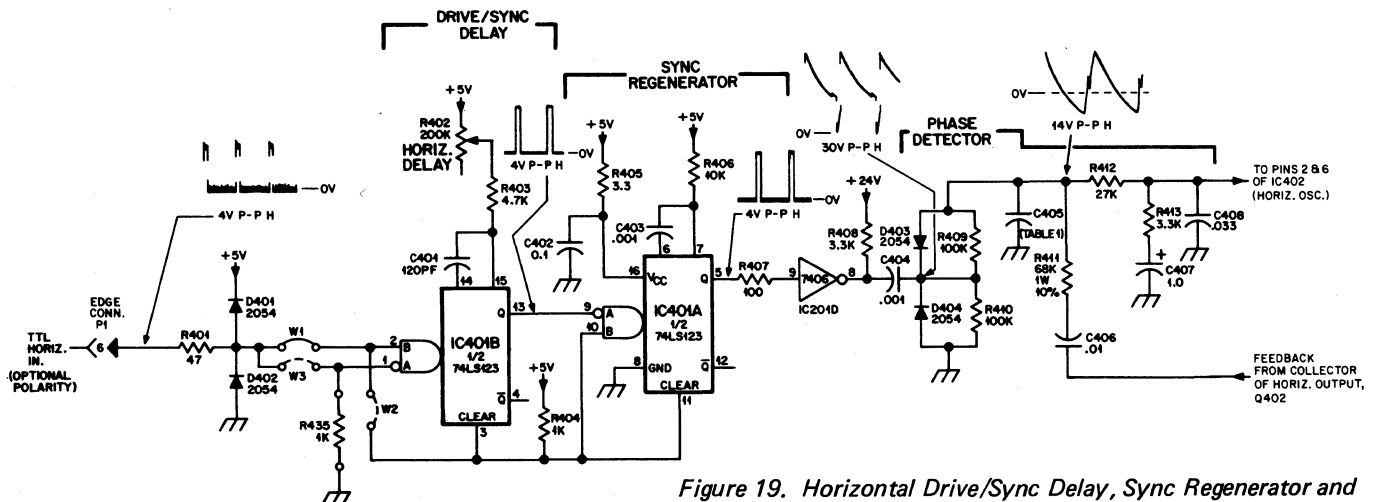


Figure 19. Horizontal Drive/Sync Delay, Sync Regenerator and Phase Detector Circuits

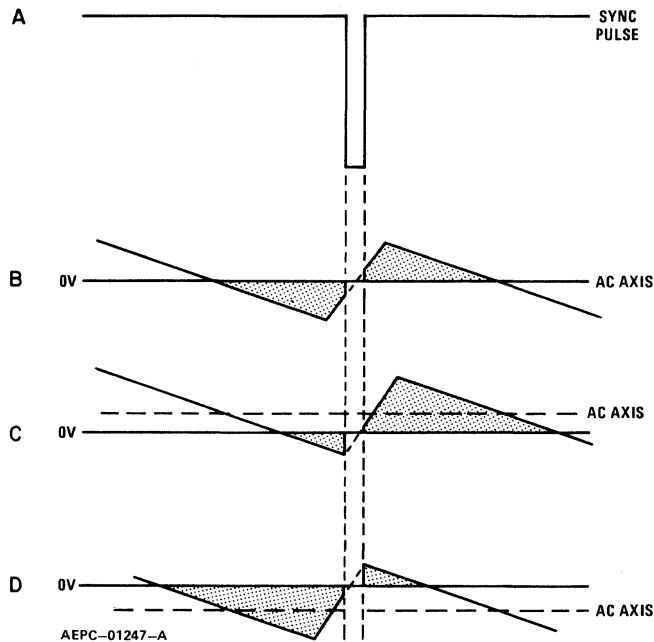


Figure 20. Phase Synchronization Waveforms

ground reference (waveform C, Figure 20). Therefore, most of the sawtooth's waveform is now above ground which will produce a positive voltage on C405. This is the correct polarity to cause the horizontal oscillator to speed up to correct the phase lag. Likewise, if the horizontal time base is leading the sync pulse, the sawtooth will be clamped to ground at a point above its AC axis. This clamping action will cause the sawtooth's AC axis to shift to a point below the ground reference (waveform D, Figure 20). Now most of the sawtooth's waveform is below ground, which will produce a negative voltage on C405. This is the correct polarity to cause the horizontal oscillator to slow down. The voltage level on C405 is dependent upon which point of the sawtooth is clamped. This also determines how far its AC axis will shift above or below ground.

R412, C407, R413 and C408 comprise the phase detector filter. The bandpass of this filter is designed to provide correction of horizontal oscillator phase without ringing or hunting.

#### HORIZONTAL OSCILLATOR/DRIVER (Refer to Figure 21)

Integrated circuit timer IC402 operates as an astable square wave oscillator. Its free running frequency is determined by resistors R415, R416, and capacitor C409. The phase detector correction voltage is coupled through resistor R414 to pins 2 and 6 of IC402 to vary the frequency of the oscillator. A second input to IC402, pin 5, allows control of the oscillator free-run frequency by means of R418, HORIZ. HOLD control.

The non-symmetrical output of IC402 (pin 3) is coupled to the horizontal driver transistor, Q401, through C411 and current limiting resistor R419. D405 protects Q401 from

reverse base-emitter voltage. Q401 operates as a switch to drive the horizontal output transformer T401. T401 is a voltage stepdown transformer to provide a low impedance drive to Q402. R421 is a current limiting resistor for Q401 and C414 is an AC bypass capacitor. R420 and C413 damp the transformer to prevent ringing when Q401 goes into cutoff.

#### HORIZONTAL OUTPUT (Refer to Figure 21)

The secondary of T401 provides the required low drive impedance for Q402. Components R422 and C415 form a time constant for fast turn-off of Q402. The horizontal output transistor, Q402, is simply a switch that is turned on and off at the horizontal scan rate by the drive signal applied to its base. A sawtooth current through the deflection coils is required to sweep the beam linearly across the CRT screen. The sweep begins at the center of the CRT and sweeps to the right. This happens when Q402 is turned on and its collector voltage drops to near zero. C419 begins discharging through the deflection coils to deflect the beam to the right edge of the CRT. At this time, Q402 cuts off and C419 ceases to supply current to the deflection coils. However, an induced voltage appears across the deflection coil as the magnetic field collapses, and an oscillation occurs between the deflection coils and C416.

During the first half cycle of this oscillation, the induced voltage is felt across the collector of now cut off Q402, C416, and the primary of T402, the flyback transformer. This voltage is stepped up by T402 and rectified to produce the required high voltage that is applied to the 2nd anode of the CRT. The electron beam is also deflected to the left edge of the CRT at this time because the collapsing magnetic field of the deflection coils reverses polarity.

During the second half cycle of the deflection coils/C416 oscillation, the voltage on the collector of still cut off Q402 becomes negative. At this time, camper diode D406 becomes forward biased and begins conduction. The deflection coil current gradually decreases to zero during damper conduction allowing the beam to sweep linearly to the center of the screen.

The horizontal retrace pulse charges C422 through D407 to provide operating voltage for G2 of the CRT. Momentary transients at the collector of Q402, should they occur, are limited to the voltage on C422 since D407 will conduct if the collector voltage exceeds this value. Coil L402 is a magnetically biased Horiz. Linearity coil that shapes the deflection current for optimum trace linearity. Coil L401 is a series Horiz. Width control. Components R425 and C418, R424 and C417 are damping network components for the Horizontal Linearity (L402) and Width (L401) controls.

The 24 volt supply to the horizontal output is coupled through diode D409 to pin 3 of the transformer, T402. Autoformer action of the transformer boosts the effec-

