MOTOROLA

M68SXD150(D2)

M6800
EXORterm 150
EXORciser DISPLAY CONSOLE

User's Guide

MICROSYSTEMS

M68SXD150(D2)
April, 1979

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EXORciser DISPLAY CONSOLE
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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

EXORterm 150 is a CRT-based terminal designed for use with EXORciser, the Motorola M6800 Development Support System. In its role as an EXORciser display console, EXORterm 150 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 is based on the M6800 family of LSI devices. As such, all software representing the various functions is coded from the MC6800 Instruction Set. A shared memory utilizing Phase 1 and 2 clocks 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. This permits the EXORterm 150 Terminal to replace currently available terminals.

This manual provides general information, installation, and operating instructions for the M68SXD10150 (110V, 60 Hz) or the M68SXD20150 (220V, 50 Hz) EXORterm 150 terminal. EXORterm 150 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 EXORterm 150 are divided into three categories: Operational Features, Hardware Features, and Software Features.

1.2.1 Operational Features

The following list of operational features are inherent in the design of EXORterm 150:

- 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 EXORciser
- 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 following hardware features are standard with EXORterm 150:

- 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 contrast, 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 communications 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

FIGURE 1-1. EXORterm 150 Display Unit

1.2.3 Software Features

The following software features are standard with the EXORterm 150:

- EXbug system development firmware that contains the system development and diagnostic programs
- Embedded Field Attribute Codes (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
- EXORciser Control software process module used to coordinate the functions of EXORterm 150 in its EXORciser-oriented activity.

1.3 SPECIFICATIONS

The specifications for EXORterm 150 are identified in Table 1-1.

TABLE 1-1. EXORterm 150 Specifications

CHARACTERISTICS	SPECIFICATIONS
Power Requirements	110 Vac, 60 Hz @ 4A (M68SXD10150) 220 Vac, 50 Hz @ 2A (M68SXD20150)
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 system	
ROM	2K bytes (Executive) 4K bytes (Display/Communications) 2K bytes (EXORciser/Display Format) 2K bytes (Extended Display)
RAM	2K bytes (Display) 1K byte (Scratchpad)
Current Loop Interface Signals	20 to 60 mA
RS-232C Interface Signals	
Input Signals	EIA RS-232C compatible serial data/control input lines (±30 Vdc signal range)
Output Signals	EIA RS-232C compatible serial data/control output lines (±10 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"(W) x 12.13"(H) x 20.29"(D) Keyboard: 18.54"(W) x 3.50"(H) x 8.54"(D)

TABLE 1-1. EXORterm 150 Specifications (Cont'd)

CHARACTERISTICS	SPECIFICATIONS
Physical Characteristics (Cont'd)	
Weight	Terminal: 61 lbs. Keyboard: 6.5 lbs.
Input/Output Connectors	
Current Loop (6 pin)	AMP 1-350241-9 with pins 350037-1 or equiv.
RS-232C (25 pin)	CINCH DB-25P or equivalent
Keyboard (20 pin)	AMP 88107-1 or equivalent
Cable Connector Kit	Includes: two EIA 25-pin connectors and one 6-pin current loop connector (Motorola part number M68SVS40500)

1.4 GENERAL INFORMATION

EXORterm 150 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 EXORterm 150 in its EXORciser oriented activity. Figure 1-2 provides a block diagram of EXORterm 150.

EXORterm 150 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 EXORterm 150.

1.4.1 Video Monitor

The Motorola model M3000 Video 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 (character produced using only a 7 x 9 dot matrix). Data displayed by the Video 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 internal regulated power supply which incorporates a universal power transformer, thus permitting the supply to operate from either 115 or 230 Vac, 50/60 Hz.

In addition to the power supply, two other printed circuit boards are used in the Video 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. All standard operating and adjustment controls are located on these circuit boards except for brightness, which is located on the EXORterm's front panel.

1.4.2 CRT Controller Board

The CRT Controller Board is a single, 13½ x 16 inch printed circuit board located in the base of the EXORterm's chassis/housing assembly. It incorporates the circuitry needed to control all of the functions of the EXORterm 150. 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 Microprocessing Unit (MPU), three MC6820 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 all EXORterm 150 functions. These programs are more fully described in paragraph 1.4.6.

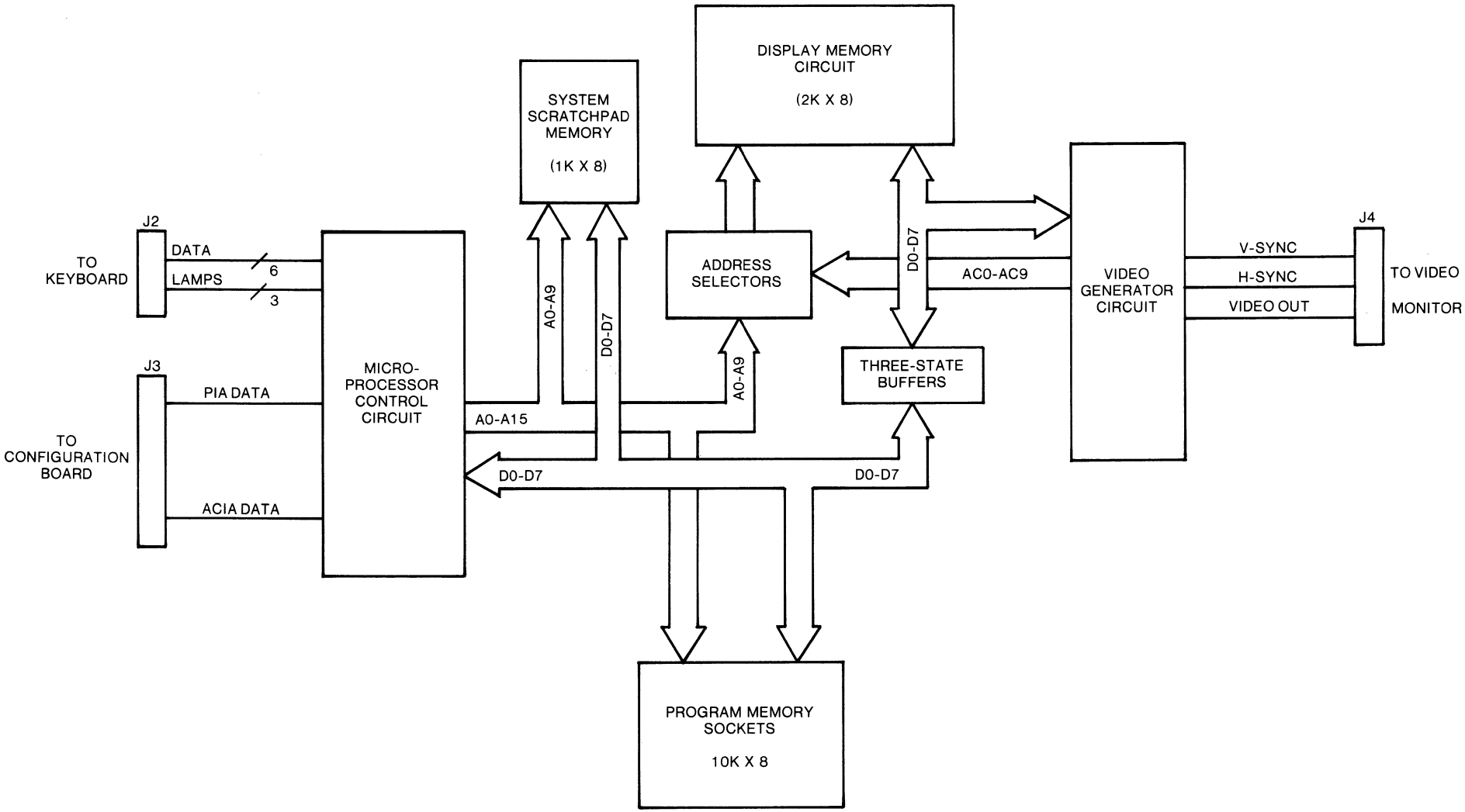


FIGURE 1-2. EXORterm 150 Block Diagram

The PIA provides a 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 EXORciser. 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 (1 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 Video Monitor for positioning the characters on the screen. The sync signals and the sequentially accessed memory circuits are synchronized together to display data at the proper location on the screen.

1.4.2.3 *Display Memory Circuit* — The Display Memory Circuit consists of sixteen 1K x 1 static memory devices, organized into 2048 8-bit bytes. This circuit is used to store data displayed on the CRT screen, and is shared between the Microprocessor Control Circuit and the Video Generator Circuit. This shared memory technique permits the MPU to directly store data 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 actual data displayed within the 80 character positions of all 24 lines is controlled by a 7-bit word stored at the corresponding address within the 1920 byte positions reserved for display storage within the Display Memory Circuit. These words contain a 7-bit ASCII character. All 7-bit characters are displayed within a 7 x 9 dot matrix on the display screen. The 128 characters capable of being displayed are shown in Table 1-2.

When used in conjunction with the keyboard assembly, the EXORterm 150 can be operated in the Local mode for testing both the keyboard and display operation. When operated in this mode, data exchange between the EXORterm 150 and the EXORciser is prevented.

1.4.2.4 *Program Memory Circuit* — The Program Memory Circuit contains the firmware programs used to control the EXORterm's operation. It consists of eight 2K byte mask programmable ROM 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 (refer to 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 EXORterm back panel, and contains the switches used for manual operation selections. The connectors used to interconnect EXORterm 150 with an EXORciser 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.

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, and the bezel and back panel. The metal bottom plate is attached to the bottom of the base with screws. The metal shroud slips over the EXORterm 150 assembly, and attaches on the sides near the lower edge of the base.

The Power Supply is mounted at the rear of the EXORterm 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 EXORterm 150 is electronic. The keys are solid-state memory action capacitive modules which are connected to an encoder within the assem-

TABLE 1-2. Display Codes and Characters

ASCII CODE (HEX)	CHARACTER	ASCII CODE (HEX)	CHARACTER	ASCII CODE (HEX)	CHARACTER	ASCII CODE (HEX)	CHARACTER
00	α	20	(blank)	40	@	60	
01	β	21	!	41	A	61	a
02	γ	22	"	42	B	62	b
03	δ	23	#	43	C	63	c
04	ϵ	24	$	44	D	64	d
05	ζ	25	%	45	E	65	e
06	η	26	&	46	F	66	f
07	θ	27	'	47	G	67	g
08	ι	28	(	48	H	68	h
09	κ	29	)	49	I	69	i
0A	λ	2A	*	4A	J	6A	j
0B	μ	2B	+	4B	K	6B	k
0C	ν	2C	,	4C	L	6C	l
0D	ξ	2D	—	4D	M	6D	m
0E	o	2E	.	4E	N	6E	n
0F	π	2F	/	4F	O	6F	o
10	ρ	30	0	50	P	70	p
11	σ	31	1	51	Q	71	q
12	τ	32	2	52	R	72	r
13	υ	33	3	53	S	73	s
14	ϕ	34	4	54	T	74	t
15	χ	35	5	55	U	75	u
16	ψ	36	6	56	V	76	v
17	ω	37	7	57	W	77	w
18	Ω	38	8	58	X	78	x
19	$\sqrt{\ }$	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	Σ	3E	>	5E	^	7E	~
1F	$\simeq$	3F	?	5F	_	7F	//

bly. 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, All Capital Letters mode, etc.). To further enhance the efficiency of the terminal, 12 special function keys have been encoded to invoke functions unique to the development system in each of three command levels — DOS, EXBUG, and MAID. Refer to Chapter 3 for a detailed description of the keyboard assembly key functions.

1.4.6 Resident Executive Firmware

The Resident Executive Firmware controls the operation of the EXORterm 150. Six process modules have been implemented in the Resident Executive 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 Monitor Operator Calls (MOC's); MOC's 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

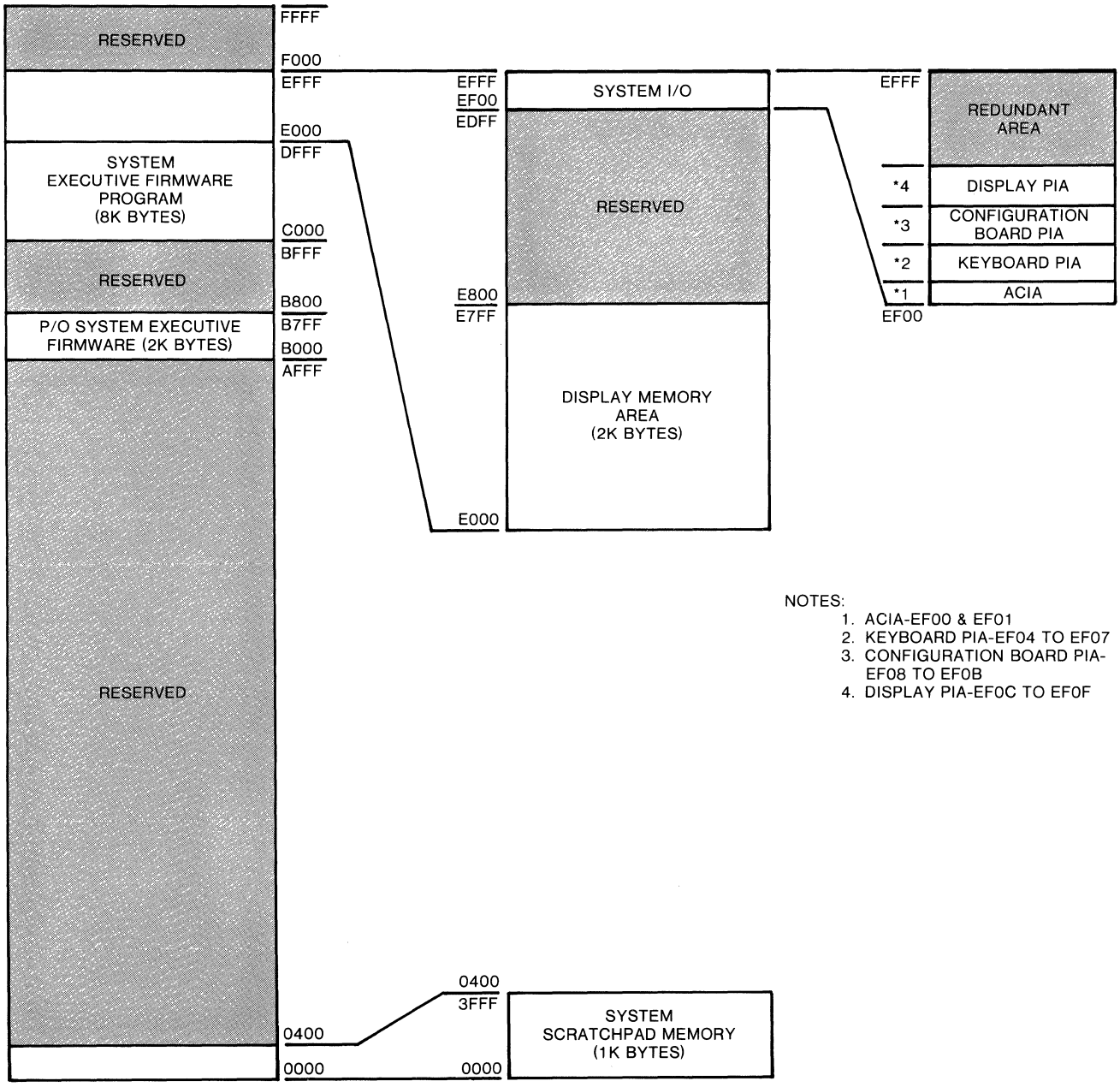


FIGURE 1-3. EXORterm 150 Memory Map

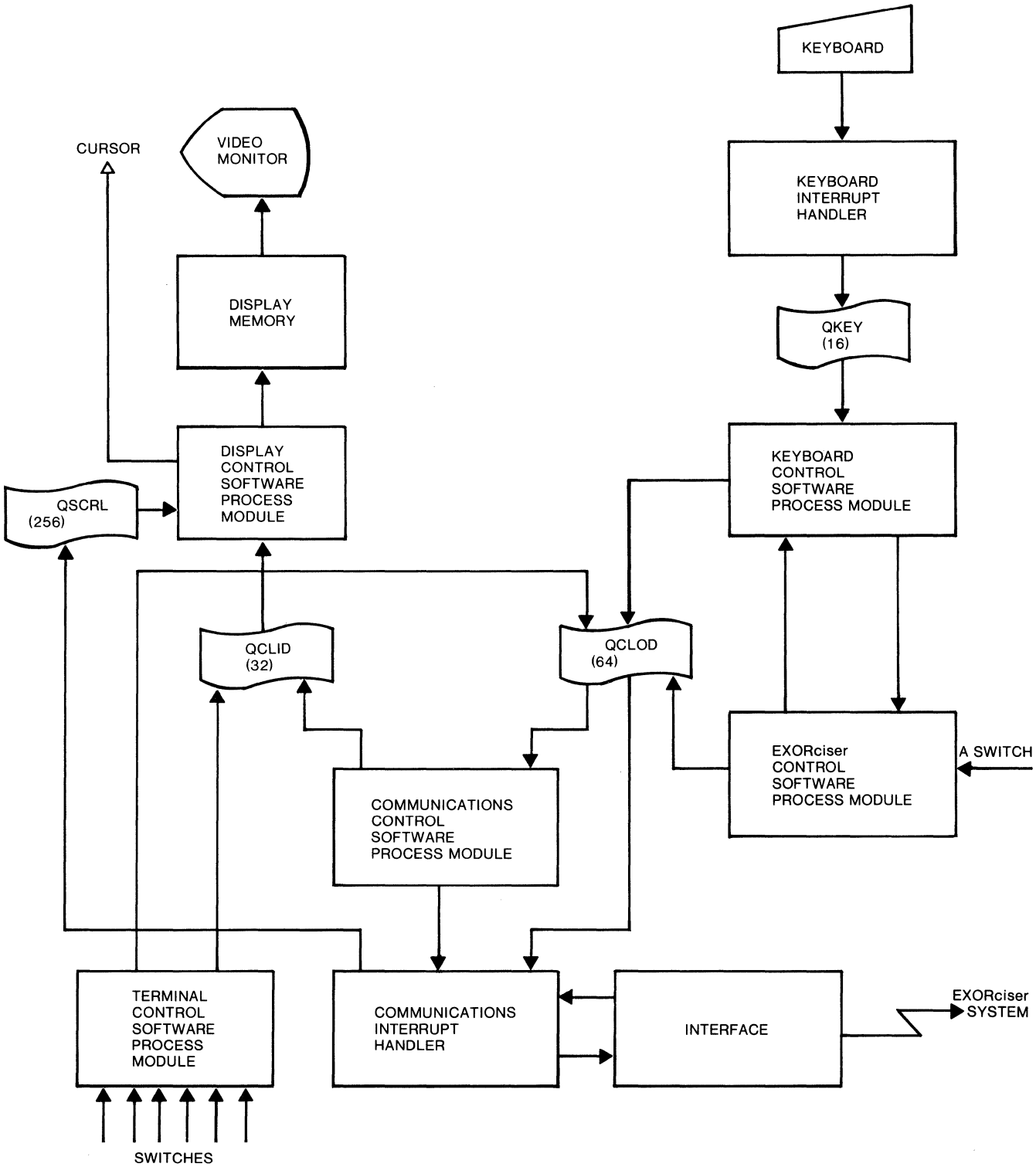


FIGURE 1-4. EXORterm 150 System Flow Chart

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 EXORciser Control software process module controls the functions of the EXORterm 150 that pertain to its use as an EXORciser display console. This module determines the format of the display area and the mode of communication.