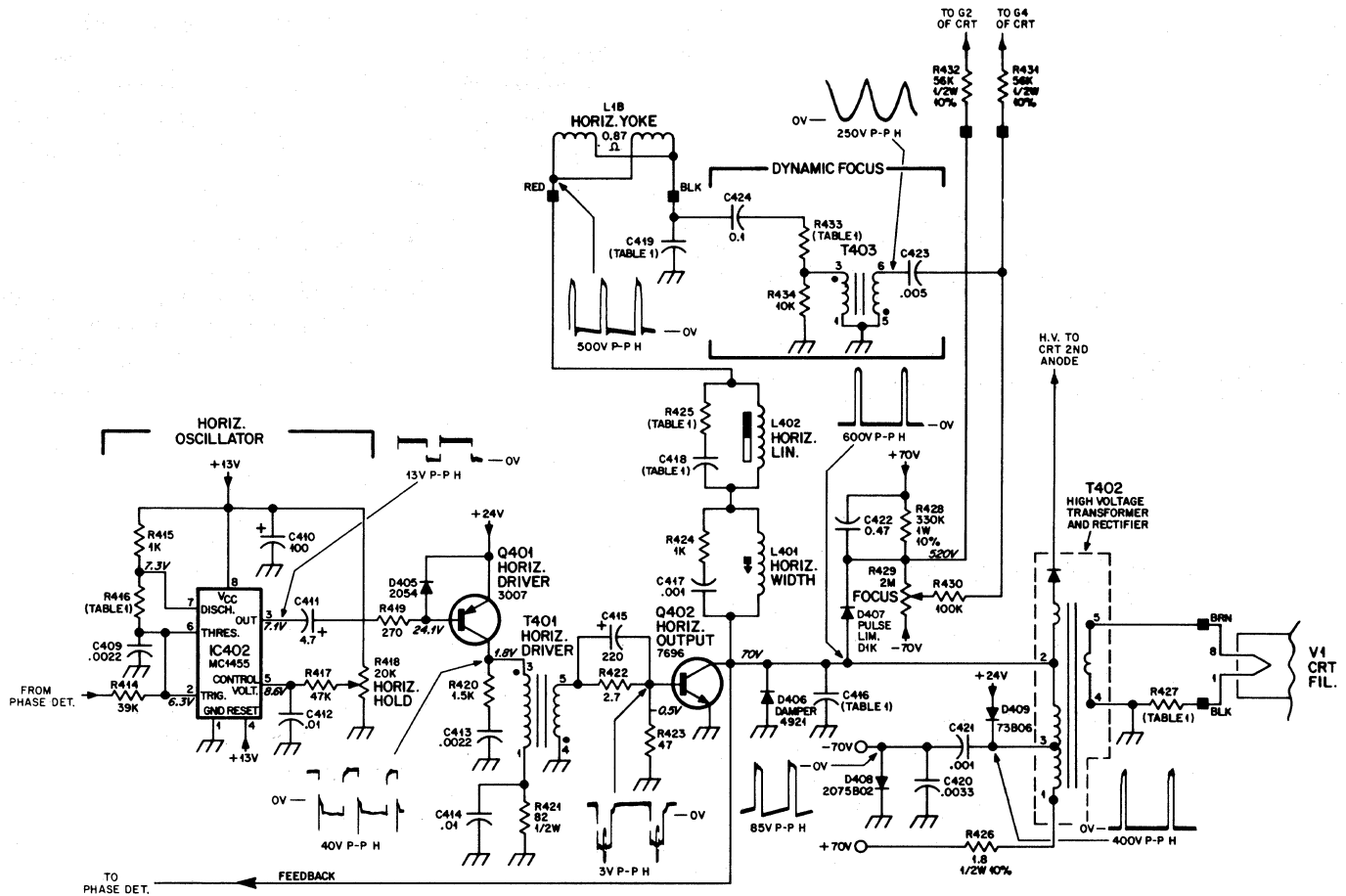


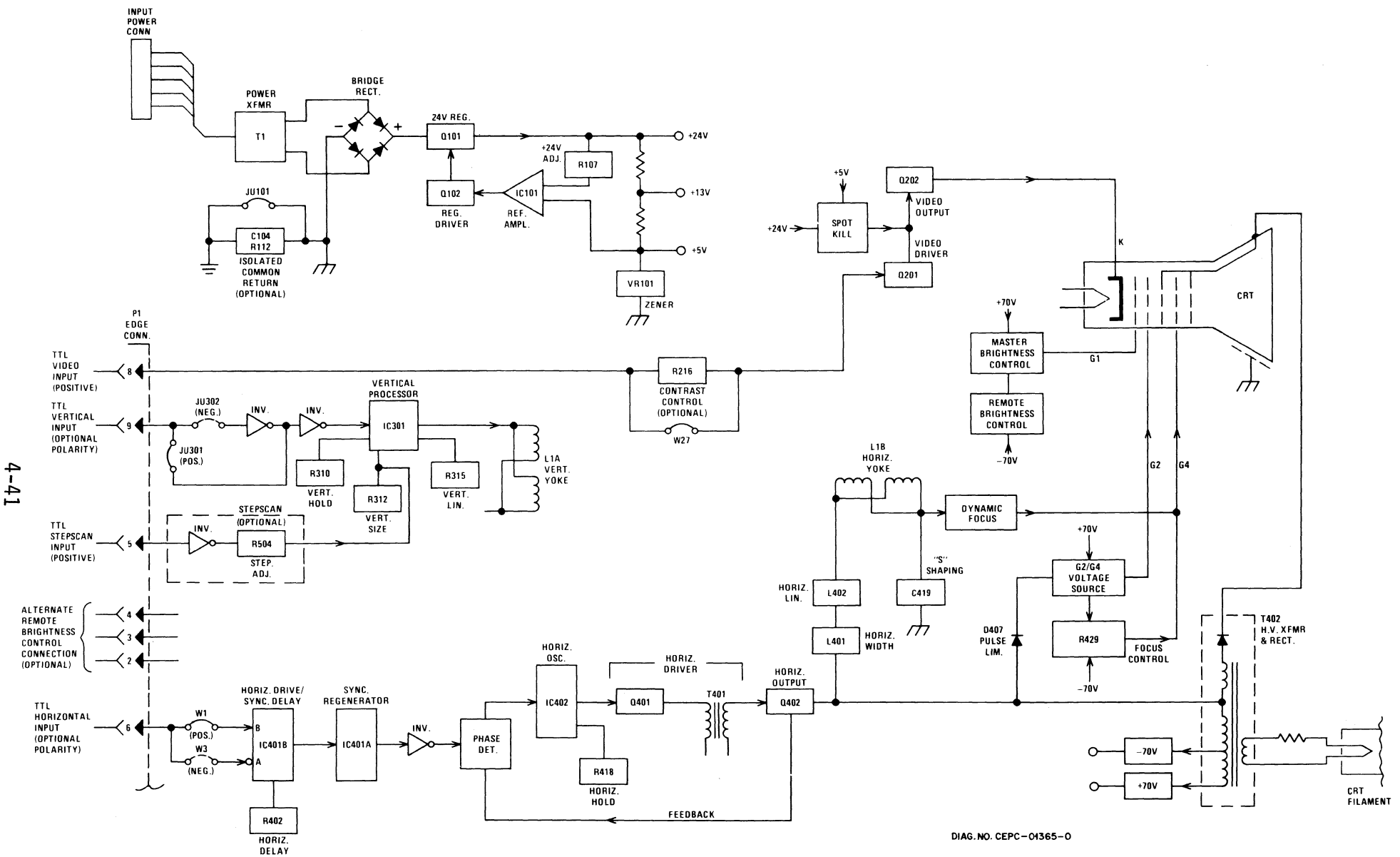
Figure 21. Horizontal Oscillator, Driver and Output Circuits, and Dynamic Focus Circuit

tive supply voltage to the transformer to the 70 volts appearing on pin 1 of T402. This voltage is filtered by C205 and provides the 70 volt source for the chassis. A capacitive divider, C421 and C420, and diode D408 provides a -70 volt supply for the CRT G1 electrode.

#### DYNAMIC FOCUS (Refer to Figure 21)

Due to the geometry of a CRT, the electron beam travels a greater distance when deflected to a corner as compared to the distance traveled at the center of the CRT screen. As a result of these various distances traveled, optimum focus can be obtained at only one point. For general applications, an adequate adjustment can be realized by setting the focus while viewing some point mid-way between the center of the CRT screen and a corner, thus optimizing the overall screen focus. When an application requires a

tighter specification, one of the simplest methods for improvement is to modulate the focus voltage at a horizontal sweep rate. Now optimum focus voltage is made variable on the horizontal axis of the CRT, which compensates for the beam travel along this axis. The AC component of the focus voltage is developed by stepping up the voltage across capacitor C419 via transformer T403. The linear current ramp in the horizontal yoke winding, L1B, also flows through capacitor C419. The ramp is integrated, the result being a parabolic waveform. This parabola is coupled through capacitor C424 and resistor R433 to the primary of transformer T403. The approximately 250V P-P parabola present at pin 6 of T403 is superimposed on the DC voltage from the FOCUS control, R429, via capacitor C423. This mixed AC and DC voltage results in a waveform of proper phase and amplitude, which is coupled through isolating resistor R431 to the CRT focus anode.