1.5 EQUIPMENT SUPPLIED

This manual is shipped with the EXORterm 150, together with supplements based on options included.

1.6 OPTIONAL EQUIPMENT

Two options are available for the EXORterm 150 to enhance its capabilities. The first is the Extended Communications Feature (M68SXD10100). This feature provides the necessary control for operating the terminal with 103 or 202 (or equivalent) modem devices. For further information regarding this option, refer to the Extended Communications Feature Supplement.

The second optional item is a round, 10-foot long, interconnecting cable that can be purchased by customers who do not choose to build their own RS-232 cable with the connector kit provided. The cable (M68SVS40100) can be used to interconnect the EXORterm 150 to the EXORciser or to type 103 or 202 (or equivalent) modem devices.

CHAPTER 2
INSTALLATION INSTRUCTIONS AND INTERCONNECTION CONSIDERATIONS

2.1 INTRODUCTION

This chapter provides the unpacking, inspection, installation, and interconnection instructions for EXORterm 150. It also discusses the module's interconnection signals.

2.2 UNPACKING INSTRUCTIONS

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

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

2.3 INSPECTION

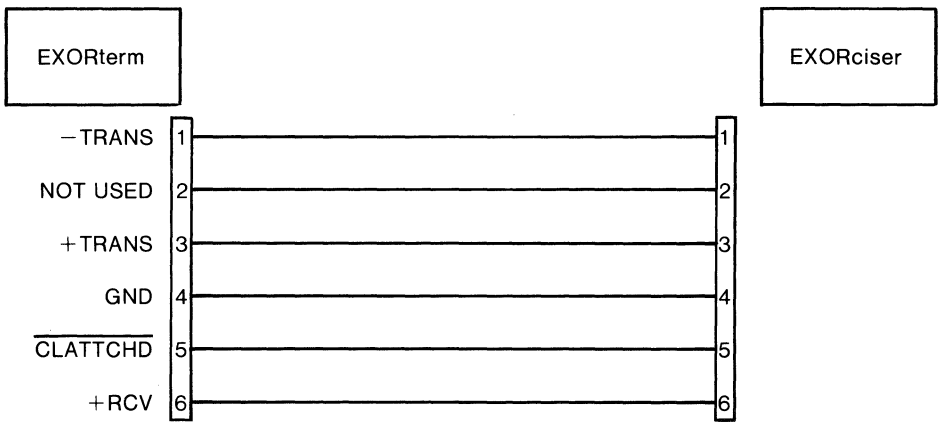
The EXORterm assembly should be inspected upon receipt for broken, damaged, or missing parts, or any other physical or electrical damage.

2.4 INSTALLATION INSTRUCTIONS

The user has the option of interfacing the EXORterm 150 with EXORciser by way of the RS-232C or current loop connectors located on the rear panel of the EXORterm. The user also has the option of interfacing the EXORterm 150 to a type 103 or 202 (or equivalent) modem device by way of the RS-232C connector. Refer to Figures 2-1, 2-2, and 2-3 for EXORterm interconnections.

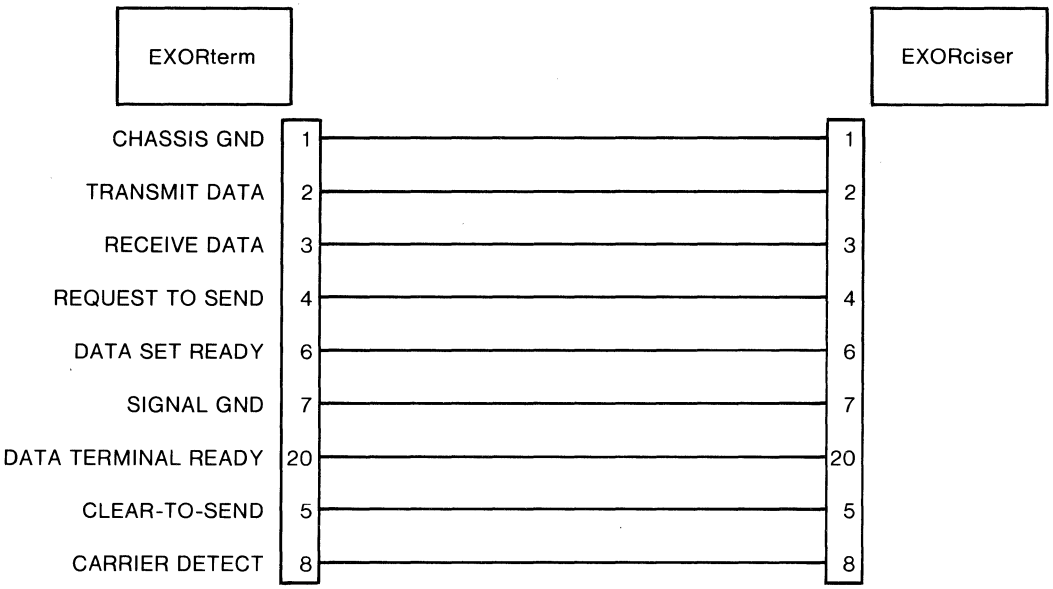
2.5 EXORterm 150 INTERCONNECTIONS

Interconnections to EXORterm 150 can be made via three different connectors — one internal to the terminal, and two external. The internal connector is used for connecting the keyboard. The external connectors (current loop connector and RS-232C interface connector) are used to connect the EXORciser or modem device to EXORterm 150. The signals provided on these connectors are identified in Tables 2-1, 2-2, and 2-3.



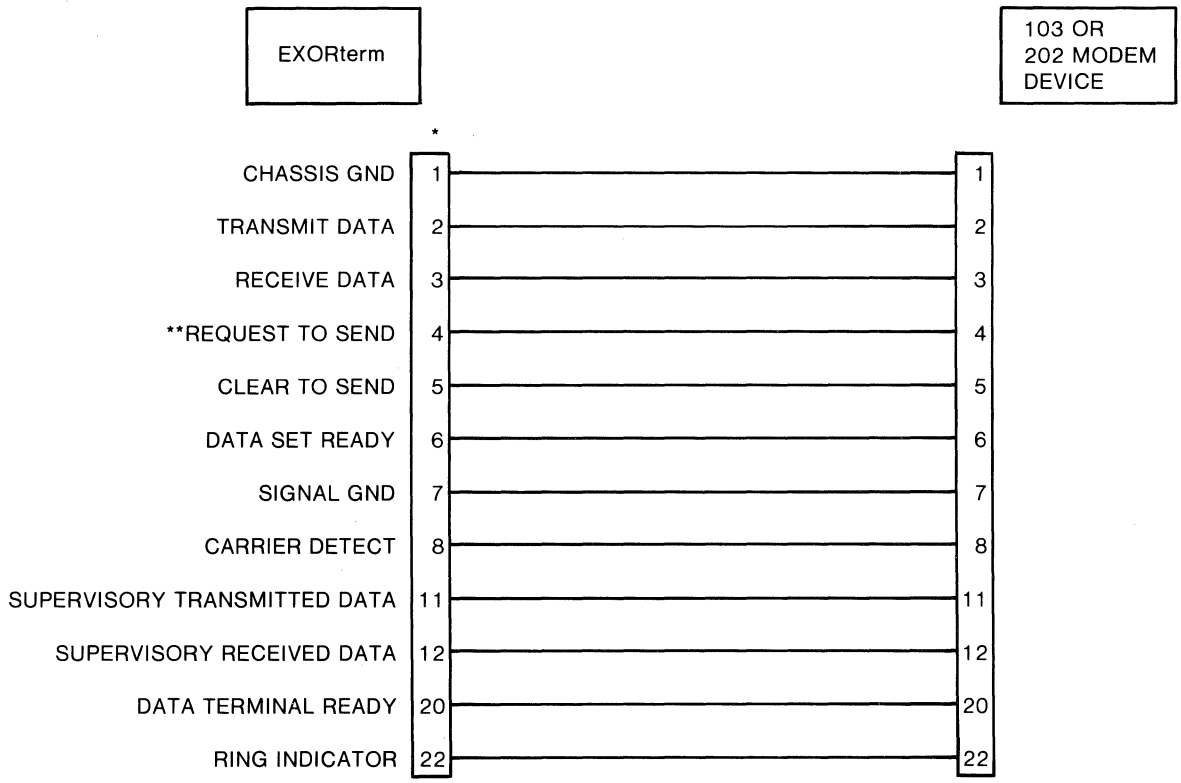
NOTE:
USE AMP 1-350241-9 WITH PIN NUMBERS 350037-1 OR EQUIVALENT CONNECTOR

FIGURE 2-1. EXORterm 150/EXORciser Current Loop Interconnection Cable



NOTE:
USE CINCH DB-25P OR
EQUIVALENT CONNECTOR

FIGURE 2-2. EXORterm 150/EXORciser RS-232C Interconnection Cable



NOTES:
*USE CINCH DB-25P OR
EQUIVALENT CONNECTOR

**NOT REQUIRED FOR 103 MODEM

FIGURE 2-3. EXORterm 150/Modem Device RS-232C Interconnection Cable

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 input ASCII encoded characters from the keyboard.
2	KB-D1	KEYBOARD data (bit 1) — Same as KB-D0 on P2-1.
3	KB-D2	KEYBOARD data (bit 2) — Same as KB-D0 on P2-1.
4	KB-D3	KEYBOARD data (bit 3) — Same as KB-D0 on P2-1.
5	KB-D4	KEYBOARD data (bit 4) — Same as KB-D0 on P2-1.
6	KB-D5	KEYBOARD data (bit 5) — Same as KB-D0 on P2-1.
7	KB-D6	KEYBOARD data (bit 6) — Same as KB-D0 on P2-1.
8	KB-D7	KEYBOARD data (bit 7) — The data line used to define whether the input 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 attached to the EXORterm.
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 Interface Signals

PIN NUMBER	SIGNAL MNEMONICS	SIGNAL NAME AND DESCRIPTION
1	−TRANS	−TRANSMIT — This −12 Vdc line provides the signal return for the EXORciser, 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 the EXORciser ground. This pin is also connected to pin 5 via a jumper connection in the cable.
5	$\overline{\text{CLATTCHD}}$	CURRENT LOOP ATTACHED — This low level input signal indicates that a current loop device is attached to the EXORterm 150.
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	CHASSIS	CHASSIS GROUND — Common for the −12 Vdc source. This line provides a safety ground connection directly to the power supply for RS-232C compatible devices.
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 Basic Display Unit, 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.
9,10		Not used.
11	SUPERVISORY TRANSMIT DATA	SUPERVISORY TRANSMIT DATA — This line transfers data to a 202 Modem device (or equivalent) for transmission.
12	SUPERVISORY RECEIVE DATA	SUPERVISORY RECEIVE DATA — This line accepts received data from a 202 Modem device (or equivalent).
13 to 19		Not used.
20	DATA TERMINAL READY	DATA TERMINAL READY — This output line indicates to the RS-232C device that the Basic Display Unit is ready.
21		Not used.
22	RING INDICATOR	RING INDICATOR — This line indicates that the 103 or 202 Modem has been called (received a ring from an external source).
23 to 25		Not used.

CHAPTER 3
OPERATING INSTRUCTIONS

3.1 INTRODUCTION

The EXORterm 150 provides the means for communication between the EXORciser and the designer of any M6800-based microcomputer system. It is assumed in this chapter that the user is designing his system as described in the M6800 Microprocessor Applications Manual, preparing his program in accordance with the M6800 Microprocessor Programming Reference Manual, and has a good working knowledge of the EXORciser. This chapter is intended to familiarize the user with the location and basic functions of the EXORterm 150 controls. Directives that permit the user to configure, evaluate, and debug his final system hardware and software are entered directly from the keyboard.

3.2 OPERATING CONTROLS

The operating controls of the EXORterm 150 are comprised of three functional groups: front panel controls, rear panel controls, and keyboard assembly.

3.2.1 Front Panel Controls

The front panel controls turn the EXORterm 150 on and off and adjust the brightness of the CRT display. These controls are shown in Figure 3-1.

3.2.2 Rear Panel Controls

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-hand side 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 3-1.

3.2.3 Keyboard Assembly Controls

Figure 3-2 illustrates all functional keys of the keyboard assembly. The keys are grouped into three categories:

- Mode Select Keys — These keys select the mode of operation of the EXORterm 150.
- Character and Control Keys — These keys generate the ASCII characters, plus providing control and editing functions.
- Function Keys — The 12 function keys (F1 through F12) are used to select a specific operation at a specific command level. Thus, these keys provide a shorthand method of inputting the same operation one key at a time. When rear panel switch A is off, these keys select EXbug or disk functions. *This feature is used only in EXORterm 150/EXORciser I configurations. On EXORterm 150/EXORciser II configurations, switch A must be positioned to ON.*

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). If the OFF/ENABLE switch is positioned to ENABLE, FAC codes are permitted to perform their designated function. If the OFF/DISPL switch is in the DISPL position, the FAC codes will be displayed. The OFF/ENABLE switch must be in the ENABLE position and the OFF/DISPL switch in the OFF position for normal EXORterm/EXORciser 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 EXORterm 150/EXORciser operations.
VIDEO INV	The VIDEO INV (Video Invert) switch permits the user to select

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

CONTROL	FUNCTION
	either a black background with white lettering (OFF) or a white background with black lettering (ON).
A	This switch selects the EXORciser I personality. The switch must be positioned OFF to enable EXORterm 150/EXORciser I operations. The switch must be positioned ON for EXORterm 150/EXORciser II operations.
B and C	Not used.
SPEC CHAR	This switch permits all the special characters to be displayed on the screen when in the DISPL position. 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	The DUPLEX 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. For EXORterm 150/EXORciser, only 110 baud requires two stop bits.
CONNECTION	This switch permits the use of a 103 or 202 MODEM or DIRECT connection via the RS-232 or current loop communication interface. MODEM selection can be used only when the optional Extended Communication Feature is provided. If the Extended Communication Feature is not provided and an optional keyboard is attached, the keyboard's target lighted keys are blinked at half-second intervals.
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 is 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).

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

CONTROL	FUNCTION
CODE	The CODE 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 Basic Display Unit 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.

3.2.3.1 *Mode Select Keys* — The keyboard's mode select keys perform the following functions:

[ALL CAPS] Depressing the ALL CAPS key causes the keyboard to enter the All Capital Letters mode (key will illuminate). 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. Since the EXORciser recognizes only upper-case alphabetic characters, the All Capital Letters mode must be selected.

[AUTO LF] In the Automatic Line Feed mode, a line feed command is automatically inserted when a carriage return is output. (Not used with EXbug or Disk Assembler/Editor).

[ON 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 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. (Not used with EXbug)

3.2.3.2 *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 the ASCII control characters. If the EXORterm 150 is in the Special Character mode, the CTRL key can be used to generate the special characters (θ, ϕ, Ω, etc.).

[LF] The LF (Line Feed) command 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. The valid escape characters are listed in Table 3-4. Two escape characters in sequence are used to represent an escape character to be displayed.

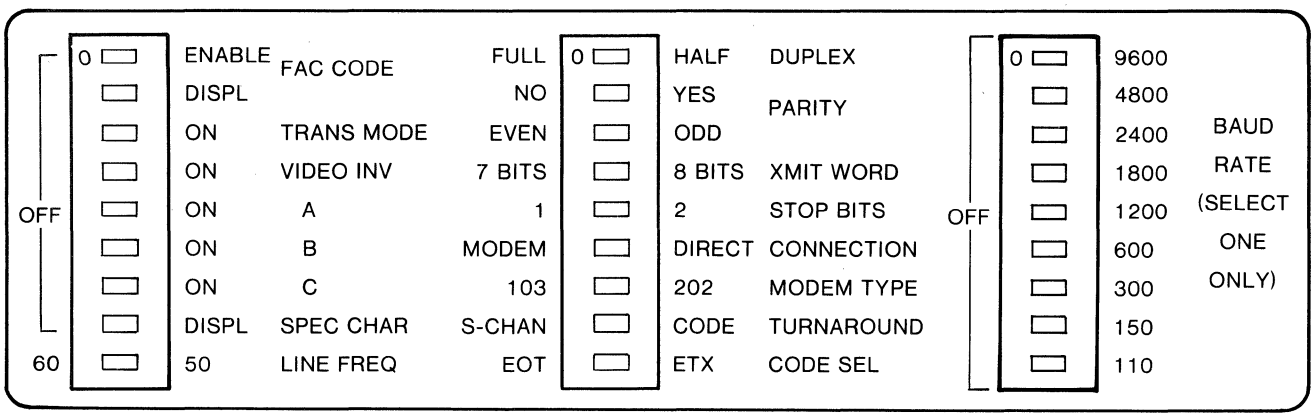
[BREAK] Pressing the BREAK key forces a "space" condition on the communications interface of the EXORterm 150. Minimum space condition is 300 milliseconds.

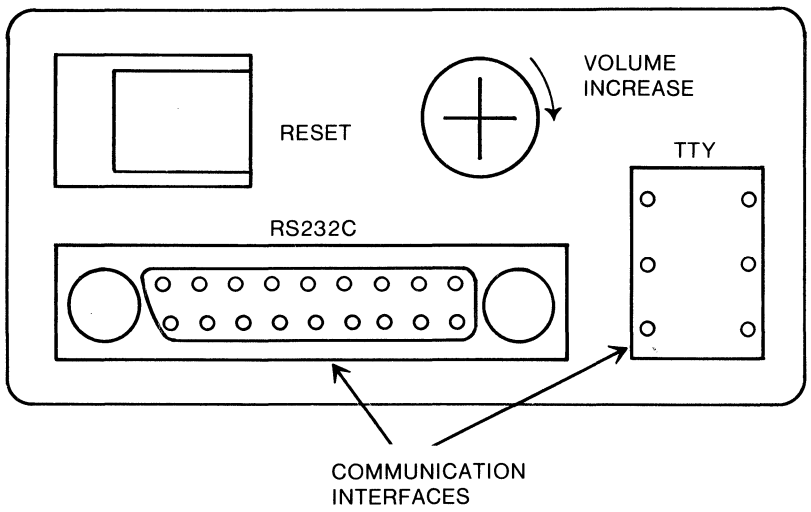
[RETURN] The Carriage RETURN key places the cursor at the beginning of the present line (left margin).

NOTE

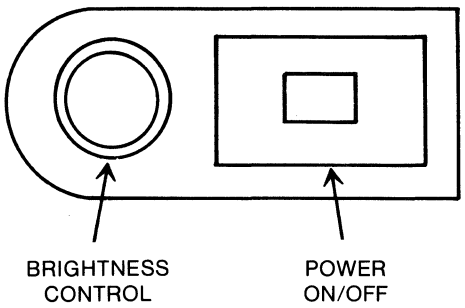
The following keys are not used with EXbug or normal Disk Assembler or Editor programs. However, they may be used with special Editors.

[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, cursor moves to the left-most column in top line and





A. REAR PANEL CONTROLS



B. FRONT PANEL CONTROLS

FIGURE 3-1. EXORterm 150 — Front and Rear Panel Controls

FIGURE 3-2. Keyboard Assembly Controls

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 the display to be filled with spaces (20_{16}). Cursor moves to Home position. In Protect mode, all non-protected positions in the 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] The non-shifted and shifted functions of this key are ignored in Scroll mode. In Page mode, the non-shifted function of this key (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 the 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 (see Table 4-7). 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 INS CHAR (Insert Character) 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 Insert Character 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 character (20_{16}). The cursor does not change position. In Protect mode, the Delete Character 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 (09_{16}) to set a tab, or the ASCII control character CAN (18_{16}) to clear a tab. The commands are separated by space characters (20_{16}) 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 where the 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 where the cursor rests is filled with space characters

(20_{16}). Cursor moves to the first position of the blank line.

[LINE ERASE] In Scroll and Page modes, the non-shifted function of the key (Page Erase) erases all positions from the cursor position to the end of the display. These positions are filled with space characters (20_{16}) 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 space characters and the cursor does not change position.

In Scroll and Page modes, the shifted function of the key (Line Erase) 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 key erases all non-protected positions to the end of the line. The positions are filled with space characters 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.

TABLE 3-2. Keyboard Assembly, Encoded Values

CHARACTER	COMMENTS	KEYBOARD CHARACTER*	7-BIT STD CODE		
			DECIMAL VALUE	OCTAL VALUE	HEX VALUE
NUL	Null or tape feed	@C	0	000	00
SOH	Start of heading	AC	1	001	01
STX	Start of text	BC	2	002	02
ETX	End of text	CC	3	003	03
EOT	End of transmission	DC	4	004	04
ENQ	Enquire (who are you, WRU)	EC	5	005	05
ACK	Acknowledge	FC	6	006	06
BEL	Bell	GC	7	007	07
BS	Backspace	HC	8	010	08
HT	Horizontal tab	IC	9	011	09
LF	Line feed	LF, LFS, or JC	10	012	0A
VT	Vertical tab	KC	11	013	0B
FF	Form feed	LC	12	014	0C
RETURN	Carriage return	RETURN,RETURNS or MC	13	015	0D
SO	Shift out (to red ribbon)	NC	14	016	0E
SI	Shift in (to black ribbon)	OC	15	017	0F
DLE	Data Link Escape	PC	16	020	10
DC1	Device Control 1	QC	17	021	11
DC2	Device Control 2	RC	18	022	12
DC3	Device Control 3	SC	19	023	13
DC4	Device Control 4	TC	20	024	14
NAK	Negative acknowledge	UC	21	025	15
SYN	Synchronous idle	VC	22	026	16
ETB	End of transmission block	WC	23	027	17
CAN	Cancel	XC	24	030	18

TABLE 3-2. Keyboard Assembly, Encoded Values (Cont'd)

CHARACTER	COMMENTS	KEYBOARD CHARACTER*	7-BIT STD CODE		
			DECIMAL VALUE	OCTAL VALUE	HEX VALUE
EM	End of medium	Y^{C}	25	031	19
SUB	Substitute	Z^{C}	26	032	1A
ESC	Escape, prefix	ESC,ESC^{S}, or [^{C}	27	033	1B
FS	File separator	/^{C}	28	034	1C
GS	Group separator	]^{C}	29	035	1D
RS	Record separator	^^{C}	30	036	1E
US	Unit separator	_^{C}	31	037	1F
SP	Space or blank	Space Bar	32	040	20
!	Exclamation point	1^{S}	33	041	21
"	Quotation marks (dieresis)	2^{S}	34	042	22
#	Number sign	3^{S}	35	043	23
$	Dollar sign	4^{S}	36	044	24
%	Percent sign	5^{S}	37	045	25
&	Ampersand	6^{S}	38	046	26
'	Apostrophe (acute accent, closing single quote)	7^{S}	39	047	27
(	Opening parenthesis	8^{S}	40	050	28
)	Closing parenthesis	9^{S}	41	051	29
*	Asterisk	:^{S}	42	052	2A
+	Plus sign	;^{S}	43	053	2B
,	Comma (cedilla)	,	44	054	2C
-	Hyphen (minus)	-	45	055	2D
.	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	A^{S}	65	101	41
B	Upper case letter B	B^{S}	66	102	42
C	Upper case letter C	C^{S}	67	103	43
D	Upper case letter D	D^{S}	68	104	44
E	Upper case letter E	E^{S}	69	105	45
F	Upper case letter F	F^{S}	70	106	46
G	Upper case letter G	G^{S}	71	107	47
H	Upper case letter H	H^{S}	72	110	48
I	Upper case letter I	I^{S}	73	111	49
J	Upper case letter J	J^{S}	74	112	4A
K	Upper case letter K	K^{S}	75	113	4B
L	Upper case letter L	L^{S}	76	114	4C
M	Upper case letter M	M^{S}	77	115	4D

TABLE 3-2. Keyboard Assembly, Encoded Values (Cont'd)

CHARACTER	COMMENTS	KEYBOARD CHARACTER*	7-BIT STD CODE		
			DECIMAL VALUE	OCTAL VALUE	HEX VALUE
N	Upper case letter N	N^{S}	78	116	4E
O	Upper case letter O	O^{S}	79	117	4F
P	Upper case letter P	P^{S}	80	120	50
Q	Upper case letter Q	Q^{S}	81	121	51
R	Upper case letter R	R^{S}	82	122	52
S	Upper case letter S	S^{S}	83	123	53
T	Upper case letter T	T^{S}	84	124	54
U	Upper case letter U	U^{S}	85	125	55
V	Upper case letter V	V^{S}	86	126	56
W	Upper case letter W	W^{S}	87	127	57
X	Upper case letter X	X^{S}	88	130	58
Y	Upper case letter Y	Y^{S}	89	131	59
Z	Upper case letter Z	Z^{S}	90	132	5A
[	Opening bracket	[	91	133	5B
\	Reverse slant	\	92	134	5C
]	Closing bracket	]	93	135	5D
^	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
BREAK	Execute Break	BREAK or BREAK^{S}	140	214	8C
F1	EXbug, MAID, or DOS command	F1	160	240	A0
F2	EXbug, MAID, or DOS command	F2	161	241	A1
F3	EXbug, MAID, or DOS command	F3	162	242	A2

TABLE 3-2. Keyboard Assembly, Encoded Values (Cont'd)

CHARACTER	COMMENTS	KEYBOARD CHARACTER*	7-BIT STD CODE		
			DECIMAL VALUE	OCTAL VALUE	HEX VALUE
F4	EXbug, MAID, or DOS command	F4	163	243	A3
F5	EXbug, MAID, or DOS command	F5	164	244	A4
F6	EXbug, MAID, or DOS command	F6	165	245	A5
F7	EXbug, MAID, or DOS command	F7	166	246	A6
F8	EXbug, MAID, or DOS command	F8	167	247	A7
F9	EXbug, MAID, or DOS command	F9	168	250	A8
F10	Disk Operating Command	F10	169	251	A9
F11	MAID command	F11	170	252	AA
F12	EXBUG command	F12	171	253	AB
HOME	Cursor to home position	HOME	192	300	C0
↑	Cursor up one line	↑ or ↑S	193	301	C1**
↓	Cursor down one line	↓ or ↓S	194	302	C2**
←	Cursor left one column	← or ←S	195	303	C3**
→	Cursor right one column	→ or →S	196	304	C4**
PAGE MODE	Select Page Mode operation	Page Mode or Page ModeS	199	307	C7
INS CHAR	Insert Character	INS CHAR or INS CHARS	208	320	D0
DEL CHAR	Delete Character	DEL CHAR or DEL CHARS	209	321	D1
PAGE ERASE	Page Erase	ERASE	212	324	D4
LINE ERASE	Line Erase	ERASES	213	325	D5
INS LINE	Insert Line	INS LINE or INS LINES	214	326	D6
DEL LINE	Delete Line	DEL LINE or DEL LINES	215	327	D7
CLEAR	Erase Screen	HOMES	216	330	D8
SEND PAGE	Send All Data	SEND	217	331	D9
→|	Forward Tab	→| or →|S	218	332	DA
|←	Backward Tab	|← or |←S	219	333	DB
SET TABS	Initialize Set Tabs Function	SET TABS or SET TABSS	220	334	DC
SEND LINE	Send 1 line of Data	SENDS	221	335	DF
AUTO LF	Automatic Line Feed	AUTO LF or AUTO LFS	247	367	F7
ON LINE	On Line Mode	ON LINE or ON LINES	248	370	F8
ALL CAPS	Limited ASCII output from keyboard to all characters using SHIFT	ALL CAPS	-	-	-
CTRL	Control Key	CTRL	-	-	-
SHIFT	SHIFT Key	SHIFT	-	-	-

* For implementation on keyboard, c = control and s = shift.

** In Scroll mode, the encoded value is translated by the Resident Executive Firmware of the Basic Display Unit. The translated value is transmitted on the communications interface. The transmitted value for C1, C2, C3, and C4 are 0B, 02, 08, and 0C, respectively.

3.2.3.3 *Function Keys* — The 12 function keys (F1 through F12) are used to select a specific operation at a specific command level when the communications interface is connected to the integral development facility and the rear panel A switch is in the OFF position. When used in this capacity, the terminal is normally operated in Scroll mode, except when performing page-oriented editing. As such, text displayed on the screen will scroll upward, one line at a time, as data is keyed into the terminal from the keyboard or is received via the communications interface. The upper 22 lines on the screen are available for user text, and scroll upward from the 22nd line as the text is entered. Lines scrolled off the top will be lost unless the terminal is operating with appropriate software. The bottom two lines (lines 23 and 24) are reserved for the terminal and are used to display the mnemonic function names for each of the 12 function keys located on the keyboard (designated F1 through F12).

The terminal operates in the full duplex mode (On Line), meaning the characters input via the keyboard are transmitted via the communications interface to the integral development facility and then echoed back to the terminal. In this mode, the terminal will display only

the characters echoed back. In half duplex mode (Local), characters entered from the keyboard are displayed directly. The half duplex mode is used only for testing and demonstration purposes.

The keyboard provides the means of inputting the full 128-character ASCII set plus the various function keys. The function keys (F1 through F12) are used to select a specific operation at a specific command level. Thus, these keys provide a shorthand method of inputting the same operation one key at a time.

Function keys F10, F11 and F12 are used to select the command level desired. They also provide the means of proceeding from one command level to another. Figure 3-3 shows the data displayed on the CRT when power is initially applied to the EXORterm 150 or when the RESET pushbutton on the rear panel is depressed.

NOTE

The box shown around the various commands in the following CRT display illustrations is used to indicate that the word within the box is displayed in reverse video. This is used to indicate to the operator the command level currently selected. The function of the remaining function keys (F1 through F9) is then specified for each command level. Table 3-3 provides the corresponding mnemonics for each function key at each of the three command levels.

The display on the CRT corresponding to the function keys is at half intensity for F1-F4 and F9-F12 and at full intensity for F5-F8. This is to facilitate visual selection of display with the color tone of the corresponding function key group.

When the terminal is initialized, it defaults to the EXbug command level (as shown in Figure 3-3). If function key F11 is then depressed, the MAID command level is automatically entered and the word MAID is displayed on the 22nd line of the CRT. Figure 3-4 shows the various MAID commands that can then be initiated with a single stroke of the appropriate function key.

When the function key F10 (DOS) is depressed, the Disk Operating System command level is automatically entered. However, since three different Disk Operating Systems can be used with EXORterm 150 (either EDOS or MDOS), the commands that are available by using the function keys are different. The EXORterm 150 automatically adjusts to any disk system (EXORdisk I, EXORdisk II, or EXORdisk III). The various function key commands available for the EDOS-based EXORdisk I are shown in Figure 3-5 while the commands available for the MDOS-based EXORdisk II/III are shown in Figure 3-6. Also, note that the word DOS (displayed under F10 on the CRT) is changed to reflect the appropriate disk system. Entering the DOS command level causes the call E800;G to be printed on line 22 of the CRT.

For a description of additional MAID commands not represented by function keys but which may be entered on the keyboard, refer to the applicable EXORciser User's Guide. For a detailed description of all MDOS and EDOS commands, refer to their associated User's Manual.