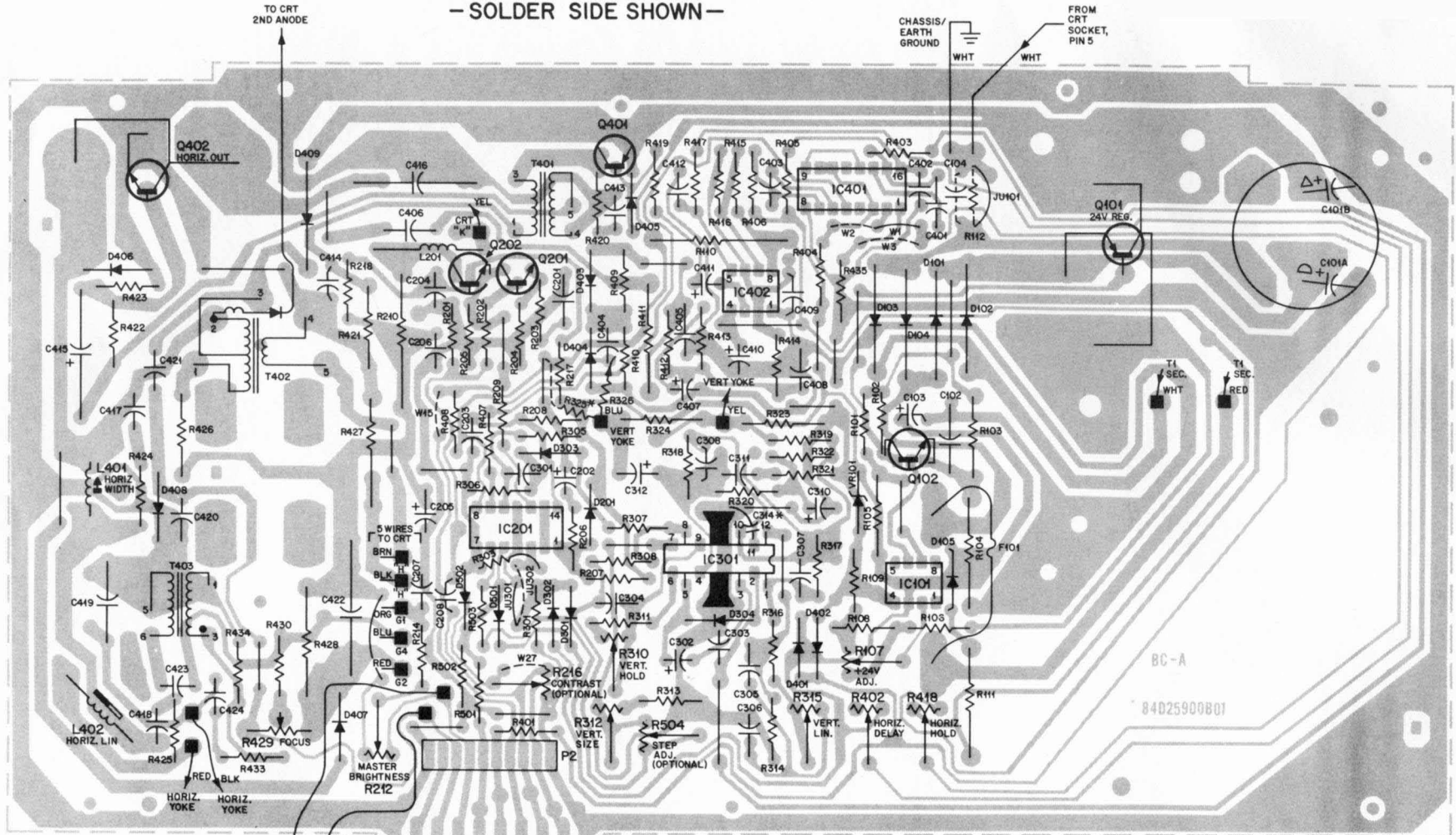
Block Diagram



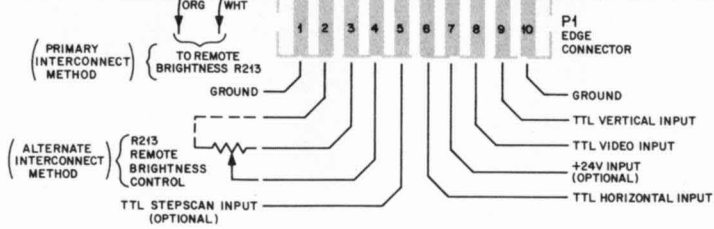


4-43/4-44

- SOLDER SIDE SHOWN -



BC-A  
84025900801



\* LOCATED ON SOLDER SIDE OF CIRCUIT CARD

SOLDER SIDE FOIL OVERLAY DEPC-01346-0  
DEPC-01347-0

Circuit Card Layout - Solder Side

## APPENDIX A

### GLOSSARY OF TERMS

ACCUMULATOR - A register of the arithmetic/logic unit of a central processor used as intermediate storage during the formation of algebraic sums, or for other intermediate logical and arithmetic operations.

ACIA (asynchronous communication interface adapter) - An integrated circuit that provides a means of efficiently interfacing the MPU to devices requiring an asynchronous serial data format.

ACTIVATE - To make a process eligible for execution.

ASCII CODE - The acronym for American Standard Code for Information Interchange. This standardized code is used extensively in data transmission. The code includes 128 upper case and lower case letters, numerals, and special purpose symbols, each encoded by a unique 7-bit binary number.

ASYNCHRONOUS COMMUNICATION - A method of transferring data where the timing of character placement on connecting communication lines is not critical. Each transferred character is preceded by a start bit and followed by a stop bit, permitting the interval between characters to vary.

BAUD RATE - Synonymous with signal events (bits)-per-second and used as a measure of serial data flow between a computer and/or communication devices.

BIT - A binary digit. A bit is the smallest unit of data in a digital computer.

BREAKPOINT - A location in a program at which execution of that program can be halted to permit visual check, printing out, or other performance analysis.

BUFFER - An electronic circuit which forms a temporary store for data or information signals.

BUS - A circuit or group of circuits which provide a communication path between two or more devices, such as between a central processor, memory, and peripherals.

BYTE - A set of contiguous binary bits, usually eight, which are operated on as a unit. A byte can also be a subset of a computer word.

CARRY BIT - A condition (or status) bit that can be set or reset by certain data operations, and its status can be directly tested by a program.

CHARACTER - One of a set of alphabetic, numeric, and/or graphic symbols. Each character is represented in its set by a unique binary code.

CIRCULAR QUEUE - A mechanism that allows variable amounts of data to be stored until a process is ready to receive it.

CODE - A system of characters and rules for representing information in a language capable of being understood and used by a computer. Code can be in the form of alphanumeric characters or binary data that can be directly executed by a computer.

CONTROL CHARACTER - A character whose occurrence in a particular context initiates, modifies, or halts operation.

COUNTER - A device such as a register or a memory location which is used to record the number of events. Counters can typically be incremented, decremented, preset to a value, or cleared.

CYCLE TIME - The time required by a computer to read from or write into the system memory. If system memory is core, the read cycle time includes a write-after-read (restore) subcycle. Cycle time is often used as a measure of computer performance, since this is a measure of the time required to fetch an instruction.

EXECUTE - To perform a specified computer instruction. To run a program.

FETCH - The action of obtaining an instruction from a stored program and decoding that instruction. Also refers to that portion of a computer instruction cycle when that action is performed.

FIRMWARE - A computer program (software) that is implemented in hardware, such as read-only memory.

FLAG - An indicator, usually a single binary bit, whose state is used to inform a later section of a program that a condition, identified with the flag and designated by the state of the flag, had occurred. A flag can be software and/or hardware implemented.

HALF DUPLEX - Refers to a communication channel which can receive and transmit, but not simultaneously.

INTERRUPT - Suspension of normal program execution to execute a higher priority service routine, as requested by a peripheral device. After completing service routine execution, the interrupted program execution is restored at the point where it was interrupted.

INSTRUCTION - The smallest single operation that the computer can be directed to operate.

INTERRUPT VECTOR - Typically, two memory locations assigned to an interrupting device and containing the starting address and processor status word for its service routine.

JUMP - An instruction which, when executed, can cause the computer to fetch the next instruction to be executed from a location other than the next sequential location. Synonymous with "Branch".

LINE ROLLOVER - Cursor moving to the left on a display screen - proceeds from left-most column of current line to right-most column of previous line; proceeds from left-most column of top line to right-most column of last line. Cursor moving to the right - proceeds from right-most column of current line to left-most column of next line; proceeds from right-most column of last line to left-most column of top line.

MEMORY - A general term which refers to any storage media for binary data. Basic memory functional types include read/write and read-only.

MEMORY MAP - A listing of addresses or symbolic representations of addresses which define the boundaries of the memory address space occupied by a program or a series of programs.

MICROPROCESSOR - A single LSI circuit which performs the functions of a CPU. Some characteristics of a microprocessor include small size, inclusion in a single integrated circuit or a set of integrated circuits, and low cost.

MONITOR - A program, typically part of a larger operating system, which provides a uniform method of program timing, scheduling, and handling of input/output tasks.

OVERFLOW - A condition occurring in a computer when the results of a mathematical operation produces a result which has a magnitude exceeding the capacity of the computer data word size.

PAGE ROLLOVER - Cursor movement upward on a display screen - proceeds from top line to last line in same column. Cursor movement downward - proceeds from last line to top line in same column.

PARITY CHECK - A method of checking the correctness of binary data after that data has been transferred from or to storage. An additional bit, called the parity bit, is appended to the binary word or character to be transferred. The parity bit is the single-digit sum of all the binary digits in the word or character, and its logical state can be assigned to represent either an even or an odd number of 1's making up the binary word. Parity is checked in the same manner in which it is generated.

PC (program counter) - A special-purpose CPU register which contains the address of the next instruction to be fetched and executed.

PIA (peripheral interface adapter) - An integrated circuit that provides a flexible method of connecting byte-oriented peripherals to an MPU. The PIA features built-in registers which not only make it programmable but also provide temporary data storage to simplify data transfer.

PRIORITY - The sequence in which various entries and tasks are processed or peripheral devices are served. Priorities are based on analyses of codes associated with an entry or task, or the positional assignment of a peripheral device within a group of devices.

PROCESS - A body of code (a program) performing a specific function(s).

PROGRAM - A complete sequence of computer instructions necessary to solve a specific problem, perform a specific action, or respond to external stimuli in a prescribed manner. As a verb, it means to develop a program.

RAM (random-access memory) - A computer memory structured so that the time required to access any data item stored in the memory is the same as for any other item.

REGISTER - A temporary storage unit which can be implemented as a hardware device or as a software structure, and used to store data for manipulation and/or processing reference. Typically, a register consists of a single computer word or a portion of a word.

SERIAL I/O - A method of data transfer between a computer and a peripheral device in which data is transmitted for input to the computer (or output to the device) bit by bit over a single circuit.

SCRATCH PAD MEMORY - Any memory space used for the temporary storage of data. Typically, scratch pad memories are high-speed integrated circuits which are addressed as internal registers.

SERVICE ROUTINE - A set of instructions to perform a programmed operation, typically in response to an interrupt.

SHIFT REGISTER - A register in which binary data bits are moved as a contiguous group a prescribed number of positions to the right or to the left.

STACK - A dynamic, sequential data list, usually contained in system memory, having special provisions for program.

STATIC MEMORY - A type of semiconductor read/write random access memory which does not require periodic refresh cycles.

SUBROUTINE - A short program segment which performs a specific function and is available for general use by other programs and routines.

USER PROGRAM - A program written by the user to make the system perform any desired task.

VECTOR - See INTERRUPT VECTOR.

WORD - A set of binary bits handled by the computer as the primary unit of information. The length of a computer word is determined by the hardware design. Typically, each system memory location contains one word.

## APPENDIX B

### CRT EDITOR MODE

#### INTRODUCTION

The purpose of this appendix is to describe the CRT editor mode personality of the terminal, how the CRT editor mode is invoked, and what the user may expect to be sent from the CRT.

#### CRT EDITOR MODE PERSONALITY

The CRT editor control firmware resides in a 2K ROM mounted on the CRT controller board. The firmware interfaces with the CRT control firmware.

A special EROM socket is mounted on the controller board at location U89 to allow the placement of the CRT editor EROM.