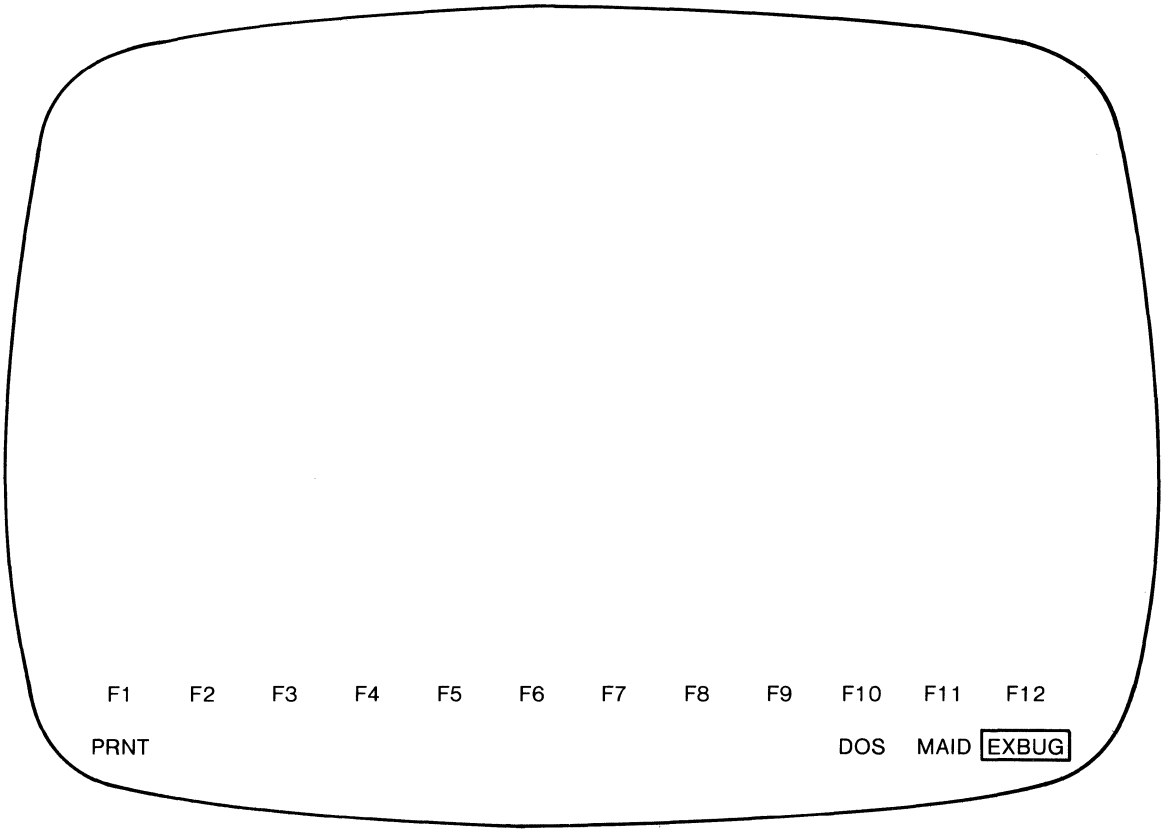


FIGURE 3-3. CRT Display for EXbug Command Level Selection

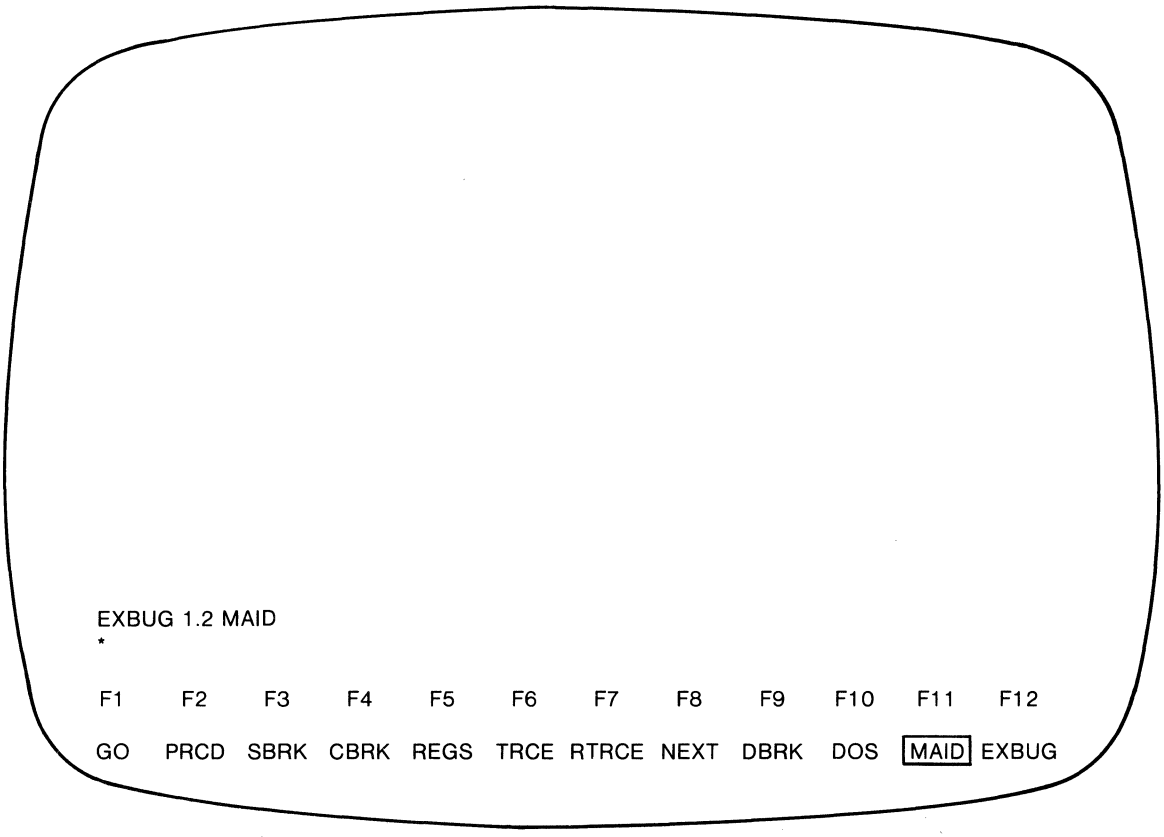


FIGURE 3-4. CRT Display for MAID Command Level Selection

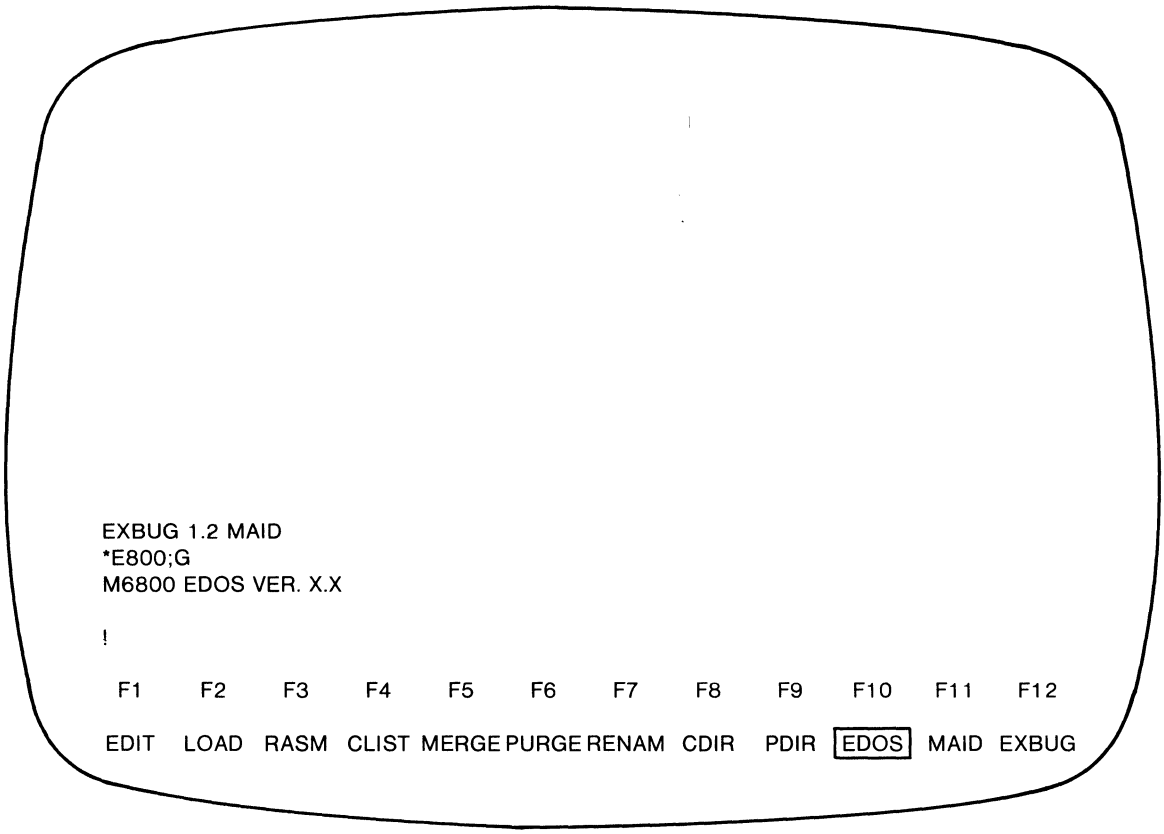


FIGURE 3-5. CRT Display for DOS Command Level Selection using EDOS

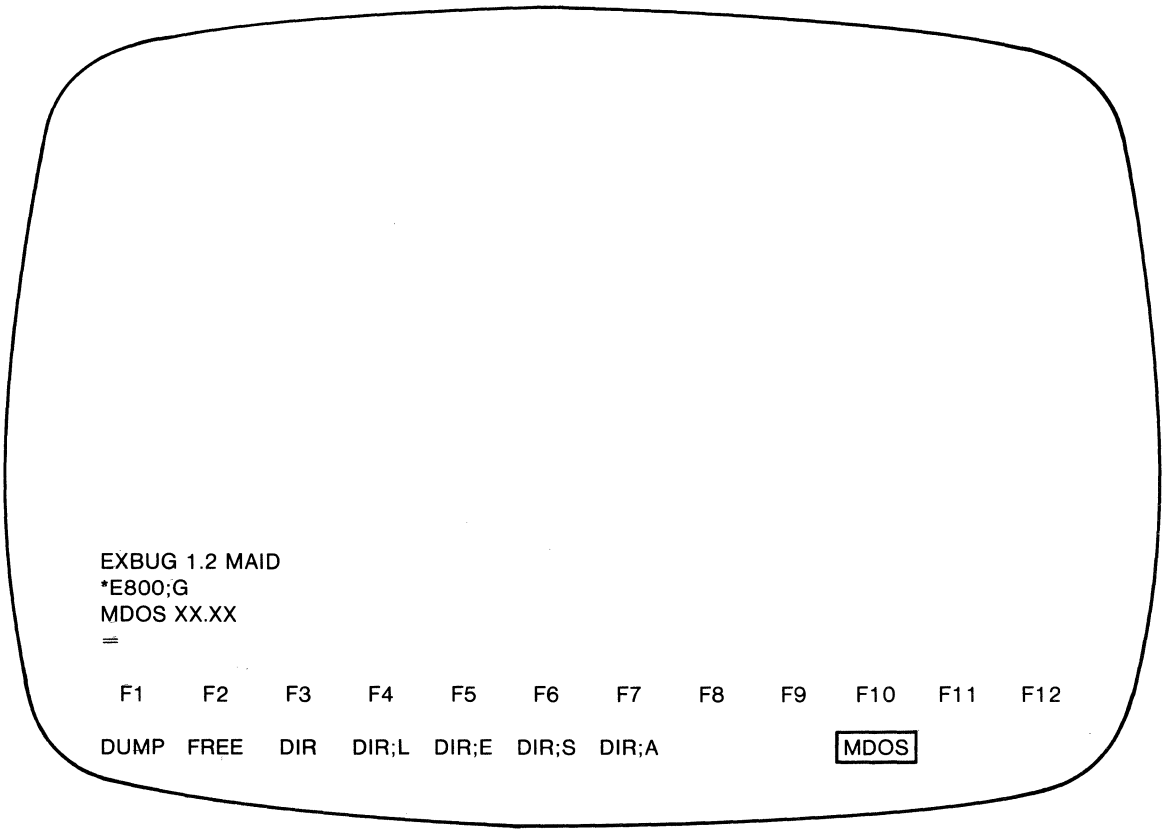


FIGURE 3-6. CRT Display for DOS Command Level Selection using MDOS

TABLE 3-3. Function Key Commands

EXBUG COMMAND LEVEL —

KEY	MNEMONIC	EXBUG COMMAND	DESCRIPTION
F1	PRNT	PRNT	Initiates the EXORterm's Print Dump function.

MAID COMMAND LEVEL —

KEY	MNEMONIC	MAID COMMAND	DESCRIPTION
F1	GO	;G	Execute the user's program starting at the auto restart memory address.
F2	PRCD	;P	Continue executing from the current program counter setting.
F3	SBRK	;V	Enter a breakpoint.
F4	CBRK	;U	Remove all breakpoints.
F5	REGS	$R	Display/change the user's program registers.
F6	TRCE	$T	Set the trace mode.
F7	RTRCE	;T	Reset the trace mode.
F8	NEXT	;N	Trace one instruction.
F9	DBRK	$V	Display the memory location of each breakpoint.

MDOS COMMAND LEVEL —

KEY	MNEMONIC	MDOS COMMAND	DESCRIPTION
F1	DUMP	DUMP	Display disk sectors (logical/physical).
F2	FREE	FREE	Display amount of free space on a disk.
F3	DIR	DIR	Display the contents of the directory on selective basis, including optional allocation information.
F4	DIR;L	DIR;L	Display directory information on local printer.
F5	DIR;E	DIR;E	Display entire directory entry information.
F6	DIR;S	DIR;S	System files may be included when displaying family of files.
F7	DIR;A	DIR;A	Display complete allocation description of each file name.

EDOS COMMAND LEVEL —

KEY	MNEMONIC	EDOS COMMAND	DESCRIPTION
F1	EDIT	EDIT	Enables editing of the contents of the input file, using the Text Editor. Edited data is stored into the new output file.
F2	LOAD	LOAD	Loads the contents of the object file into RAM memory for execution.
F3	ASM	ASM	Assembles the contents of the source file and directs the object file to the destination file.
F4	CLIST	CLIST	Print the contents of the file on the list output device.
F5	MERGE	MERGE	Allows one or more files to be concatenated into a new file.

TABLE 3-3. Function Key Commands (Cont'd)

EDOS COMMAND LEVEL — KEY	MNEMONIC	EDOS COMMAND	DESCRIPTION
F6	PURGE	PURGE	Deletes the designated files from the diskette in drive unit u, and then repacks the contents of that diskette, making the disk space available for additional files.
F7	RENAM	RENAM	Rename the old file with the new file.
F8	CDIR	CDIR	List the contents of the file directory on the diskette in drive unit u. Lists the file names, attributes, and file sizes in sectors to the console.
F9	PDIR	PDIR	Lists the contents of the file directory on the diskette in drive unit u. Lists the file names, attributes, and file sizes to the line printer.

3.3 COMMUNICATION INTERFACE COMMANDS

The communications interface is used to transfer serial data between the EXORterm 150 and the EXORciser. The interface consists of two parts. The first receives data and commands from the EXORciser or host system. The second part transmits data and commands to the EXORciser. Hence, the interface is a two-way simultaneous communications mechanism.

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 set of 8-bit bytes recognized by the EXORterm 150 is restricted to the hexadecimal values 00_{16} through FF_{16}. A byte whose value is within the range of 00_{16} to $7F_{16}$ 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_{16} through $1F_{16}$ 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_{16} to FF_{16} 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 ($1B_{16}$) followed by a byte whose value is within the range of 20_{16} to $7F_{16}$. 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 3-4 summarizes the commands available for EXORterm 150. It provides 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

In Table 3-4, some of the commands are not used with EXbug or normal disk assembler or editor programs. However, they may be used with special editors.

Table 3-5 lists the ASCII codes used to position the cursor in the absolute display area. To position the cursor, a command followed by the ASCII position code(s) must be received on the interface. The commands that are used to perform this function are: LOAD CURSOR, BOTTOM DISPLAY LINE, TOP DISPLAY LINE, LEFT DISPLAY COLUMN, and RIGHT DISPLAY COLUMN.

TABLE 3-4. Communication Interface Commands

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
HOME	CO	ESC,@	VIRTUAL	SCROLL	CURSOR MOVES TO LEFT-MOST COLUMN IN TOP LINE.	1	2	COMMAND BYTE(S)
				PAGE	CURSOR MOVES TO LEFT-MOST COLUMN IN TOP LINE.			
				PROTECT	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.			
CURSOR UP ONE LINE (↑)	C1	ESC,A	VIRTUAL	SCROLL	IGNORED	1	2	COMMAND BYTE(S)
				PAGE	CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLL-OVER.			
				PROTECT	CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLL-OVER, SEEKS NON-PROTECTED COLUMN TO THE LEFT.			
CURSOR DOWN ONE LINE (↓)	C2	ESC,B	VIRTUAL	SCROLL	CURSOR MOVES DOWN ONE LINE IN SAME COLUMN. IF ALREADY IN LAST LINE, SCROLL IS EXECUTED AND LAST LINE IS BLANKED.	1	2	COMMAND BYTE(S)
				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.			

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
CURSOR LEFT ONE COLUMN (←)	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 (→)	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, 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 (SEE TABLE 3-5)
				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 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
LOAD CURSOR (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 PAGE, PROTECT	IGNORED 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, PAGE, 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, PAGE, 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, PAGE, 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 (SEE TABLE 3-5).
FORWARD TAB →|	DA	ESC,Z	VIRTUAL	SCROLL PAGE PROTECT	CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITHOUT LINE ROLLOVER). CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITH LINE AND PAGE ROLLOVER) AS DEFINED BY THE SET TABS COMMAND. CURSOR MOVES RIGHT TO LEFT — MOST COLUMN OF NEXT NON-PROTECTED FIELD (WITH LINE AND PAGE ROLLOVER).	1	2	COMMAND BYTE(S)

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
BACK TAB |—	DB	ESC,[	VIRTUAL	SCROLL	CURSOR MOVES LEFT TO PREVIOUS TAB POSITION (WITHOUT LINE ROLLOVER).	1	2	COMMAND BYTE(S)
				PAGE	CURSOR MOVES LEFT TO PREVIOUS TAB POSITION (WITH LINE AND PAGE ROLLOVER).			
				PROTECT	CURSOR MOVES LEFT TO LEFT — MOST COLUMN OF PREVIOUS NON-PROTECTED FIELD (WITH LINE AND PAGE ROLLOVER).			
SET TABS	DC	ESC,/	VIRTUAL	PAGE, SCROLL, 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, PAGE, PROTECT	SETS TRANSPARENT MODE OPERATION; CURSOR DOES NOT CHANGE POSITION.	1	2	COMMAND BYTE(S)
RESET TRANSPARENT MODE	ED	ESC,m	ABSOLUTE	SCROLL, PAGE, PROTECT	RESETS TRANSPARENT MODE OPERATION; CURSOR DOES NOT CHANGE POSITION.	1	2	COMMAND BYTE(S)
SET VIDEO INVERT	EE	ESC,n	ABSOLUTE	SCROLL, PAGE, PROTECT	SETS VIDEO INVERT OPERATION; CURSOR DOES NOT CHANGE POSITION.	1	2	COMMAND BYTE(S)

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	ESC. SEQ.	DESCRIPTION
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	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: **INDICATOR CODE FUNCTION** PE 98 PARITY ERROR RO 9A RECEIVE OVERRUN FE 9B FRAMING ERROR	1	2	COMMAND BYTE(S)

TABLE 3-4. 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.	
DISPLAY STATUS ON (Cont'd)					FRAMING AND PARITY ERROR COMMANDS ARE FOLLOWED BY THE BYTE SUFFERING THE ERROR CONDITION.			
DISPLAY STATUS OFF	F3	ESC,s	ABSOLUTE	SCROLL, PAGE, PROTECT	RECEIVED STATUS INDICATORS PE, RO, AND FE CANNOT BE DISPLAYED.	1	2	COMMAND BYTE(S)
ASCII BEL (BELL)	07	NONE	N.A.	SCROLL, PAGE, PROTECT	CAUSES THE BELL TO ISSUE TONE FOR A PERIOD OF ONE-HALF SECOND.	1		COMMAND BYTE
ASCII BS (BACKSPACE)	08	NONE	VIRTUAL	SCROLL	CURSOR MOVES LEFT ONE COLUMN WITHOUT LINE ROLLOVER.	1		COMMAND BYTE
				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.			
ASCII HT (HORIZONTAL TAB)	09	NONE	VIRTUAL	SCROLL	CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITHOUT LINE ROLLOVER) AS DEFINED BY THE SET TABS COMMAND.	1		COMMAND BYTE
				PAGE	CURSOR MOVES RIGHT TO NEXT TAB POSITION (WITH LINE AND PAGE ROLLOVER) AS DEFINED BY THE SET TABS COMMAND.			
				PROTECT	CURSOR MOVES RIGHT TO THE LEFT—MOST COLUMN OF THE NEXT NON-PROTECTED FIELD (WITH LINE AND PAGE ROLLOVER).			

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
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	IGNORED			
				PROTECT	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 (SEE TABLE 3-5)
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	IGNORED	1		COMMAND BYTE
				PAGE	CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLLOVER.			

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
ASCII VT (VERTICAL TAB) (Cont'd)				PROTECT	CURSOR MOVES UP ONE LINE IN SAME COLUMN WITH PAGE ROLL-OVER. SEEKS NON-PROTECTED COLUMN TO THE LEFT.			
ASCII FF (FORM FEED)	OC	NONE	VIRTUAL	SCROLL	CURSOR MOVES RIGHT ONE COLUMN WITHOUT LINE ROLLOVER.	1		COMMAND BYTE
				PAGE	CURSOR MOVES RIGHT ONE COLUMN WITH LINE AND PAGE ROLL-OVER.			
				PROTECT	CURSOR MOVES RIGHT ONE COLUMN WITH LINE AND PAGE ROLL-OVER. SEEKS NON-PROTECTED COLUMN TO THE RIGHT.			
ASCII CR (CARRIAGE RETURN)	OD	NONE	VIRTUAL	SCROLL, PAGE	CURSOR MOVES TO LEFT MARGIN.	1		COMMAND BYTE
				PROTECT	CURSOR MOVES TO LEFT MARGIN. SEEKS NON-PROTECTED COLUMN TO THE RIGHT.			
LEFT DISPLAY COLUMN	CB	ESC,K	ABSOLUTE	SCROLL, PAGE, 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 (SEE TABLE 3-5)
RIGHT DISPLAY COLUMN	CC	ESC,L	ABSOLUTE	SCROLL, PAGE, 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 (SEE TABLE 3-5)
SET PROTECT MODE	CD	ESC,M	VIRTUAL	SCROLL	SCROLL MODE IS RESET, PROTECT MODE IS SET.	1	2	COMMAND BYTE(S)
				PAGE	PAGE MODE IS RESET, PROTECT MODE IS SET.			

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
SET PROTECT MODE (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	D0	ESC,P	VIRTUAL	SCROLL PAGE	IGNORED 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)

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
CHARACTER INSERT (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	IGNORED	1	2	COMMAND BYTE(S)
				PAGE	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.			
				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 3-4. 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	STARTING WITH CURSOR POSITION, LINE IS BLANKED TO THE RIGHT WITH SPACE (20) CHARACTER. CURSOR DOES NOT CHANGE POSITION.	1	2	COMMAND BYTE(S)
				PROTECT	ALL COLUMNS IN NON-PROTECTED FIELD UNDER AND CONTIGUOUS RIGHT OF CURSOR ARE BLANKED. CURSOR DOES NOT CHANGE POSITION.			
LINE INSERT	D6	ESC,V	VIRTUAL	SCROLL, PROTECT	IGNORED	1	2	COMMAND BYTE(S)
				PAGE	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.			
SEND PAGE	D9	ESC,Y	VIRTUAL	SCROLL	IGNORED	1	2	COMMAND BYTE(S)
				PAGE	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			

TABLE 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
SEND PAGE (Cont'd)					FIELD ATTRIBUTE CODES TO INDICATE START AND END PROTECTED FIELDS.			
				PROTECT	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, PROTECT	IGNORED	1	2	COMMAND BYTE(S)
				PAGE	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.			
CLEAR	D8	ESC,X	VIRTUAL	SCROLL	ALL POSITIONS IN DISPLAY AREA ARE FILLED WITH SPACES (20). CURSOR MOVES TO HOME POSITION.	1	2	COMMAND BYTE(S)
				PROTECT	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.			

TABLE 3-4. 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.	
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. (See M6800 EXORciser User's Guide, Figure 4-1). 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 3-4. Communication Interface Commands (Cont'd)

COMMAND	INTERFACE VALUE		DISPLAY AREA	MODE	ACTION/EFFECT	BYTE SEQUENCE		
	NON-ESC.	ESC. SEQ.				NO. OF BYTES NON-ESC.	NO. OF BYTES ESC. SEQ.	DESCRIPTION
SEND LINE	DF	ESC,_	VIRTUAL	SCROLL	IGNORED	1	2	COMMAND BYTE(S)
				PAGE	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.			
				PROTECT	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.			
FIELD ATTRIBUTES —			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)
SET BLINK	E0	ESC,						
RESET BLINK	E1	ESC,a						
SET VIDEO INVERT	E2	ESC,b						
RESET VIDEO INVERT	E3	ESC,c						
SET HALF BRIGHT	E4	ESC,d						

TABLE 3-4. 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 — (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.

TABLE 3-5. 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

3.4 INITIALIZATION

The first step performed when initializing the EXORterm 150 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* EXORterm 150/EXORciser operations:

a. FAC CODE OFF/ENABLE switch to ENABLE
b. FAC CODE OFF/DISPL switch to OFF
c. VIDEO INVERT switch to desired position
d. A, B, and C to OFF
e. SPEC CHAR switch to OFF
f. DUPLEX switch to FULL
g. PARITY switch to NO
h. XMIT WORD switch to 7 BITS
i. STOP BITS switch to 1
j. CONNECTION switch to DIRECT
k. BAUD RATE switch to 9600
l. TRANS MODE TO OFF

When the operation of the unit has been established, power can be applied by pressing the power on switch located on the front panel. The EXORterm 150 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
i. Line 23 contains the function key titles (F1-F12)
j. Line 24 contains the EXbug command mnemonics and the fixed mnemonics for function keys 10, 11, and 12 as EDOS or MDOS, MAID, and EXBUG, respectively.

After a one-minute warmup, adjust the brightness control to produce a well-defined cursor. The EXORterm 150 is now ready for data transmission.

NOTE

The rear panel single-pole, single-throw switch DIP arrays used to establish the operation of the EXORterm 150 are read only when power is applied to the terminal, or the RESET switch is set.

3.5 OPERATOR TEST PROCEDURE

The basic operation functions of the terminal can be validated (exclusive of the serial communications interface) by an operator-monitored series of checks when the unit is first powered up. These checks can also be made if a unit malfunction 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.

3.5.1 Power On Check

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

After a one-minute warmup, the screen should be blank with the cursor block blinking in the upper left-hand corner of the screen. With the exception of lines 23 and 24, no other characters should be visible on the screen at this point. If the cursor is not visible on the screen, turn the brightness control until the raster is faintly visible. The cursor should now be visible. Adjust the brightness and contrast controls to produce a well-defined cursor.

3.5.2 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 the 'a' key and enter a number of the characters in memory and on the display.
b. Depress the SHIFT key and enter more characters. Note that any letters entered are now capitalized.
c. Depress the RETURN key and notice that the cursor moves to the first location of that line.
d. Depress the LINE FEED key and note that the cursor moves to the same column in the line directly below its previous location.
e. Depress the ESCAPE followed by '@' keys, and note that the cursor returns to the Home position (the first column on the first line).
f. Depress the LINE FEED key several times, followed by several 'a' keys. This should move the cursor toward the center of screen.
g. Depress the 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 followed by upper case 'B' keys, repeating this sequence until the cursor reaches the bottom line of the display.
b. Depress the ESCAPE followed by upper case 'D' keys, repeating this sequence until the cursor nears the last position on the line.
c. Depress the ESCAPE followed by upper case 'C' keys, repeating this sequence to cause the cursor to wrap around to the last position of the line above.
d. Depress the ESCAPE followed by '@' keys to move the cursor to the first character position of the first line.

This completes the operator self-test of the EXORterm 150.

TABLE 3-6. Function Key to EXORciser Commands

EXBUG COMMAND LEVEL —

KEY	MNEMONIC	EXBUG COMMAND	DESCRIPTION
F1	PRNT	PRNT	Initiates the EXORciser's Print Dump function.

MAID COMMAND LEVEL —

KEY	MNEMONIC	MAID COMMAND	DESCRIPTION
F1	GO	;G	Execute the user's program starting at the auto restart memory address.
F2	PRCD	;P	Continue executing from the current program counter setting.
F3	SBRK	;V	Enter a breakpoint.
F4	CBRK	;U	Remove all breakpoints.
F5	REGS	$R	Display/change the user's program registers.
F6	TRCE	$T	Set the trace mode.
F7	RTRCE	;T	Reset the trace mode.
F8	NEXT	;N	Trace one instruction.
F9	DBRK	$V	Display the memory location of each breakpoint.

MDOS COMMAND LEVEL —

KEY	MNEMONIC	MDOS COMMAND	DESCRIPTION
F1	DUMP	DUMP	Display disk sectors (logical/physical).
F2	FREE	FREE	Display amount of free space on a disk.
F3	DIR	DIR	Display the contents of the directory on selective basis, including optional allocation information.
F4	DIR;L	DIR;L	Display directory information on local printer.
F5	DIR;E	DIR;E	Display entire directory entry information.
F6	DIR;S	DIR;S	System files may be included when displaying family of files.
F7	DIR;A	DIR;A	Display complete allocation description of each file name.

EDOS COMMAND LEVEL —

KEY	MNEMONIC	EDOS COMMAND	DESCRIPTION
F1	EDIT	EDIT	Enables editing of the contents of the input file, using the Text Editor. Edited data is stored into the new output file.
F2	LOAD	LOAD	Loads the contents of the object file into RAM memory for execution.
F3	ASM	ASM	Assembles the contents of the source file and directs the object file to the destination file.
F4	CLIST	CLIST	Print the contents of the file on the list output device.
F5	MERGE	MERGE	Allows one or more files to be concatenated into a new file.

TABLE 3-6. Function Key Commands (Cont'd)

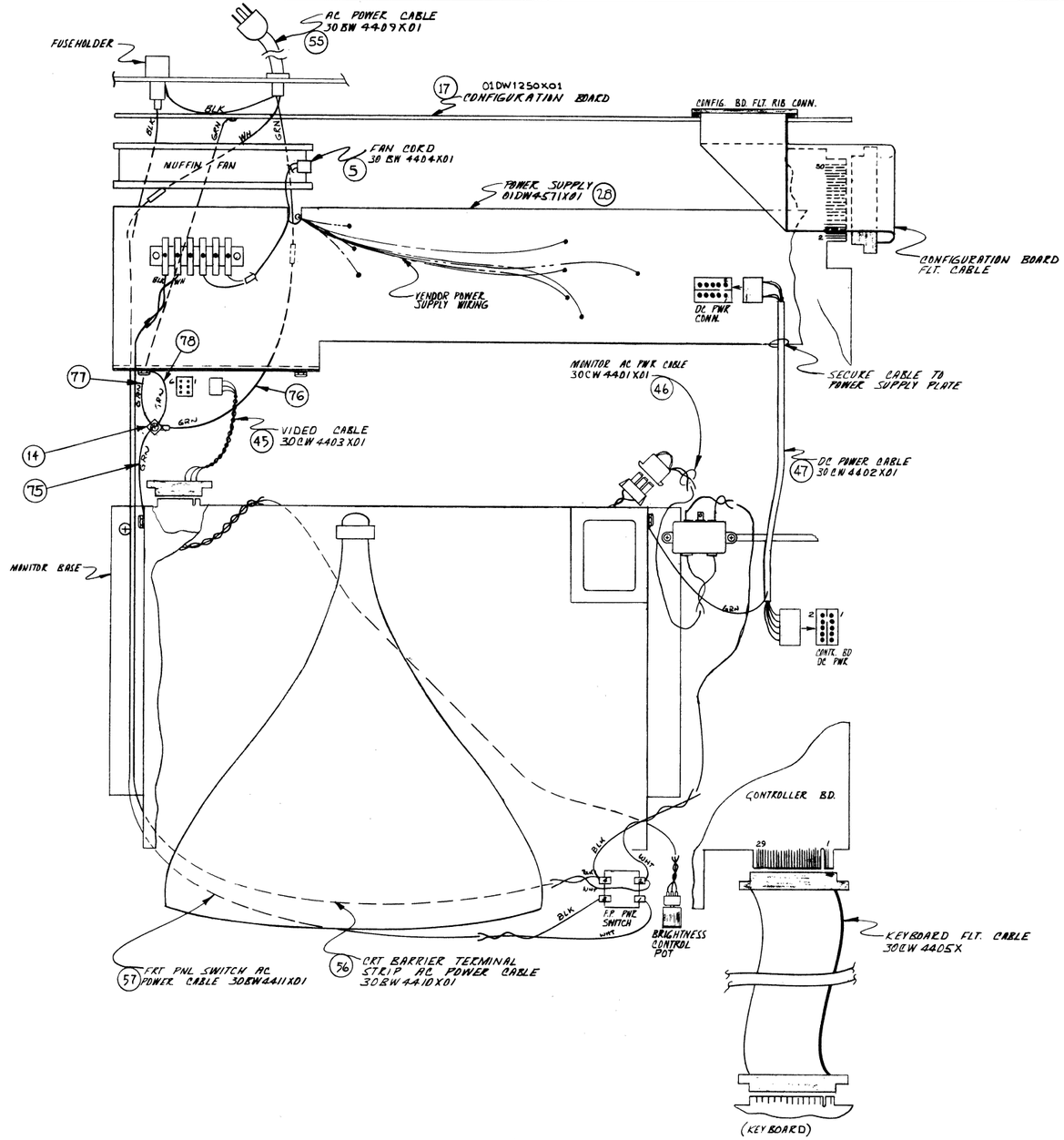
EDOS COMMAND LEVEL —

KEY	MNEMONIC	EDOS COMMAND	DESCRIPTION
F6	PURGE	PURGE	Deletes the designated files from the diskette in drive unit u, and then repacks the contents of that diskette, making the disk space available for additional files.
F7	RENAM	RENAM	Rename the old file with the new file.
F8	CDIR	CDIR	List the contents of the file directory on the diskette in drive unit u. Lists the file names, attributes, and file sizes in sectors to the console.
F9	PDIR	PDIR	Lists the contents of the file directory on the diskette in drive unit u. Lists the file names, attributes, and file sizes to the line printer.

CHAPTER 4
DIAGRAMS

4.1 SCHEMATIC AND INTERCONNECTION DIAGRAMS

This chapter contains the interconnection diagram for the EXORterm 150. Also, the schematics are provided for the CRT Controller PC Board, Configuration PC Board, Power Supply Assembly and Video Monitor Assembly.



ISSUE	NO.	REVISION	DATE
M	H-759	UPDATE DWG'S TO CORRESPOND TO B/M CHANGES	10/17/78
L	H355	ADDED FIND NUMBERS — AND SHEET 2	29 NOV 77
K	B156	RELEASE TO PROD.	9/14/77

DO NOT SCALE DRAWING, WORK TO DIMENSIONS ONLY

SCALE —

WORK ORDER NO. | PROJECT NO.