#### General Processing Characteristics

The CRT editor personality is enabled/disabled by the host system through the use of commands transmitted across the communication line. If the CRT editor mode is enabled, the CRT enters a pseudo half-duplex mode requiring no echo from the host, and performs certain text editing functions. Optionally, the terminal notifies the host system when the cursor has been moved off the current line. If the current line has changed, the new data is always transmitted as part of a message packet.

When the CRT editor mode is disabled, the terminal performs normally. All data and command message packets sent by the terminal to the host system cause the keyboard to be locked. It is the responsibility of the host system to transmit an unlock keyboard command to the terminal when the host is ready to receive more data. However, if for some reason the host does not respond to a message, the terminal operator may depress the BREAK key. The break condition is then present on the communication line and the keyboard is unlocked.

All commands currently implemented for the CRT are available to the host system. However, only a subset of those commands is available to the terminal operator. Refer to Chapter 3 for a detailed discussion of the terminal communication interface commands and command structure.

#### CRT EDITOR MODE INTERFACE

##### System Initialization

The CRT performs its normal initialization procedures as part of the power on/restart functions. The system is initialized to scan the communication line input in order to look for CRT editor mode enable and disable commands. Until the enable command is detected, the CRT operates as a normal terminal. Upon receipt of the enable command, the terminal conditions itself for the CRT editor mode of operation. This mode causes message packets to be sent to the host system when certain actions on the part of the terminal operator take place.

## Keyboard Commands

Table 1 lists the normal keyboard functions of the terminal, and how these are processed under the CRT editor mode.

TABLE 1. CRT Editor Keyboard Commands

| COMMAND                                | COMMAND VALUE (Hex) | CRT ACTION   | MESSAGE TO HOST   |
|--|---------------------|--|---|
| Home                                   | C0                  | Normal   | Yes   |
| Cursor up (↑)                          | C1                  | Normal   | Yes   |
| Cursor down (↓)                        | C2                  | Normal   | Yes   |
| Cursor left (←)                        | C3                  | Cursor stays in same line - no line or page rollover.  | No  |
| Cursor right (→)                       | C4                  | Cursor stays in same line - no line or page rollover.  | No  |
| Set scroll mode<br>or<br>Set page mode | C8<br>C7            | Ignored  | No  |
| Forward tab                            | DA                  | Cursor stays in same line - no line or page rollover.  | No  |
| Back tab                               | DB                  | Cursor stays in same line - no line or page rollover.  | No  |
| Set tabs                               | DC                  | The character following the tabs command becomes the default tab character.  | No  |
| ASCII CR                               | 0D                  | Causes the current line to be transmitted if a change has occurred. A CR, LF sequence is performed.  | Yes - the terminating character appears as a line send command (\$DF) |
| Character insert                       | D0                  | All characters under and to the right of the cursor are moved one position to the right, and a blank character is inserted; the cursor does not change position. | No  |
| Character delete                       | D1                  | Normal   | No  |



TABLE 1. CRT Editor Keyboard Commands (cont'd)

| COMMAND               | COMMAND VALUE (Hex) | CRT ACTION  | MESSAGE TO HOST |
|-----------------------|---------------------|---|-----------------|
| Page erase            | D4                  | Ignored   | No              |
| Line erase            | D5                  | Cursor is returned to left margin and the line is blank   | No              |
| Line insert           | D6                  | Normal  | Yes (1)         |
| Line delete           | D7                  | Normal  | Yes (1)         |
| Clear/Home            | D8                  | Only the home function is performed   | Yes (1)         |
| Send page             | D9                  | Ignored   | No              |
| Send line             | DF                  | Ignored   | No              |
| Function keys         | A0-BF               | No CRT action   | Yes (1)         |
| Control-W             | 17                  | No CRT action   | Yes (1)         |
| Delete last character | 7F                  | The character immediately to the left of the cursor is blanked, and cursor moves left one position. | No              |

NOTES: 1. Sent only if in return command mode (see Table 2) or if data has been changed on a line.

2. All other ASCII commands and escape sequence commands are ignored.

3. If data is being entered on the last line of the virtual display and the operator enters a character into the last character position and depresses RETURN or LF keys, all lines will be scrolled up, the bottom line blanked, and a message will be sent. The terminating character will be a send page command (\$D9).

## Communication Commands

Table 2 lists the commands used to enable and disable the CRT editor mode of operation.

TABLE 2. CRT Editor Communication Commands

| COMMAND                 | COMMAND VALUE (Hex)   |
|-------------------------|---|
| Enable CRT editor mode  | 8E followed by an ASCII character representing the key value to be used for the line repeat function. If the repeat function is not desired, the character must be \$FF.  |
| Disable CRT editor mode | 8F The CRT editor mode is disabled and the CRT is placed in the scroll mode.  |
| Return command mode     | 90 Optional - upon receipt of this command, with the CRT editor mode enabled, the terminal causes a message packet to be sent each time the cursor moves from one line to another. This option allows the host application to know at all times the exact location of the cursor.                                       |
| Non-return command mode | 91 Upon CRT editor mode initialization or receipt of this command, the "non-return" mode is set. This mode causes a message packet to be sent only when the cursor moves off a line that has been changed or when a carriage return or line feed is issued while the cursor is on the last line of the virtual display. |

## Message Packet Format

The message packet format in Table 3 is used to transmit data from the terminal to the host. Data transmitted to the terminal from the host follows the existing message/command protocol defined in Chapter 3.

TABLE 3. Message Packet Format

| BYTE |                       | BYTE  | DESCRIPTION  |
|------|-----------------------|-------|--|
| 0    | STX                   | 0     | Start of data (\$DD)   |
|      | FILLER<br>BYTE        | 1     | Filler byte (\$FF)   |
| 2    | CHANGE<br>FLAG        | 2     | Line change indicator<br>\$FF = No change<br>n = ASCII line<br>number of lines changed   |
| 4    | CURSOR<br>LINE        | 3     | Terminating character -<br>represents function that<br>caused the packet to be sent  |
| 6    | COL. 1<br>CHARACTER   | 4-5   | Cursor line/column repre-<br>sented by an ASCII code<br>(see Table 3-7). The line<br>column values reflect the<br>current cursor position. |
|      | COL. 2<br>CHARACTER   | 6-N-1 | The ASCII characters from<br>the line that was just<br>changed.  |
|      | COL. M-1<br>CHARACTER |       |  |
|      | COL. M<br>CHARACTER   | N     | End of data (\$DE)   |
| N    | ETX                   |       |  |

## APPENDIX C

### COMMUNICATION INTERFACE COMMANDS

#### INTRODUCTION

The communications interface is used to transfer serial data between the terminal and the development system. The interface consists of two parts. The first receives data and commands from the development system. The second part transmits data and commands to the development system. The interface is a two-way simultaneous communications mechanism (full duplex).

An 8-bit byte which totally and uniquely defines each character, which may be upper or lower case, or a control function, is the basic element that is communicated on the interface. The byte contains seven bits, equivalent to the code of a character, and an eighth bit defining whether the code is to be interpreted as a display character or as a control function.

The hexadecimal values 00 through FF is the set of 8-bit bytes recognized by the terminal. A byte whose value is within the range of 00 to 7F represents a character code. The code includes the 128 ASCII upper-and lower-case letters, numerals, and general purpose symbols. In addition to the ASCII characters, the codes that normally represent the ASCII control characters (NUL, SOH, ETX, etc.) can be used to represent special characters. In the special character mode, a code received in the range of 00 through 1F is recognized as a lower-case Greek character, an upper-case Greek character (Omega or Sigma), or a special symbol character. The special character mode can be entered by setting the associated rear panel switch or by command.

A byte whose value is within the range of 80 to FF, potentially represents a command. Restricting these commands to this range provides a means of representing command bytes as escape sequences without making use of the ASCII control characters, thus avoiding conflicts with existing communications protocols which place special significance on certain ASCII control characters.

An escape sequence consists of an ASCII escape character (1B), followed by a byte whose value is within the range of 20 to 7F. The escape character is used to represent the left-most bit of the following byte. Hence, the escape sequence allows command bytes to be communicated on the interface in a strict 7-bit format. Two escape characters in sequence are used to represent a character to be displayed.

Table 1 summarizes the commands available by providing the value, display area, action/effect, and byte sequence for each command. The absolute display area is organized into 24 lines with 80 characters per line. The virtual display area is defined as being the full screen area. The byte sequence is the total number of bytes needed to achieve the action/effect.

#### NOTE

Some of the commands in Table 1 are not used with EXbug or normal disk assembler or editor programs. However, they may be used with special editors.

Table 3-7 (Chapter 3) lists the ASCII codes used to position the cursor in the absolute display area.