DWN BY SAC DATE 8-24-77 | ENGRG. | DATE

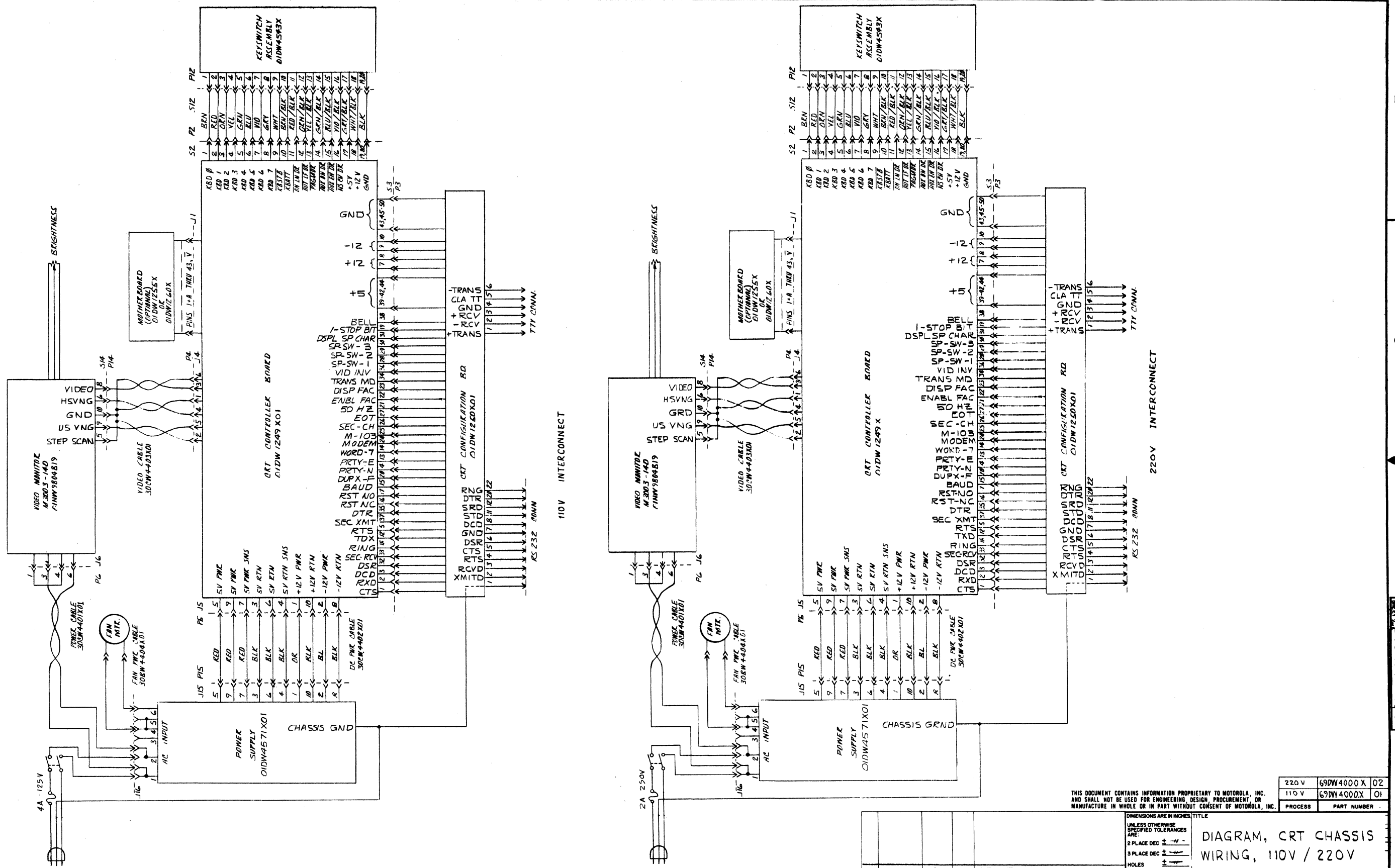
CHECKED BY | DATE | APPROVED [signature] DATE 9-6-77

MOTOROLA INC.
Semiconductor Products Division
5005 EAST McDOWELL ROAD, PHOENIX, ARIZONA 85008

DIAGRAM, CRT CHASSIS WIRING, 110V/220V

DWG. NO. 69DW4000X | SHEET NO. 1 OF 2

DWG. NO. 69DW4000X | SHEET NO. 1 of 2 | ISSUE L



SYM	SIZE AFTER PLATING	QTY
HOLE LIST		

ISSUE	REL./CN NO.	DATE	APPD	DESCRIPTION
M	H759	10/1/78	C.S	UPDATE DWG'S TO CORRESPOND TO B/M CHANGES
L	CN H355	29NOV77		REDRAWN FROM 69CW4000X (2 SHEETS)

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PROCESS	PART NUMBER
220V	69DW4000X 02
110V	69DW4000X 01

DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
2 PLACE DEC ±
3 PLACE DEC ±
HOLES ±
ANGLES ±
SCALE:
DO NOT SCALE DWG.

TITLE: DIAGRAM, CRT CHASSIS WIRING, 110V / 220V

DR Gregory DATE DEC 77 ME DATE
APPD DATE EE DATE
ORIG MODEL

MOTOROLA INC. microsystems
3102 N. 56TH ST. PHOENIX, AZ 85018

DWG NO. 69DW4000X
SHEET 2 OF 2

WHEN REFERRING TO THIS DWG. STATE PT NO. AND APPLICABLE ISSUE SYMBOL

69DW4000X L

REVISIONS						
REV	ECO NO	ZONE	CHANGE	DATE	BY	ENGR
K	B1161	—	RELEASED FOR PRODUCTION	9-8-77	K.S	W.S
L	H1406	—	REVISED SHEET 3 - REF ZR 4	10-28-77	C.P	C.S
M	H1481	—	C-11, C-13 WAS 100 UF	5-22-78	K.H	
R	H727		SEE SHEET (2) TWO	3/14/78	C.S	
S	H809		SEE SHEET-2.	4/4/79	C.S.	
T	H1004		SEE SHEET-3	4/27/79	G.C.	

MPU BUS CKT.

NOTES:
1. FOR PARTS LIST SEE EMOIDW1249X01

MOTOROLA INC.
Discrete Semiconductor Division

TITLE: SCHEMATIC- CRT CONTROLLER BD.

DRAWN BY E/M DESIGNS	DATE 6-28-77
CHECKED BY	DATE
ENGR. APPROVAL	DATE
SIZE E	CODE IDENT. NO. 04713
DRAWING NO.	63EW1249X
SCALE	WEIGHT
SHEET 1 OF 3	

UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES .XX± .XXX± MILLIMETERS .X± .XX± ANGULAR ± 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.

MATERIAL | HEAT TREAT | APPLIED FINISH

NEXT ASSEMBLY | USED ON | APPLICATION

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REVISIONS					
REV	ECO NO.	ZONE	CHANGE	DATE	BY	ENGR
K	8161	—	RELEASED FOR PRODUCTION	2-11-77	K.S	W.S
L	H486		REVISED SHEET 3 - NOT IR-4	2-24-78	CF	E.S

S H1809 CHG'D U116 FROM SIAW1131X17 TO SIAW1555X01 4/11/79
T H1004 SEE SHEET NO 3. 4/11/79

R H727 REVISED FROM MCM6838CE TO U89-SIAW1827X02, U70-TO SIAW1827X03, U57-SIAW1827X01 OR SCM44836, U11 TO SCM44835 U49 TO SCM44977, U104 TO SCM44976, U98 TO SCM44975, U78 TO SCM 10/16/78

P H682 CHG'D TRANSPOSED AV-2 AV-3, ALSO IDY0 TO DY1 9/16/77

SEE PAGE ONE
SEE PAGE 3

U62 MC7415 7P
U92 MC7415 7P
U101 MC7415 7P

U90 U105 U71 U99 U60 U111 U50 U79 — EVEN
U93 U82 U74 U40 U53 U27 U13 — ODD
U28 U83 U41 U14 U94 U75 U54 U64

2102-A4

U106 MC7404
U107 7432
U113 MC7432
U117 MC4006P
U72 MC7432
U51 7410
U37 MC3006
U10 MC7408
U120 MC7430
U121 8T97
U112 8T97
U73 U39 U12 U52 BT28
U69 MC7400
U118 825129 256X4 PROM
U119 MC4006P
U89 SIAW1827X02
U70 SIAW1827X03
U59 SCM44836 OR SIAW1827X01
U110 SCM44833
U49 SCM44977
U104 SCM44976
U98 SCM44975
U78 SCM44831

R11 10Ω 1/2W
C6 .68UF
C7 68UF
C8 1UF
MC7905 OUT

AC-Ø AC-1 AC-2 AC-3 AC-4 AC-5 AC-6 AC-7 AC-8 AC-9
EVEN
WRT PUL
R/W
VUA
EVEN-FF
Ø2
EXT-IN
ETXX
+5V +12V GND -12V -5V
AØ A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15
EM-Ø EM-1 EM-2 EM-3 EM-4 EM-5 EM-6 EM-7 OM-Ø OM-1 OM-2 OM-3 OM-4 OM-5 OM-6 OM-7
D7 D6 D5 D4 D3 D2 D1 DØ
WRT DSPL EV
WRT DSPL ODD
ØØXX EN
R/WØØXX
DSPL EVN EN
DSPL ODD EN
ØØXX+EV SEL
IN-EVEN
OUT-EVEN
R/W
ODD DSPLMEM
EVEN DSPLMEM
ØØXX
EFXX
EØXX
VIDEO REFSH
EXT-IN
ODD DSPL SEL
DISPL ODD SEL
IN-ODD
OUT-ODD
ROM OUT
ROMEN
VUA-ROM
EN ROM 1 EN ROM 2 EN ROM 3 EN ROM 4 EN ROM 5 EN ROM 6 EN ROM 7 EN ROM 8
ADDRESS DECODER
SHEET 1 SHEET 2 SHEET 3

NOTES:
1. MCM68708 MAY BE USED IF LINES ARE REMOVED FROM X2 TO X3 AND Y2 TO Y3 AND JUMPERS INSTALLED FROM X1 TO X2 AND Y1 TO Y2 IN EACH POSITION USED.
2. PROGRAMMED PER SIAW1555X01

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UNLESS OTHERWISE SPECIFIED, TOLERANCES:
INCHES .XX± .XXX±
MILLIMETERS .X± .XX±
ANGULAR ±
✓ 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.

MATERIAL
HEAT TREAT
APPLIED FINISH
DRAWN BY E/M DESIGNS DATE 6-28-77
CHECKED BY DATE
ENGR. APPROVAL DATE
SCALE WEIGHT SHEET 2 OF 3

MOTOROLA INC.
Discrete Semiconductor Division
TITLE: SCHEMATIC- CRT CONTROLLER BD.
SIZE E CODE IDENT. NO. 04713 DRAWING NO. 63EW1249X

63EW1249X

4-9/4-10

REVISIONS					
REV	ECO NO.	ZONE	CHANGE	DATE	BY	ENGR
K	8161	–	RELEASED FOR PRODUCTION	9-21-77	K.S	W.C

S H809 SEE SHEET-2. 9/6/77 CS
T H1004 CHG'D & REVISED SCHEM DWG 9/21/77 G.C.
P CHG'D 7402 TO 74502 4 PLCS 9/4/78
R SEE SHEET (2) TWO 10/4/78

SHEET 1 — UP-1 — V-BLANK FF — H-RST — INV-VID — DSP-FAC — 50HZ — SRC-DSP — DISA-FAC — INC-AC — DEC-AC — V-SYNC FF — HBC=7 — H-BLANK FF — UP-7 — CUR-10 CUR-9 CUR-8 CUR-7 CUR-6 CUR-5 CUR-4 CUR-3 CUR-2 CUR-1 CUR-Ø — SHEET 1 — AC-9 AC-8 AC-7 AC-6 AC-5 AC-4 AC-3 AC-2 AC-1 AC-Ø — SHEET 2 — DM7 DM6 DM Ø DM1 DM2 DM3 DM4 DM5 — BLINK RATE — CURS RATE — CLK-1 — UP-6 — H-SYNC — H-BLANK — EXT-CLR — UP-3 — HBC=8 — UNDL — BLANK — LC=10 — UNLN-D1 — UNLN-D2 — INV VIDEO FF — H-BRT — UP-2 — UP-4 — V-BLK — V-DRV — ILC=10 — V-SYNC FF — V-BLANK FF — UP-5 — CLR-VLC — RST-VLC — EVEN-FF — VLC-0 VLC-1 VLC-2 VLC-3 — INV VIDEO ADJ. — HALF BRIGHT ADJ. — H-BLANK-FF — H-SYNC V-SYNC VIDEO-OUT — TO CRT MONITOR — J4 — SHEET 2 — EVEN — EM-D0 EM-D1 EM-D2 EM-D3 EM-D4 EM-D5 EM-D6 EM-D7 — OM-D0 OM-D1 OM-D2 OM-D3 OM-D4 OM-D5 OM-D6 OM-D7

VIDEO GENERATOR CKT.

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NEXT ASSEMBLY | USED ON | APPLICATION

UNLESS OTHERWISE SPECIFIED, TOLERANCES:
INCHES .XX± .XXX±
MILLIMETERS .X± .XX±
ANGULAR ±
√ 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.

MATERIAL | HEAT TREAT | APPLIED FINISH

DRAWN BY E/M DESIGNS — DATE 6-28-77
CHECKED BY — DATE
ENGR. APPROVAL — DATE

MOTOROLA INC.
Discrete Semiconductor Division

TITLE: SCHEMATIC- CRT CONTROLLER BD.

SIZE E | CODE IDENT. NO. 04713 | DRAWING NO. 63EW1249X
SCALE | WEIGHT | SHEET 3 OF 3

63EW1249X

ASTERISK INDICATES DATA WHICH IS NONMANDATORY —FOR INFORMATION ONLY.

NOTES:

1. ALL RESISTANCE VALUES ARE IN OHMS, 1/4 WATT, ± 5%.
2. * USE TO MEET CUSTOMER OPTION RS 232 SPEC OF 30 VOLTS/MICR-SECONDS MAXIMUM SLEW RATE.
3. JUMPER AT PT 9 FOR 60mA CURRENT LOOP.
4. REMOVE JUMPERS 1, 3, 5, AND 7 CONNECT JUMPERS 2, 4, 6 AND 8 FOR 20 mA CURRENT SOURCE APPLICATION
5. JUMPER J3-1 AND J3-2 FOR USE WITH EXORCISER.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REV. PIN NO.3 ON J1	4/28/77	
	B	ADDED U10	5-11-77	
	C	REV. PIN NO'S ON J1	5-24-77	
	D	REVISED	6-15-77	
	E	ADDED NOTES - R3 WAS 99K, J3-3, 16 WAS 16.3	7-9-77	
	F	RELS'D FOR PROD. B 153	7/8/77	
C 5th	L	ADDED R35 AND 36 = Q9 AND 1 BAUD OUT	10 SEPT 77	CN M 318
	M	C1,2,3 WAS 100 UF	2-20-78	H451
	N	REVISE NOTE - 2.	8-23-78	H674

63EW1250X

TO CRT CONTROLLER BOARD

TO CRT CONTROLLER BD.

SYM	SIZE	QTY
HOLE LIST		

INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES AND END USE. SURFACE FINISH
TOLERANCES: TWO PLACE DEC ±, THREE PLACE DEC ±, ANGLES ±, HOLE DIA +
MATERIAL:
FINISH:
NEXT ASSEMBLY | USED ON
★ APPLICATION

APPROVALS
DR BY MJS 15MAR77
CHK BY
APPD. | PROJ. NO.
CONTRACT NO.
RELEASE NUMBER, EFFECTIVITY & DATE
APPROVED NAME DATE
APPROVED NAME DATE

FOR PARTS LIST SEE BM01DW1250X01

MOTOROLA INC. Military Electronics Division
WESTERN CENTER 8201 EAST McDOWELL ROAD SCOTTSDALE, ARIZONA

SCHEMATIC, CRT CONFIGURATION BOARD

SIZE E | CODE IDENT NO. 94990 | 63EW1250X

SCALE — | WEIGHT | SHEET 1 OF 1

4-13/4-14

MOTOROLA

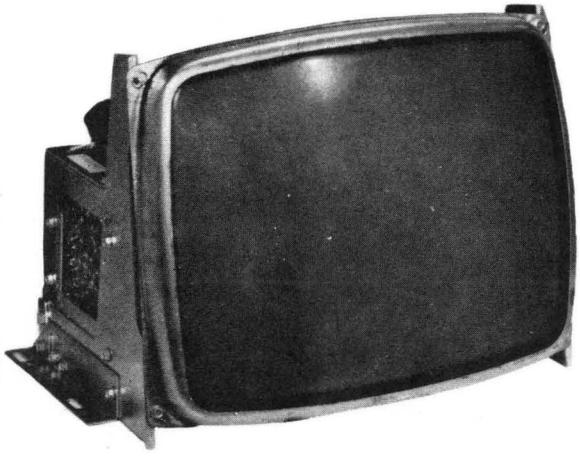
SERVICE MANUAL

MODELS*

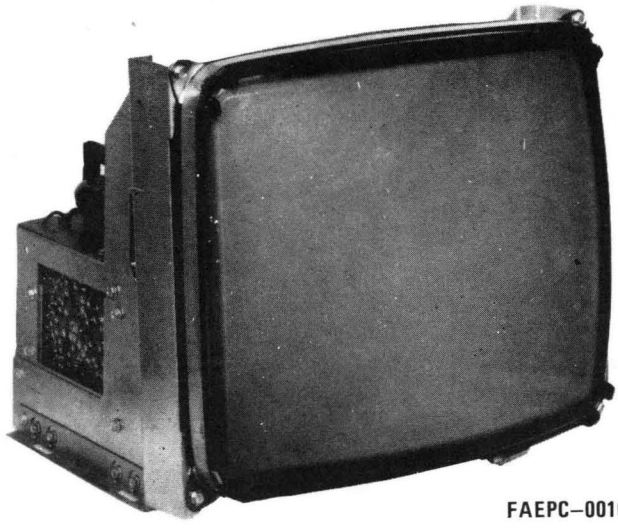
M3000-140, 240, 340
M3003-140, 240, 340
M4000-140, 240, 440
M4003-140, 240, 440

*INCLUDES StepScan™ MOTOROLA

TABLE OF CONTENTS



Model M3000/M3003 (12" – CRT)



FAEPC-00169

Model M4000/M4003 (15" – CRT)

CAUTION

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

MOTOROLA INC.
Data Products
CAROL STREAM, ILLINOIS 60187

MANUAL VP 27 PART NO. 68P25253A57-1
PRINTED IN U.S.A.
PRICE $2.00

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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.