TABLE 1. Communication Interface Commands

| COMMAND                  | INTERFACE VALUE |           | DISPLAY AREA | MODE                      | ACTION/EFFECT   | BYTE SEQUENCE |           |                 |
|--------------------------|-----------------|-----------|--------------|---------------------------|---|---------------|-----------|-----------------|
|                          | NON-ESC.        | ESC. SEQ. |              |                           |   | NO. OF BYTES  |           | DESCRIPTION     |
|                          |                 |           |              |                           |   | NON-ESC.      | ESC. SEQ. |                 |
| HOME                     | CO              | ESC,@     | VIRTUAL      | SCROLL<br>PAGE<br>PROTECT | CURSOR MOVES TO LEFT-MOST COLUMN IN TOP LINE.<br>CURSOR MOVES TO LEFT-MOST COLUMN IN TOP LINE.<br>CURSOR MOVES TO LEFT-MOST COLUMN IN TOP LINE, SEEKS NON-PROTECTED COLUMN TO RIGHT; IF NONE EXISTS, CURSOR REMAINS IN LEFT-MOST COLUMN OF TOP LINE.  | 1             | 2         | COMMAND BYTE(S) |
| CURSOR UP ONE LINE (1)   | C1              | ESC,A     | VIRTUAL      | SCROLL<br>PAGE<br>PROTECT | IGNORED<br>CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLL-OVER.<br>CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLL-OVER, SEEKS NON-PROTECTED COLUMN TO THE LEFT.   | 1             | 2         | COMMAND BYTE(S) |
| CURSOR DOWN ONE LINE (1) | C2              | ESC,B     | VIRTUAL      | SCROLL<br>PAGE<br>PROTECT | CURSOR MOVES DOWN ONE LINE IN SAME COLUMN. IF ALREADY IN LAST LINE, SCROLL IS EXECUTED AND LAST LINE IS BLANKED.<br>CURSOR MOVES DOWN ONE LINE IN SAME COLUMN WITH PAGE ROLLOVER.<br>CURSOR MOVES DOWN ONE LINE IN SAME COLUMN WITH PAGE ROLLOVER. SEEKS NON-PROTECTED COLUMN TO THE RIGHT. | 1             | 2         | COMMAND BYTE(S) |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                        | INTERFACE VALUE |           | DISPLAY AREA | MODE            | ACTION/EFFECT   | BYTE SEQUENCE |           |  |
|--------------------------------|-----------------|-----------|--------------|-----------------|---|---------------|-----------|--|
|                                | NON-ESC.        | ESC. SEQ. |              |                 |   | NO. OF BYTES  |           | DESCRIPTION  |
|                                |                 |           |              |                 |   | NON-ESC.      | ESC. SEQ. |  |
| CURSOR LEFT ONE COLUMN<br>(←)  | C3              | ESC,C     | VIRTUAL      | SCROLL          | CURSOR MOVES LEFT ONE COLUMN WITHOUT LINE ROLLOVER.   | 1             | 2         | COMMAND BYTE(S)  |
|                                |                 |           |              | PAGE            | CURSOR MOVES LEFT ONE COLUMN WITH LINE AND PAGE ROLLOVER.   |               |           |  |
|                                |                 |           |              | PROTECT         | CURSOR MOVES LEFT ONE COLUMN WITH LINE AND PAGE ROLLOVER. SEEKS NON-PROTECTED COLUMN TO THE LEFT.   |               |           |  |
| CURSOR RIGHT ONE COLUMN<br>(→) | C4              | ESC,D     | VIRTUAL      | SCROLL          | CURSOR MOVES RIGHT ONE COLUMN WITHOUT LINE ROLLOVER.  | 1             | 2         | COMMAND BYTE(S)  |
|                                |                 |           |              | PAGE            | CURSOR MOVES RIGHT ONE COLUMN WITH LINE AND PAGE ROLLOVER.  |               |           |  |
|                                |                 |           |              | PROTECT         | CURSOR MOVES RIGHT ONE COLUMN WITH LINE AND PAGE ROLLOVER. SEEKS NON-PROTECTED COLUMN TO THE RIGHT.   |               |           |  |
| LOAD CURSOR                    | C5              | ESC,E     | VIRTUAL      | SCROLL,<br>PAGE | IF POSITION IS OUTSIDE VIRTUAL DISPLAY, COMMAND IS IGNORED; OTHERWISE, CURSOR MOVES TO DESIGNATED POSITION.   | 3             | 4         | COMMAND BYTE(S) PLUS TWO BYTES DESIGNATING CURSOR POSITION |
|                                |                 |           |              | PROTECT         | IF POSITION IS OUTSIDE VIRTUAL DISPLAY, COMMAND IS IGNORED; OTHERWISE, CURSOR MOVES TO DESIGNATED POSITION. IF POSITION CONTAINS A PROTECT FAC OR IS PART OF A PROTECTED FIELD, CURSOR IS MOVED RIGHT TO NON-PROTECTED COLUMN. IF POSITION CONTAINS A NON-PROTECT FAC, CURSOR REMAINS AT DESIGNATED POSITION; HOWEVER, ONLY FACS MAY BE |               |           |  |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                 | INTERFACE VALUE |           | DISPLAY AREA | MODE                              | ACTION/EFFECT  | BYTE SEQUENCE |           |  |
|-------------------------|-----------------|-----------|--------------|-----------------------------------|--|---------------|-----------|--|
|                         | NON-ESC.        | ESC. SEQ. |              |                                   |  | NO. OF BYTES  |           | DESCRIPTION                                    |
|                         |                 |           |              |                                   |  | NON-ESC.      | ESC. SEQ. |  |
| LOAD CURSOR<br>(Cont'd) |                 |           |              |                                   | INSERTED AT THIS POSITION AND A CURSOR RIGHT COMMAND SHOULD FOLLOW TO ENSURE CURSOR POSITIONING AT A NON-PROTECTED COLUMN.   |               |           |  |
| SET SCROLL MODE         | C8              | ESC,H     | VIRTUAL      | SCROLL<br>PAGE,<br>PROTECT        | IGNORED<br>PAGE AND PROTECT MODES ARE RESET, SCROLL MODE IS SET, CURSOR RETURNS TO HOME POSITION.  | 1             | 2         | COMMAND BYTE(S)                                |
| ENABLE KEYBOARD         | D2              | ESC,R     | N.A.         | SCROLL,<br>PAGE,<br>PROTECT       | CAUSES KEYBOARD TO BE ENABLED (DATA CAN BE ENTERED FROM KEYBOARD).   | 1             | 2         | COMMAND BYTE(S)                                |
| DISABLE KEYBOARD        | D2              | ESC,S     | N.A.         | SCROLL,<br>PAGE,<br>PROTECT       | CAUSES KEYBOARD TO BE DISABLED (DATA CANNOT BE ENTERED FROM THE KEYBOARD).   | 1             | 2         | COMMAND BYTE(S)                                |
| BOTTOM DISPLAY LINE     | CA              | ESC,J     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | THE VIRTUAL DISPLAY AREA'S LAST LINE IS MADE TO CORRESPOND WITH THE LINE DESIGNATED (SEE NOTE 3).  | 2             | 3         | COMMAND BYTE(S), ONE BYTE DESIGNATING THE LINE |
| FORWARD TAB<br>└        | DA              | ESC,Z     | VIRTUAL      | SCROLL<br><br>PAGE<br><br>PROTECT | CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITHOUT LINE ROLLOVER).<br><br>CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITH LINE AND PAGE ROLLOVER) AS DEFINED BY THE SET TABS COMMAND.<br><br>CURSOR MOVES RIGHT TO LEFT – MOST COLUMN OF NEXT NON-PROTECTED FIELD (WITH LINE AND PAGE ROLLOVER). | 1             | 2         | COMMAND BYTE(S)                                |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                | INTERFACE VALUE |           | DISPLAY AREA | MODE                              | ACTION/EFFECT   | BYTE SEQUENCE |           |  |
|------------------------|-----------------|-----------|--------------|-----------------------------------|---|---------------|-----------|--|
|                        | NON-ESC.        | ESC. SEQ. |              |                                   |   | NO. OF BYTES  |           | DESCRIPTION  |
|                        |                 |           |              |                                   |   | NON-ESC.      | ESC. SEQ. |  |
| BACK TAB<br> ←         | DB              | ESC,[     | VIRTUAL      | SCROLL<br><br>PAGE<br><br>PROTECT | CURSOR MOVES LEFT TO PREVIOUS TAB POSITION (WITHOUT LINE ROLLOVER).<br><br>CURSOR MOVES LEFT TO PREVIOUS TAB POSITION (WITH LINE AND PAGE ROLLOVER).<br><br>CURSOR MOVES LEFT TO LEFT — MOST COLUMN OF PREVIOUS NON-PROTECTED FIELD (WITH LINE AND PAGE ROLLOVER).  | 1             | 2         | COMMAND BYTE(S)                                      |
| SET TABS               | DC              | ESC,/     | VIRTUAL      | PAGE,<br>SCROLL,<br>PROTECT       | THE BLOCK OF DATA FOLLOWING THE COMMAND BYTE DEFINES THE TAB POSITIONS. THE TAB POSITIONS ARE INDICATED BY HTS (09) TO SET A TAB OR CANCEL (18) TO CLEAR A TAB, AND ARE SEPARATED BY SPACE (20) CHARACTERS TO INDICATE TAB SPACE (SETTING). THE BLOCK IS TERMINATED BY A LINE FEED CHARACTER. THE COMMAND BYTE FOLLOWED BY LF WITH NO SPACES, CANCELS OR HTS WILL CAUSE ALL TABS TO BE RESET. | VAR.          | VAR.      | COMMAND BYTE(S) SPACES, HTS (09), OR CANCEL (18), LF |
| SET TRANSPARENT MODE   | EC              | ESC,1     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | SETS TRANSPARENT MODE OPERATION; CURSOR DOES NOT CHANGE POSITION.   | 1             | 2         | COMMAND BYTE(S)                                      |
| RESET TRANSPARENT MODE | ED              | ESC,m     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | RESETS TRANSPARENT MODE OPERATION; CURSOR DOES NOT CHANGE POSITION.   | 1             | 2         | COMMAND BYTE(S)                                      |
| SET VIDEO INVERT       | EE              | ESC,n     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | SETS VIDEO INVERT OPERATION; CURSOR DOES NOT CHANGE POSITION.   | 1             | 2         | COMMAND BYTE(S)                                      |



TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                          | INTERFACE VALUE |                 | DISPLAY AREA | MODE                  | ACTION/EFFECT  | BYTE SEQUENCE |           |                 |    |    |              |    |    |                 |    |    |               |   |   |                 |
|----------------------------------|-----------------|-----------------|--------------|-----------------------|--|---------------|-----------|-----------------|----|----|--------------|----|----|-----------------|----|----|---------------|---|---|-----------------|
|                                  | NON-ESC.        | ESC. SEQ.       |              |                       |  | NO. OF BYTES  |           | DESCRIPTION     |    |    |              |    |    |                 |    |    |               |   |   |                 |
|                                  |                 |                 |              |                       |  | NON-ESC.      | ESC. SEQ. |                 |    |    |              |    |    |                 |    |    |               |   |   |                 |
| RESET VIDEO INVERT               | EF              | ESC,o           | ABSOLUTE     | SCROLL, PAGE, PROTECT | RESETS VIDEO INVERT OPERATION; CURSOR DOES NOT CHANGE POSITION.  | 1             | 2         | COMMAND BYTE(S) |    |    |              |    |    |                 |    |    |               |   |   |                 |
| SET DISPLAY SPECIAL CHARACTERS   | FC              | ESC,;           | N.A.         | SCROLL, PAGE, PROTECT | PERMITS SPECIAL CHARACTER TO BE DISPLAYED.   | 1             | 2         | COMMAND BYTE(S) |    |    |              |    |    |                 |    |    |               |   |   |                 |
| RESET DISPLAY SPECIAL CHARACTERS | FD              | ESC,            | N.A.         | SCROLL, PAGE, PROTECT | SPECIAL CHARACTERS CANNOT BE DISPLAYED.  | 1             | 2         | COMMAND BYTE(S) |    |    |              |    |    |                 |    |    |               |   |   |                 |
| END-OF-LINE FAC                  | FE              | ESC,~           | N.A.         | SCROLL, PAGE, PROTECT | AN OUTPUT COMMAND USED TO MARK UNUSED SPACE IN LINE. LINE LENGTH DETERMINED BY RIGHT-MOST DATA BYTE POSITION. REMAINING UNUSED, UNFILLED POSITIONS TO 80TH COLUMN ARE NOT CONSIDERED PART OF LINE.   | 1             | 2         | COMMAND BYTE(S) |    |    |              |    |    |                 |    |    |               |   |   |                 |
| TERMINAL RESET                   | F1              | ESC,q           | ABSOLUTE     | SCROLL, PAGE, PROTECT | CAUSES THE BASIC DISPLAY UNIT TO BE RESET AS IF THE "RESET" SWITCH HAD BEEN ACTIVATED.   | 1             | 2         | COMMAND BYTE(S) |    |    |              |    |    |                 |    |    |               |   |   |                 |
| DISPLAY STATUS ON                | F2              | ESC,r           | ABSOLUTE     | SCROLL, PAGE, PROTECT | <p>CERTAIN STATUS COMMANDS CAN BE RECEIVED ON THE COMMUNICATIONS INTERFACE AND DISPLAYED. THE LAST THREE POSITIONS IN THE ABSOLUTE DISPLAY AREA ARE USED TO SHOW A BLINKING STATUS INDICATOR. THE INDICATORS AND THEIR ASSOCIATE CODES ARE:</p> <table border="0"> <thead> <tr> <th>INDICATOR</th> <th>CODE</th> <th>FUNCTION</th> </tr> </thead> <tbody> <tr> <td>PE</td> <td>98</td> <td>PARITY ERROR</td> </tr> <tr> <td>RO</td> <td>9A</td> <td>RECEIVE OVERRUN</td> </tr> <tr> <td>FE</td> <td>9B</td> <td>FRAMING ERROR</td> </tr> </tbody> </table> | INDICATOR     | CODE      | FUNCTION        | PE | 98 | PARITY ERROR | RO | 9A | RECEIVE OVERRUN | FE | 9B | FRAMING ERROR | 1 | 2 | COMMAND BYTE(S) |
| INDICATOR                        | CODE            | FUNCTION        |              |                       |  |               |           |                 |    |    |              |    |    |                 |    |    |               |   |   |                 |
| PE                               | 98              | PARITY ERROR    |              |                       |  |               |           |                 |    |    |              |    |    |                 |    |    |               |   |   |                 |
| RO                               | 9A              | RECEIVE OVERRUN |              |                       |  |               |           |                 |    |    |              |    |    |                 |    |    |               |   |   |                 |
| FE                               | 9B              | FRAMING ERROR   |              |                       |  |               |           |                 |    |    |              |    |    |                 |    |    |               |   |   |                 |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                       | INTERFACE VALUE |           | DISPLAY AREA | MODE                              | ACTION/EFFECT   | BYTE SEQUENCE |           | DESCRIPTION     |
|-------------------------------|-----------------|-----------|--------------|-----------------------------------|---|---------------|-----------|-----------------|
|                               | NON-ESC.        | ESC. SEQ. |              |                                   |   | NO. OF BYTES  |           |                 |
|                               |                 |           |              |                                   |   | NON-ESC.      | ESC. SEQ. |                 |
| DISPLAY STATUS ON<br>(Cont'd) |                 |           |              |                                   | FRAMING AND PARITY ERROR COMMANDS ARE FOLLOWED BY THE BYTE SUFFERING THE ERROR CONDITION.   |               |           |                 |
| DISPLAY STATUS OFF            | F3              | ESC,s     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | RECEIVED STATUS INDICATORS PE, RO, AND FE CANNOT BE DISPLAYED.  | 1             | 2         | COMMAND BYTE(S) |
| ASCII BEL<br>(BELL)           | 07              | NONE      | N.A.         | SCROLL,<br>PAGE,<br>PROTECT       | CAUSES THE BELL TO ISSUE TONE FOR A PERIOD OF ONE-HALF SECOND.  | 1             |           | COMMAND BYTE    |
| ASCII BS<br>(BACKSPACE)       | 08              | NONE      | VIRTUAL      | SCROLL<br><br>PAGE<br><br>PROTECT | CURSOR MOVES LEFT ONE COLUMN WITHOUT LINE ROLLOVER.<br><br>CURSOR MOVES LEFT ONE COLUMN WITH LINE AND PAGE ROLLOVER.<br><br>CURSOR MOVES LEFT ONE COLUMN WITH LINE AND PAGE ROLLOVER. SEEKS NON-PROTECTED COLUMN TO THE LEFT.   | 1             |           | COMMAND BYTE    |
| ASCII HT<br>(HORIZONTAL TAB)  | 09              | NONE      | VIRTUAL      | SCROLL<br><br>PAGE<br><br>PROTECT | CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITHOUT LINE ROLLOVER) AS DEFINED BY THE SET TABS COMMAND.<br><br>CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITH LINE AND PAGE ROLLOVER) AS DEFINED BY THE SET TABS COMMAND.<br><br>CURSOR MOVES RIGHT TO THE LEFT-MOST COLUMN OF THE NEXT NON-PROTECTED FIELD (WITH LINE AND PAGE ROLLOVER). | 1             |           | COMMAND BYTE    |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                 | INTERFACE VALUE |           | DISPLAY AREA | MODE                  | ACTION/EFFECT  | BYTE SEQUENCE |           |  |
|-------------------------|-----------------|-----------|--------------|-----------------------|--|---------------|-----------|--|
|                         | NON-ESC.        | ESC. SEQ. |              |                       |  | NO. OF BYTES  |           | DESCRIPTION                                    |
|                         |                 |           |              |                       |  | NON-ESC.      | ESC. SEQ. |  |
| SET PAGE MODE           | C7              | ESC,G     | VIRTUAL      | SCROLL                | SCROLL MODE IS RESET, PAGE MODE IS SET, CURSOR RETURNS TO HOME POSITION.   | 1             | 2         | COMMAND BYTE(S)                                |
|                         |                 |           |              | PAGE PROTECT          | IGNORED<br>PROTECT MODE IS RESET, PAGE MODE IS SET, CURSOR RETURNS TO HOME POSITION.                             |               |           |  |
| TOP DISPLAY LINE        | C9              | ESC,I     | ABSOLUTE     | SCROLL, PAGE, PROTECT | THE VIRTUAL DISPLAY AREA'S TOP LINE IS MADE TO CORRESPOND WITH THE LINE DESIGNATED (SEE NOTE 3).                 | 2             | 3         | COMMAND BYTE(s), ONE BYTE DESIGNATING THE LINE |
| READ CURSOR             | C6              | ESC,F     | VIRTUAL      | SCROLL, PAGE, PROTECT | 4 BYTES ARE SENT ON THE INTERFACE — START DATA COMMAND, TWO BYTE CURSOR POSITION, END DATA COMMAND.              | 1             | 2         | COMMAND BYTE(S)                                |
| ASCII LF (LINE FEED)    | OA              | NONE      | VIRTUAL      | SCROLL                | CURSOR MOVES DOWN ONE LINE IN SAME COLUMN. IF ALREADY IN LAST LINE, SCROLL IS EXECUTED AND LAST LINE IS BLANKED. | 1             |           | COMMAND BYTE                                   |
|                         |                 |           |              | PAGE                  | CURSOR MOVES DOWN ONE LINE IN SAME COLUMN, WITH PAGE ROLLOVER.   |               |           |  |
|                         |                 |           |              | PROTECT               | CURSOR MOVES DOWN ONE LINE IN SAME COLUMN WITH PAGE ROLLOVER. SEEKS NON-PROTECTED COLUMN TO THE RIGHT.           |               |           |  |
| ASCII VT (VERTICAL TAB) | OB              | NONE      | VIRTUAL      | SCROLL<br>PAGE        | IGNORED<br>CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLLOVER.   | 1             |           | COMMAND BYTE                                   |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                                | INTERFACE VALUE |           | DISPLAY AREA | MODE                              | ACTION/EFFECT   | BYTE SEQUENCE |           |                                  |
|--|-----------------|-----------|--------------|-----------------------------------|---|---------------|-----------|----------------------------------|
|  | NON-ESC.        | ESC. SEQ. |              |                                   |   | NO. OF BYTES  |           | DESCRIPTION                      |
|  |                 |           |              |                                   |   | NON-ESC.      | ESC. SEQ. |                                  |
| ASCII VT<br>(VERTICAL TAB)<br>(Cont'd) |                 |           |              | PROTECT                           | CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLL-OVER. SEEKS NON-PROTECTED COLUMN TO THE LEFT.  |               |           |                                  |
| ASCII FF<br>(FORM FEED)                | OC              | NONE      | VIRTUAL      | SCROLL<br><br>PAGE<br><br>PROTECT | CURSOR MOVES RIGHT ONE COLUMN WITHOUT LINE ROLLOVER.<br><br>CURSOR MOVES RIGHT ONE COLUMN WITH LINE AND PAGE ROLL-OVER.<br><br>CURSOR MOVES RIGHT ONE COLUMN WITH LINE AND PAGE ROLL-OVER. SEEKS NON-PROTECTED COLUMN TO THE RIGHT. | 1             |           | COMMAND BYTE                     |
| ASCII CR<br>(CARRIAGE RETURN)          | OD              | NONE      | VIRTUAL      | SCROLL,<br>PAGE<br><br>PROTECT    | CURSOR MOVES TO LEFT MARGIN.<br><br>CURSOR MOVES TO LEFT MARGIN. SEEKS NON-PROTECTED COLUMN TO THE RIGHT.   | 1             |           | COMMAND BYTE                     |
| LEFT DISPLAY COLUMN                    | CB              | ESC,K     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | THE VIRTUAL DISPLAY AREA'S LEFT COLUMN IS MADE TO CORRESPOND WITH THE COLUMN DESIGNATED (SEE NOTE 3).   | 2             | 3         | COMMAND BYTE(S), ONE BYTE COLUMN |
| RIGHT DISPLAY COLUMN                   | CC              | ESC,L     | ABSOLUTE     | SCROLL,<br>PAGE,<br>PROTECT       | THE VIRTUAL DISPLAY AREA'S RIGHT COLUMN IS MADE TO CORRESPOND WITH THE COLUMN DESIGNATED (SEE NOTE 3).  | 2             | 3         | COMMAND BYTE(S), ONE BYTE COLUMN |
| SET PROTECT MODE                       | CD              | ESC,M     | VIRTUAL      | SCROLL<br><br>PAGE                | SCROLL MODE IS RESET, PROTECT MODE IS SET.<br><br>PAGE MODE IS RESET, PROTECT MODE IS SET.  | 1             | 2         | COMMAND BYTE(S)                  |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                      | INTERFACE VALUE |           | DISPLAY AREA | MODE                  | ACTION/EFFECT   | BYTE SEQUENCE |           |   |
|------------------------------|-----------------|-----------|--------------|-----------------------|---|---------------|-----------|---|
|                              | NON-ESC.        | ESC. SEQ. |              |                       |   | NO. OF BYTES  |           | DESCRIPTION   |
|                              |                 |           |              |                       |   | NON-ESC.      | ESC. SEQ. |   |
| SET PROTECT MODE<br>(Cont'd) |                 |           |              | PROTECT               | IGNORED — CURSOR SEEKS FIRST NON-PROTECTED COLUMN ON SCREEN. SIMULATES "HOME" COMMAND.  |               |           |   |
| WRITE ABSOLUTE               | CE              | ESC,N     | ABSOLUTE     | SCROLL, PAGE, PROTECT | THE BLOCK OF DATA OR COMMAND BYTES ARE WRITTEN INTO THE ABSOLUTE DISPLAY AREA STARTING AT THE ABSOLUTE CURSOR POSITION DESIGNATED. THE COMMAND BYTES ARE RESTRICTED TO THE SET OF FIELD ATTRIBUTE COMMANDS. THE CURSOR DOES NOT CHANGE POSITION.  | VAR.          | VAR.      | COMMAND BYTE(S), START DATA COMMAND, 2 BYTE CURSOR POSITION, VARIABLE DATA OR COMMAND BYTES, END DATA COMMAND |
| READ ABSOLUTE                | CF              | ESC,O     | ABSOLUTE     | SCROLL, PAGE, PROTECT | THE ABSOLUTE DISPLAY POSITIONS, STARTING WITH THE 1ST CURSOR POSITION IN THE COMMAND SEQUENCE AND ENDING WITH THE 2ND CURSOR POSITION, ARE SENT OUT ON THE INTERFACE. THIS BLOCK OF DATA IS FRAMED WITH THE START DATA AND END DATA COMMANDS. EACH END OF LINE FROM THE DISPLAY AREA IS FLAGGED BY AN END-OF-DATA (F9;ESC,y) CHARACTER. | 5             | 6         | COMMAND BYTE(S), 2 BYTE CURSOR POSITION — "START", 2 BYTE CURSOR POSITION — "END"                             |
| CHARACTER INSERT             | DO              | ESC,P     | VIRTUAL      | SCROLL PAGE           | IGNORED<br>ALL COLUMNS IN LINE, STARTING WITH CURSOR COLUMN, ARE MOVED RIGHT ONE COLUMN. THE BYTE IN THE RIGHT-MOST COLUMN IS DISCARDED. THE DATA BYTE IS PLACED AT THE CURSOR AND THE CURSOR IS ADVANCED ONE COLUMN TO THE RIGHT WITH LINE ROLLOVER.   | 3             | 5         | COMMAND BYTE(S), DATA BYTE(S), COMMAND BYTE(S) (SEE NOTE 4)   |