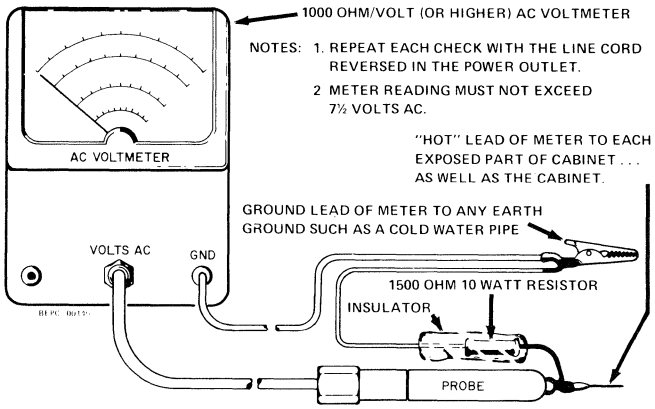
4. An ISOLATION TRANSFORMER should always be used during the servicing of a unit whose chassis is connected to one side of the power line. Use a transformer of adequate power rating as this protects the serviceman from accidents resulting in personal injury from electrical shocks. It will also protect 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.

ELECTRICAL SPECIFICATIONS *

	MODEL M3000/M3003	MODEL M4000/M4003
PICTURE TUBE:	12" measured diagonally (305 mm); 74 sq. in. viewing area (477 sq. cm); 110° deflection angle; integral implosion protection; M3000/3003–140: P4 phosphor without anti-reflective faceplate M3000/3003–240: P4 phosphor with anti-reflective faceplate M3000/3003–340: P31 phosphor without anti-reflective faceplate	15" measured diagonally (381 mm); 100 sq. in. viewing area (645 sq. cm); 110° deflection angle; integral implosion protection; M4000/4003–140: P4 phosphor without anti-reflective faceplate M4000/4003–240: P4 phosphor with anti-reflective faceplate M4000/4003–440: P31 phosphor with anti-reflective faceplate
POWER INPUT:	115/230V AC, 60 watts (nominal), or 70V DC	
FUSES:	0.8 Amp Slo-Blo	0.8 Amp Slo-Blo
LOW VOLTAGE POWER SUPPLY:	Electronically regulated over AC inputs from 107V to 135V, or 214V to 270V	
INPUT SIGNALS:	TTL SEPARATE HORIZONTAL, VERTICAL, VIDEO:	2.5V to 5.0V P-P, video drive, sync positive at input (input impedance: 75 ohms to 250 ohms video termination, > 2K ohms vertical and horizontal)
PULSE RISE TIME (TYPICAL):	30V rise in less than 20 nSec	
RESOLUTION (TYPICAL):	800 lines center, 600 lines corners	
VIDEO RESPONSE (TYPICAL):	Within –3 dB, 10 Hz to 22 MHz	
LINEARITY:	Within 2% as measured with standard EIA ball chart and dot pattern	
HIGH VOLTAGE:	14kV nominal at 20 uAmp beam current	17kV nominal at 20 uAmp beam current
HORIZONTAL RETRACE TIME:	11.0 uSec maximum at 15.72 kHz – M3000/M4000 Models 11.0 uSec maximum at 18.72 kHz – M3003/M4003 Models	
SCANNING FREQUENCY:	Horizontal: 15.72 kHz ± 500 Hz; Vertical: 50/60 Hz – M3000/M4000 Models Horizontal: 18.72 kHz ± 500 Hz; Vertical: 50/60 Hz – M3003/M4003 Models	
ENVIRONMENT:	Operating temperature: 0°C to 50°C Storage temperature: –40°C to +65°C Operating altitude: 10,000 feet maximum (3048 meters) Designed to comply with applicable DHEW rules on X-Radiation Designed to enable listing under UL Specification 478	
TYPICAL DIMENSIONS:	9.12" H, 11.40" W, 8.84" D (232 x 290 x 225 mm)	10.94" H, 12.84" W, 10.22" D (278 x 326 x 260 mm)

* Specifications and descriptions subject to change without notice.

GENERAL INFORMATION

The monitors described herein are fully transistorized (except CRT) and applicable for displaying alphanumeric characters. The M3000/M3003 series monitors use a 12-inch CRT and the M4000/M4003 series monitors use a 15-inch CRT. All monitors utilize a non-composite video signal with separate TTL horizontal and vertical sync pulses. (See Schematic diagram.)

The CRT's employed are of the magnetic deflection type with integral implosion protection. An operating voltage of +70 volts DC is required from the regulated power supply for both models. A universal power transformer permits operating the monitor from either 115 or 230 volts AC, 50/60 Hz.

Input and output connections for the monitor are made through a 10-pin edge or header connector on the vertical/video circuit card. Inputs consist of video, horizontal/vertical sync, and signal ground. One additional input, TTL level StepScan, is also connected to the monitor via the 10-pin edge connector. Output connections are provided for an optional remote brightness control.

Circuitry consists of two stages for video amplification, five stages for vertical sync and deflection processing, five stages for horizontal sync and deflection processing, and a regulated +70 volt power supply. Both models also have dynamic focusing and StepScan amplifier. (See Schematic diagram.)

Three etched circuit cards are utilized, containing the vertical/video circuit, horizontal circuit, and power supply circuit. An optional low voltage logic power supply is available when a remote power source is required for logic interface circuitry. Components are mounted on the top of the circuit cards and plating 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 three circuit cards. Refer to Motorola Service Manual VP20, Part No. 68P25253A40 for complete service information on the low voltage logic power supplies.

SERVICE NOTES

CIRCUIT TRACING

Component reference numbers are printed on the top and bottom of the three circuit cards to facilitate circuit tracing. In addition, control names and circuit card terminal numbers are also shown and referenced on the schematic diagram in this manual.

Transistor elements are identified as follows:

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

COMPONENT REMOVAL

Removing components from an etched circuit card is facilitated by the fact that the circuitry (copper foil) appears on one side of the circuit card only and the component leads are inserted straight through the holes and are not bent or crimped.

It is recommended that a solder extracting gun be used to aid in component removal. An iron with a temperature controlled heating element would be desirable since it would reduce the possibility of damaging the circuit card foil due to over-heating.

The nozzle of the solder extracting gun is inserted directly over the component lead and when sufficiently heated, the solder is drawn away leaving the lead free from the copper foil. This method is particularly suitable in removing multi-terminal components.

When replacing "plug-in" transistors, please observe the following precautions:

1. The transistor sockets are not "captive", which means that the transistor mounting screws also secure the socket. When installing the transistor, the socket must be held in its proper position.

2. When replacing a plug-in transistor, silicone grease (Motorola Part No. 11M490487) should be applied evenly to the top of the heat sink and bottom of the transistor. In addition, be sure a mica insulator is positioned properly between the transistor and heat sink.

3. The transistor mounting screws 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 screws. If the screw threads are stripped by excessive pressure, a poor electrical and mechanical connection will result.

CRT REPLACEMENT

Use extreme care in handling the CRT as rough handling may cause it to implode due to high vacuum pressure. Do not nick or scratch glass or subject it to any undue pressure in removal or installation. Use goggles and heavy gloves for protection. In addition, be sure to disconnect the monitor from all external voltage sources.

1. Discharge CRT by shorting 2nd anode to ground; then remove the CRT socket, deflection yoke and 2nd anode lead.

2. Remove CRT from the front of the chassis by loosening and removing four screws; one in each corner of the CRT.

REGULATOR ADJUSTMENT

NOTE

Misadjustment of the low voltage regulator, or the horizontal oscillator may result in damage to the horizontal output transistor or pulse limiter diode. The following procedure is recommended to insure reliable operation.

1. Connect the monitor to an AC line supply; then adjust supply to 120 volts (240 volts in some applications).

2. Apply test signal to proper input. Signal should be of same amplitude and sync rate as when monitor is in service.

3. Adjust HOR. SET coil L50 (on the horizontal circuit card) until display is stable.

4. Connect a DC digital voltmeter or equivalent precision voltmeter to the emitter of the regulator output transistor, Q150 (or any +70 volt test point on the power supply circuit card).

5. Adjust the 70V ADJUST. control, R158, on the power supply circuit card for an output of +70 volts. DO NOT rotate the control through its entire range; damage to the monitor may result.

6. When adjustment is complete, the AC line supply can be varied between 105 and 130 volts AC to check for proper regulator operation. With the regulator operating properly, changes in display size should be negligible.

HORIZONTAL HOLD/OSCILLATOR ADJUSTMENT

Adjust the core of HOR. SET coil L50 until the horizontal blanking lines are vertical, or the CRT display is stable (synced).

DYNAMIC FOCUS ADJUSTMENT

The DYNAMIC FOCUS coil is factory set and should not normally require further adjustment. However, if it becomes necessary, use Procedure No. 1 for touching up the overall focus. Procedure No. 2 is provided if the CRT (V1) and/or DYNAMIC FOCUS coil (L52) is replaced in the field.

PROCEDURE NO. 1

1. Adjust FOCUS control R70 (on horizontal circuit card) for best focus in the center of the CRT.

2. Adjust DYNAMIC FOCUS coil L52 for best edge focus.

3. Alternate between adjusting R70 and L52 until overall CRT focus is optimized.

PROCEDURE NO. 2

1. Connect an oscilloscope (DC coupled) between the junction of R71 and C63 (on horizontal circuit card) and signal ground.

CAUTION

High voltage is present.

2. Adjust the oscilloscope controls until one cycle of the horizontal rate sinewave appears as shown in Figure 1.

3. Adjust the DYNAMIC FOCUS coil, L52 for a minimum sinewave amplitude of not more than 125 volts P-P.

NOTE

Be sure that the one cycle appearing on the oscilloscope is not a harmonic of the horizontal rate sinewave. This may occur if the DYNAMIC FOCUS coil, L52, is misadjusted to the extent that L52 will produce the second harmonic. The coil must be adjusted to produce the minimum amplitude of the fundamental frequency only. Confirm the preceding by momentarily connecting the oscilloscope across the primary of T50. Only one cycle or pulse should appear.

4. Observe the center of the CRT display and adjust the FOCUS control, R70, for optimum focus; then record the DC voltage (represented as amplitude "A" in Figure 1) between the DC 0 volt reference and the negative peak of the sinewave.

5. Observe the edges of the CRT display and adjust the FOCUS control, R70, for optimum focus; then record the DC voltage (represented as amplitude "B" in Figure 1) between the DC 0 volt reference and the positive peak of the sinewave .

6. Subtract the negative peak voltage from the positive peak voltage. The difference becomes the voltage value to which the DYNAMIC FOCUS coil, L52, must be adjusted.

7. While observing the sinewave, adjust the DYNAMIC FOCUS coil, L52, until amplitude "C" (see Figure 1) equals the difference voltage value determined in step 6.

8. While observing the oscilloscope, readjust the FOCUS control, R70, until the negative peak of the sinewave is positioned above the DC 0 volt reference line equal to the voltage value recorded in step 4.

Amplitude "A" – Represents adjusting FOCUS control, R70, for best CRT center FOCUS.

Amplitude "B" – Represents adjusting FOCUS control, R70, for best CRT edge FOCUS.

Amplitude "C" – Represents adjusting DYNAMIC FOCUS coil, L52, for final P-P setting that is equal to difference between amplitude "A" and "B".

NOTE: After amplitude "C" is adjusted, amplitude "A" must be reset to the original voltage value that provided best CRT center FOCUS.

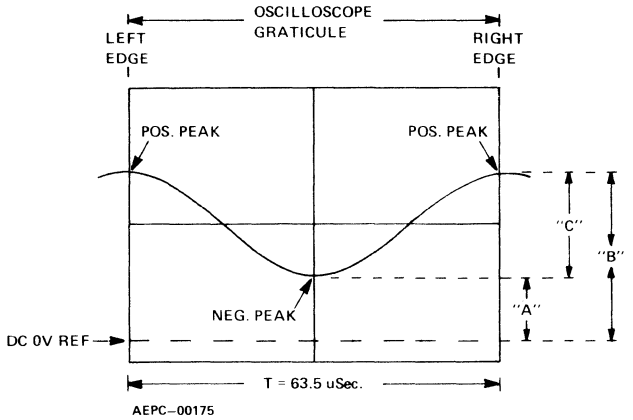
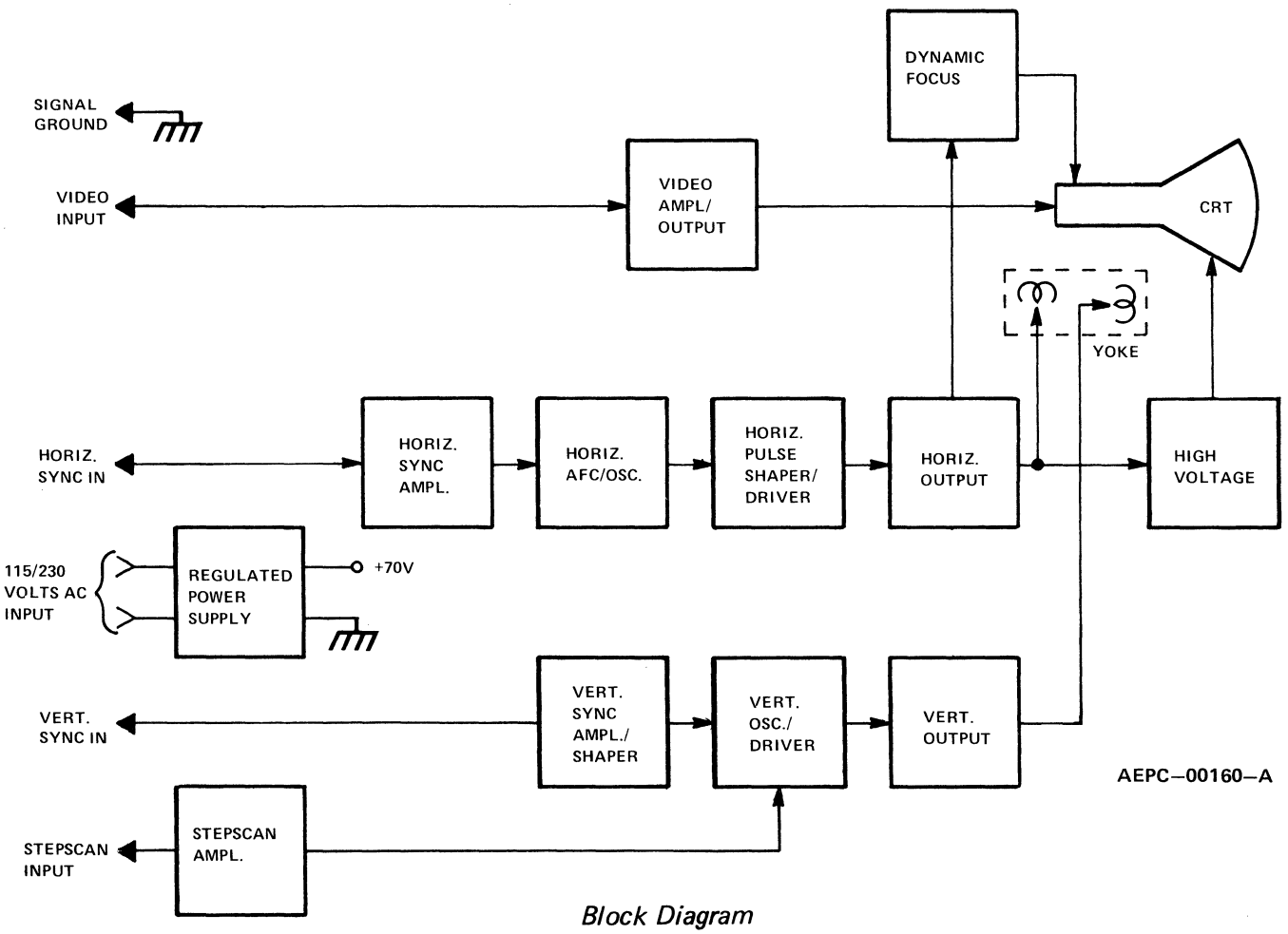


Figure 1. Adjusting Dynamic Focus with an Oscilloscope



Block Diagram

THEORY OF OPERATION

POWER SUPPLY

(Refer to Figure 2.)

The power supply is a transformer operated, full wave, regulated series pass circuit that maintains a constant output voltage with line input variations of ±12.5%. Depending on how connector S2 is wired, operation from 115 or 230 volts, 50/60 Hz is possible. Integrated circuit IC150 is the reference amplifier, transistor Q152 is a regulator buffer, transistor Q151 is the regulated output driver, and Q150 is the series pass transistor.

The output voltage, +70V, appears at the emitter of Q150. This voltage is divided between R157, R158 and R159. The voltage appearing on the arm of potentiometer R158 (70V ADJ. control) is the reference input to the non-inverting input of reference amplifier IC150.