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TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                      | INTERFACE VALUE |           | DISPLAY AREA | MODE         | ACTION/EFFECT  | BYTE SEQUENCE |           |                 |
|------------------------------|-----------------|-----------|--------------|--------------|--|---------------|-----------|-----------------|
|                              | NON-ESC.        | ESC. SEQ. |              |              |  | NO. OF BYTES  |           | DESCRIPTION     |
|                              |                 |           |              |              |  | NON-ESC.      | ESC. SEQ. |                 |
| CHARACTER INSERT<br>(Cont'd) |                 |           |              | PROTECT      | SAME AS PAGE, EXCEPT MOVEMENT RESTRICTED TO SEQUENCE OF NON-PROTECTED COLUMNS TO THE RIGHT OF CURSOR POSITION. (CONTIGUOUS NON-PROTECTED FIELD).   |               |           |                 |
| CHARACTER DELETE             | D1              | ESC,Q     | VIRTUAL      | SCROLL PAGE  | IGNORED<br>ALL COLUMNS IN LINE, STARTING WITH CURSOR COLUMN +1 ARE MOVED TO THE LEFT ONE COLUMN. THE RIGHT-MOST COLUMN IS FILLED WITH A SPACE (20) CHARACTER. CURSOR DOES NOT CHANGE POSITION. | 1             | 2         | COMMAND BYTE(S) |
|                              |                 |           |              | PROTECT      | SAME AS PAGE, EXCEPT THE NON-PROTECTED COLUMNS UNDER AND CONTIGUOUS TO THE RIGHT WITHIN THE NON-PROTECTED FIELD ARE MOVED.   |               |           |                 |
| PAGE ERASE                   | D4              | ESC,T     | VIRTUAL      | SCROLL, PAGE | ERASES ALL CHARACTERS FROM CURSOR TO END OF DISPLAY AND REPLACES WITH SPACE (20) CHARACTER. CURSOR DOES NOT CHANGE POSITION.   | 1             | 2         | COMMAND BYTE(S) |
|                              |                 |           |              | PROTECT      | ERASES ALL UNPROTECTED CHARACTER POSITIONS FROM THE CURSOR TO THE END OF DISPLAY AND REPLACES WITH SPACE (20) CHARACTER. CURSOR DOES NOT CHANGE POSITION.                                      |               |           |                 |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND     | INTERFACE VALUE |           | DISPLAY AREA | MODE                        | ACTION/EFFECT  | BYTE SEQUENCE |           |                 |
|-------------|-----------------|-----------|--------------|-----------------------------|--|---------------|-----------|-----------------|
|             | NON-ESC.        | ESC. SEQ. |              |                             |  | NO. OF BYTES  |           | DESCRIPTION     |
|             |                 |           |              |                             |  | NON-ESC.      | ESC. SEQ. |                 |
| LINE ERASE  | D5              | ESC,U     | VIRTUAL      | SCROLL, PAGE<br><br>PROTECT | STARTING WITH CURSOR POSITION, LINE IS BLANKED TO THE RIGHT WITH SPACE (20) CHARACTER. CURSOR DOES NOT CHANGE POSITION.<br><br>ALL COLUMNS IN NON-PROTECTED FIELD UNDER AND CONTIGUOUS RIGHT OF CURSOR ARE BLANKED. CURSOR DOES NOT CHANGE POSITION.   | 1             | 2         | COMMAND BYTE(S) |
| LINE INSERT | D6              | ESC,V     | VIRTUAL      | SCROLL, PROTECT PAGE        | IGNORED<br><br>ALL LINES, STARTING WITH CURRENT LINE, ARE MOVED DOWN ONE LINE. LAST LINE IS DISCARDED. CURRENT LINE IS BLANKED WITH SPACE (20) CHARACTER. CURSOR RESTS IN FIRST POSITION OF NEW BLANK LINE.  | 1             | 2         | COMMAND BYTE(S) |
| SEND PAGE   | D9              | ESC,Y     | VIRTUAL      | SCROLL PAGE                 | IGNORED<br><br>ALL POSITIONS FROM HOME THROUGH CURSOR POSITION, OR END OF LINE FAC ON THE LINE ON WHICH CURSOR RESTS (WHICHEVER IS FOUND FIRST), ARE SENT ON THE INTERFACE AS A BLOCK OF DATA. THIS BLOCK IS FRAMED BY THE START DATA COMMAND AND THE END DATA COMMAND. EACH END OF LINE IS FLAGGED BY AN END-OF-DATA (F9;ESC,y) CHARACTER. CURSOR DOES NOT CHANGE POSITION. NOTE: ANY PROTECTED FIELDS THAT MAY BE SENT IN THIS MODE WILL BE BRACKETED BY | 1             | 2         | COMMAND BYTE(S) |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND               | INTERFACE VALUE |           | DISPLAY AREA | MODE                       | ACTION/EFFECT  | BYTE SEQUENCE |           |                 |
|-----------------------|-----------------|-----------|--------------|----------------------------|--|---------------|-----------|-----------------|
|                       | NON-ESC.        | ESC. SEQ. |              |                            |  | NO. OF BYTES  |           | DESCRIPTION     |
|                       |                 |           |              |                            |  | NON-ESC.      | ESC. SEQ. |                 |
| SEND PAGE<br>(Cont'd) |                 |           |              | PROTECT                    | FIELD ATTRIBUTE CODES TO INDICATE START AND END PROTECTED FIELDS.<br><br>ALL NON-PROTECTED POSITIONS FROM HOME THROUGH END OF PAGE ARE SENT ON THE INTERFACE AS A BLOCK OF DATA. THIS BLOCK IS FRAMED AS IN PAGE MODE. EACH END OF FIELD IS FLAGGED BY AN END-OF-DATA (F9;ESC,y) CHARACTER. CURSOR DOES NOT CHANGE POSITION. |               |           |                 |
| LINE DELETE           | D7              | ESC,W     | VIRTUAL      | SCROLL,<br>PROTECT<br>PAGE | IGNORED<br><br>ALL LINES, STARTING WITH LINE DIRECTLY BELOW CURRENT LINE, ARE MOVED UP ONE LINE. LAST LINE IS BLANKED. CURSOR MOVES TO FIRST CHARACTER POSITION OF LINE IN WHICH IT INITIALLY RESTED.  | 1             | 2         | COMMAND BYTE(S) |
| CLEAR                 | D8              | ESC,X     | VIRTUAL      | SCROLL<br><br>PROTECT      | ALL POSITIONS IN DISPLAY AREA ARE FILLED WITH SPACES (20). CURSOR MOVES TO HOME POSITION.<br><br>ALL NON-PROTECTED POSITIONS IN DISPLAY AREA ARE FILLED WITH SPACES (20). CURSOR MOVES TO LEFT-MOST POSITION OF FIRST NON-PROTECTED FIELD, MOVES TO HOME POSITION.   | 1             | 2         | COMMAND BYTE(S) |



TABLE 1. Communication Interface Commands (cont'd)

| COMMAND               | INTERFACE VALUE |           | DISPLAY AREA      | MODE                  | ACTION/EFFECT   | BYTE SEQUENCE |           | DESCRIPTION     |
|-----------------------|-----------------|-----------|-------------------|-----------------------|---|---------------|-----------|-----------------|
|                       | NON-ESC.        | ESC. SEQ. |                   |                       |   | NO. OF BYTES  |           |                 |
|                       |                 |           |                   |                       |   | NON-ESC.      | ESC. SEQ. |                 |
| ENABLE LOAD           | FA              | ESC,z     | N.A.              | SCROLL, PAGE, PROTECT | THIS COMMAND CAUSES THE NEXT OCCURRENCE OF AN ASCII CONTROL CHARACTER "DC2" (12) TO SIGNAL THE START OF LOAD RECORDS AS DESCRIBED FOR THE EXBUG MEMORY LOAD FUNCTION.<br><br>ALSO CAUSES OCCURRENCE OF AN ASCII CONTROL CHARACTER "DC4" (14) TO SIGNAL THE END OF LOAD RECORDS. (SEE NOTE 5). | 1             | 2         | COMMAND BYTE(S) |
| DISABLE LOAD          | FB              | ESC,      | N.A.              | SCROLL, PAGE          | THIS COMMAND CAUSES THE ASCII CONTROL CHARACTERS "DC2" AND "DC4" TO BE TREATED IN THE NORMAL MANNER.  | 1             | 2         | COMMAND BYTE(S) |
| START DATA            | DD              | ESC,]     | VIRTUAL, ABSOLUTE | SCROLL, PROTECT, PAGE | THIS COMMAND BYTE IS USED TO FRAME BLOCKS OF DATA AT THE BEGINNING AND PRECEDES THE BYTE.   | 1             | 2         | COMMAND BYTE(S) |
| END DATA              | DE              | ESC,^     | VIRTUAL, ABSOLUTE | SCROLL, PAGE, PROTECT | THIS COMMAND BYTE IS USED TO FRAME BLOCKS OF DATA AT THE END AND FOLLOWS THE LAST DATA BYTE.  | 1             | 2         | COMMAND BYTE(S) |
| END-OF-DATA INDICATOR | F9              | ESC,y     | N.A.              | PAGE, PROTECT         | OUTPUT CHARACTER(S) IDENTIFYING END OF LINE (PAGE MODE) OR END OF UNPROTECTED FIELD (PROTECT MODE). USED ONLY IN SEND PAGE, SEND LINE, AND READ ABSOLUTE COMMANDS.  | 1             | 2         | COMMAND BYTE(S) |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND   | INTERFACE VALUE            |  | DISPLAY AREA     | MODE                       | ACTION/EFFECT  | BYTE SEQUENCE |           |                 |
|---|----------------------------|--|------------------|----------------------------|--|---------------|-----------|-----------------|
|   | NON-ESC.                   | ESC. SEQ.                                |                  |                            |  | NO. OF BYTES  |           | DESCRIPTION     |
|   |                            |  |                  |                            |  | NON-ESC.      | ESC. SEQ. |                 |
| SEND LINE   | DF                         | ESC, _                                   | VIRTUAL          | SCROLL PAGE<br><br>PROTECT | IGNORED<br><br>ALL POSITIONS FROM BEGINNING OF THE LINE ON WHICH CURSOR RESTS THROUGH END OF LINE ARE SENT ON THE INTERFACE AS A BLOCK OF DATA. THIS BLOCK IS FRAMED BY THE START DATA COMMAND AND THE END DATA COMMAND. CURSOR DOES NOT CHANGE POSITION. ANY PROTECTED FIELDS THAT MAY BE SENT IN THIS MODE WILL BE BRACKETED BY FIELD ATTRIBUTE CODES TO INDICATE START AND END OF PROTECTED FIELDS.<br><br>ALL NON-PROTECTED POSITIONS FROM BEGINNING OF LINE ON WHICH CURSOR RESTS THROUGH END OF THE LINE ARE SENT ON THE INTERFACE AS A BLOCK OF DATA. THIS BLOCK IS FRAMED AS IN PAGE MODE. EACH END OF FIELD IS FLAGGED BY AN END-OF-DATA (F9;ESC,y) CHARACTER. CURSOR DOES NOT CHANGE POSITION. | 1             | 2         | COMMAND BYTE(S) |
| FIELD ATTRIBUTES –<br>SET BLINK<br>RESET BLINK<br>SET VIDEO INVERT<br>RESET VIDEO INVERT<br>SET HALF BRIGHT | E0<br>E1<br>E2<br>E3<br>E4 | ESC`<br>ESC,a<br>ESC,b<br>ESC,c<br>ESC,d | VIRTUAL ABSOLUTE | SCROLL, PROTECT, PAGE      | THESE COMMANDS ARE USED TO DEFINE ATTRIBUTES IN THE DISPLAY AREA. AS SUCH, THEY SET OR RESET THE ATTRIBUTES FOR THE CURSOR PROMPT POSITION. CONTIGUOUS ATTRIBUTE COMMANDS WILL SET (OR RESET) THOSE ATTRIBUTES FOR A SINGLE PROMPT POSITION. CURSOR POSITION IS NOT CHANGED BY A FIELD ATTRIBUTE COMMAND.  | 1             | 2         | COMMAND BYTE(S) |

TABLE 1. Communication Interface Commands (cont'd)

| COMMAND                        | INTERFACE VALUE |           | DISPLAY AREA | MODE | ACTION/EFFECT | BYTE SEQUENCE |           |             |
|--------------------------------|-----------------|-----------|--------------|------|---------------|---------------|-----------|-------------|
|                                | NON-ESC.        | ESC. SEQ. |              |      |               | NO. OF BYTES  |           | DESCRIPTION |
|                                |                 |           |              |      |               | NON-ESC.      | ESC. SEQ. |             |
| FIELD ATTRIBUTES –<br>(Cont'd) |                 |           |              |      |               |               |           |             |
| RESET HALF BRIGHT              | E5              | ESC,e     |              |      |               |               |           |             |
| SET UNDERLINE                  | E6              | ESC,f     |              |      |               |               |           |             |
| RESET UNDERLINE                | E7              | ESC,g     |              |      |               |               |           |             |
| SET NON-DISPLAY                | E8              | ESC,h     |              |      |               |               |           |             |
| SET DISPLAY                    | E9              | ESC,i     |              |      |               |               |           |             |
| SET FIELD PROTECT              | EA              | ESC,j     |              |      |               |               |           |             |
| RESET FIELD PROTECT            | EB              | ESC,k     |              |      |               |               |           |             |

**NOTES:**

1. All non-escape interface values are in hexadecimal.
2. All escape interface values are ASCII characters.
3. After executing each of the virtual display boundary commands (C9, CA, CB, CC), the cursor is checked for being within the virtual display. If it is not, it is moved to the right until it is and, if Protect mode is set, it seeks a non-protected column to the right.
4. The second character insert command byte terminates the Character Insert mode. Any other command will also terminate this mode, but will not be executed.
5. Following a "DC2" control character, an improperly formatted load record or the presence of a command byte will cause this command to be aborted. The occurrence of any character other than a NULL, Line Feed, or Carriage Return embedded between load records will cause this command to be aborted.

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