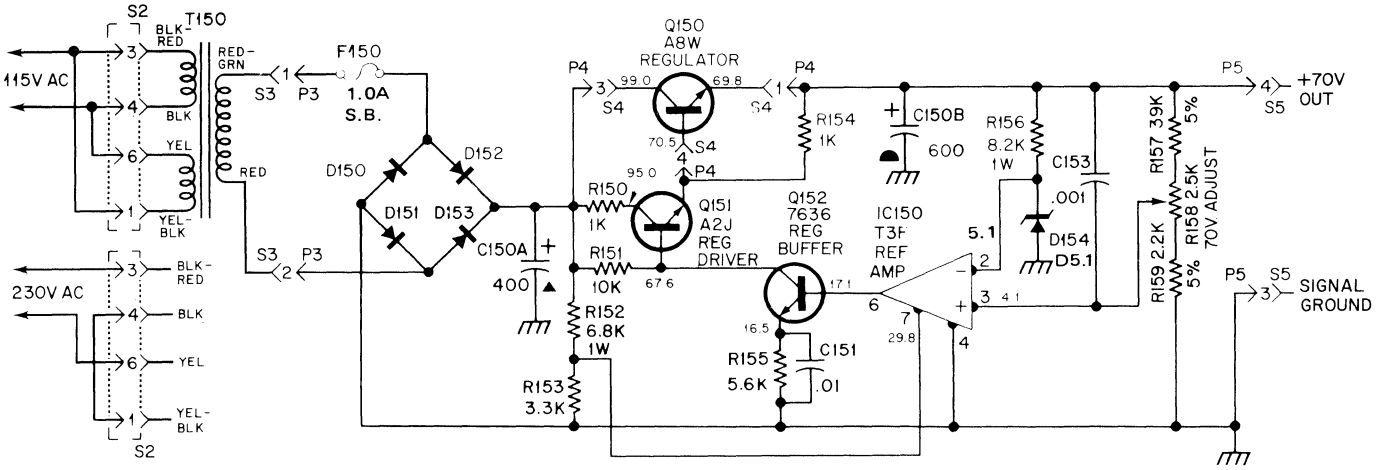


Figure 2. Power Supply Circuit

A temperature compensated zener diode, D154, establishes a fixed reference voltage at the inverting input to IC150. Resistor R156 provides a bias current for D154, which establishes its operating point. Capacitor C153 is a high frequency filter. Operating voltage for IC150 is derived from a voltage divider consisting of R152 and R153. Components R155 and C151 set the voltage gain of Q152.

An increase in output voltage will result in an increase of voltage at the base of Q152 via the non-inverting input of IC150. The change in base voltage will turn Q152 on harder, reducing its collector voltage. This reduces the forward bias to Q151, which results in less emitter current for Q150. With Q150 conducting less, the output voltage will be lowered.

VIDEO AMPLIFIER
(Refer to Figure 3.)

The linear video amplifier consists of two stages, Q100 and Q101, which are connected in a cascode configuration. This common emitter-common base arrangement greatly reduces the effect of Miller capacity (when compared to a conventional single transistor video amplifier/output stage).

A TTL compatible non-composite video signal, approximately 4.0 volts P-P, is DC coupled to the base of Q100 via R100. Resistor R112 provides proper termination for the high frequency input video signal. Capacitor C100 provides high frequency compensation to maintain a flat response when Q100 and Q101 conduct.

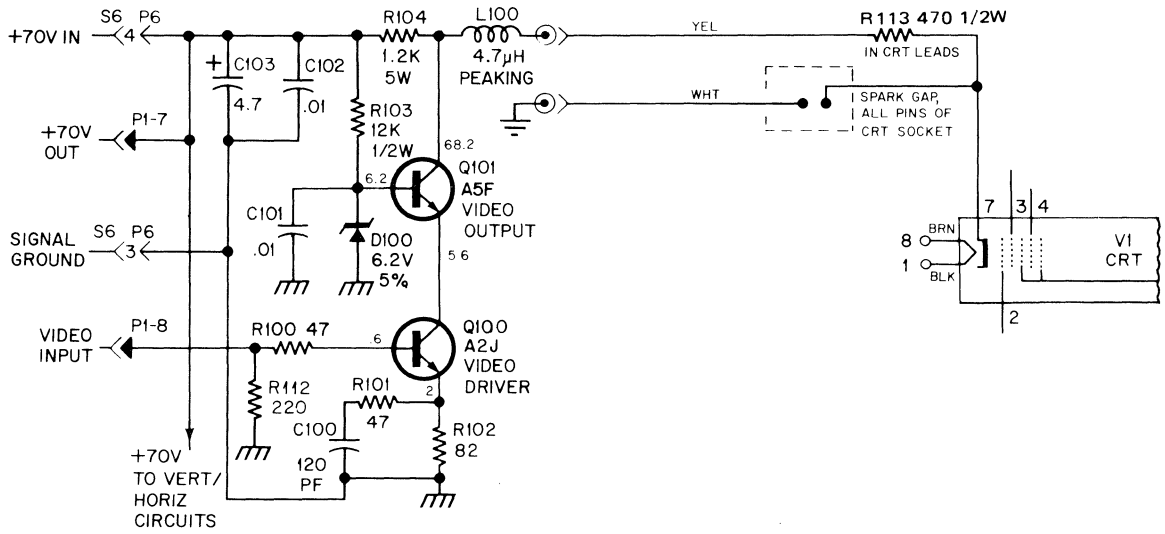


Figure 3. Video Amplifier Circuit

During no-signal conditions, Q100 is off. Transistor Q101, however, is forward biased by the 6.2 volts on its base, which is established by zener diode D100. When a video signal is applied to the base of Q100, it conducts, which causes forward biased Q101 to conduct. The resultant output is developed across R104 at the collector of Q101; then DC coupled to the cathode of V1 (CRT) via peaking coil L100 and R113. Resistor R113 isolates Q101 from transients that may occur as a result of CRT arcing. Capacitor C101 shunts to ground high frequency video that may appear on the base of Q101. Peaking coil L100 boosts the high frequencies of the video signal. Capacitor C103 provides additional filtering of the +70V, while C102 is a high frequency AC bypass capacitor.

HORIZONTAL SYNC AMPLIFIER

(Refer to Figure 4.)

The horizontal sync amplifier consists of one stage, Q50, which operates as a switch. During a no-signal condition, Q50 is off. When a positive-going horizontal sync signal, approximately 4.0 volts P-P, is applied (DC coupled) to the base of Q50, it goes into saturation. The amplified output is developed across load resistor R51, approximately 35V, which forms a voltage divider with R77. The negative-going horizontal sync pulses are AC coupled to the phase detector circuit via the R-C network consisting of R52 and C68, a high frequency pass filter.

PHASE DETECTOR

(Refer to Figure 5.)

The phase detector consists of two diodes (D50 and D51) in a keyed clamp circuit. Two inputs are required to generate the required output, one from the horizontal sync amplifier, Q50, and one from the horizontal output circuit, Q54. 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. The horizontal output (Q54) collector pulse is integrated into a sawtooth by R56 and C69. During horizontal sync

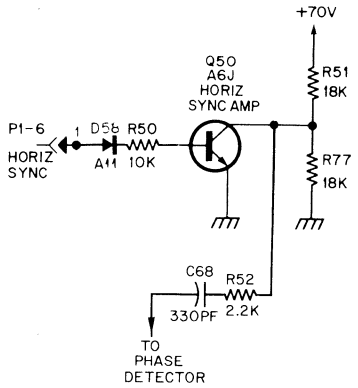


Figure 4. Horizontal Sync Amplifier Circuit

time, diodes D50 and D51 conduct, which shorts C69 to ground. This effectively clamps the sawtooth on C69 to ground at sync time. If the horizontal time base is in phase with the sync (waveform A), the sync pulse will occur when the sawtooth is passing through its AC axis and the net charge on C69 will be zero (waveform B). If the horizontal time base is lagging the sync, the sawtooth on C69 will be clamped to ground at a point negative from the AC axis. This will result in a positive DC charge on C69 (waveform C). 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, the sawtooth on C69 will be clamped at a point positive from its AC axis. This results in a net negative charge on C69, which is the required polarity to slow the horizontal oscillator (waveform D). Components R55, C52, R58 and C53 comprise the phase detector filter. The bandpass of this filter is chosen to provide correction of horizontal oscillator phase without ringing or hunting. Capacitor C50 times the phase detector for correct centering of the picture on the raster.

HORIZONTAL OSCILLATOR

(Refer to Figure 5.)

The horizontal oscillator consists of Q51, which is employed as a modified type of Hartley oscillator. The

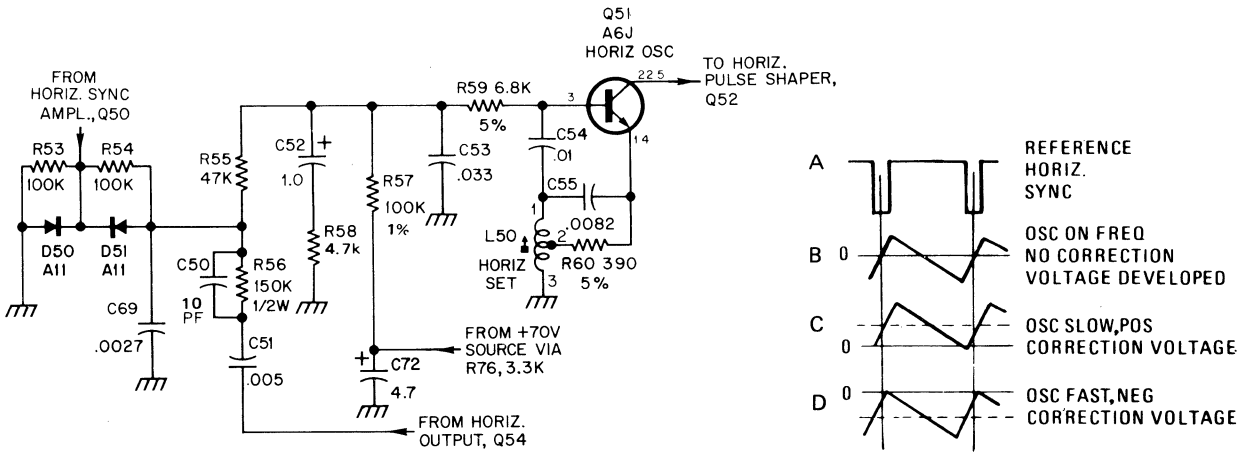


Figure 5. Phase Detector and Horizontal Oscillator Circuits

operating frequency of this oscillator is sensitive to its base input voltage. This permits control by the output of the phase detector. Resistor R57 provides DC bias to turn on Q51 and start the oscillator. The free-running horizontal frequency is adjusted with the HORIZ. SET coil, L50, which along with C54 are the frequency determining components. Capacitor C55 and resistor R60 are feedback components for the oscillator circuit.

HORIZONTAL PULSE SHAPER & DRIVER

(Refer to Figure 6.)

Transistor Q52 is a buffer stage between the horizontal oscillator and horizontal driver. It provides isolation for the horizontal oscillator as well as a low impedance drive for the horizontal driver. Components R62 and C56 form a time constant that shapes the oscillator output to the required duty cycle, approximately 50%, to drive the horizontal output circuitry. The horizontal driver stage, Q53, operates as a switch to drive the horizontal output transistor (Q54) through T50. Because of the low impedance drive and fast switching times furnished by Q52, very little power is dissipated in Q53. Components R66 and C57 provide damping to suppress ringing in the primary of T50 when Q53 goes into cutoff. (Reference Figure 8 – Resistor R68 provides current limiting for Q53 while C58 is an AC bypass capacitor.)

HORIZONTAL OUTPUT

(Refer to Figure 7.)

The secondary of T50 provides the required low drive impedance for Q54. Components R67 and C59 form a time constant for fast turn-off of the base of Q54. Once during each horizontal period, Q54 operates as a switch that connects the supply voltage across the parallel combination of the horizontal deflection yoke and the primary of the high

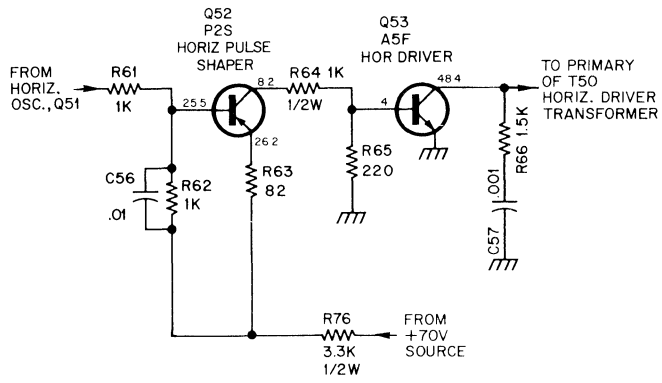


Figure 6. Horizontal Pulse Shaper and Driver Circuits

voltage transformer. The required sawtooth deflection current (through the horizontal yoke) is formed by the L-R time constant of the yoke and primary winding of the H.V. transformer, T51. The horizontal retrace pulse charges C62 through D54 to provide operating voltage for G2 of the CRT. Momentary transients at the collector of Q54, should they occur, are limited to the voltage on C62 since D54 will conduct if the collector voltage exceeds this value.

The damper diode, D53, conducts during the period between retrace and turn on of Q54. Capacitor C65 is the retrace tuning capacitor, while C61 blocks DC from the

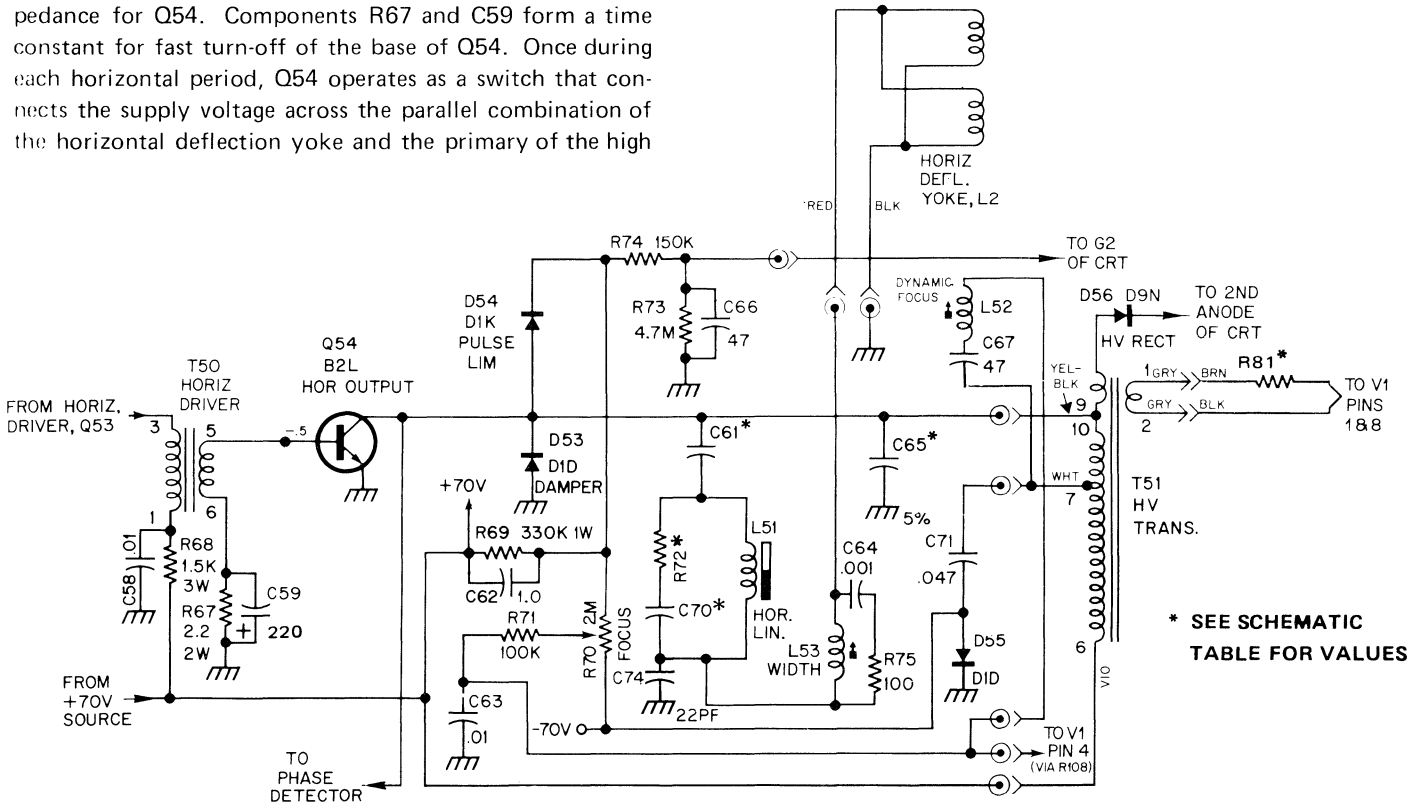


Figure 7. Horizontal Output Circuit

deflection yoke. Coil L51 is a magnetically biased linearity coil that shapes the deflection current for optimum trace linearity. Coil L53 is a series horiz. width control. Components R72 and C70, C64 and R75 are damping network components for the horizontal linearity (L51) and width (L53) controls. Capacitor C71 couples horizontal sync pulses from pin 7 of T51 to diode clamp D55, which maintains the −70V reference voltage.

DYNAMIC FOCUS

(Refer to Figure 8.)

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 focus voltage is developed by a series resonant circuit consisting of L52 and C63. This voltage is an 80V P-P horizontal rate pulse coupled from a tap on the horizontal output transformer, T51, via C67. The normal DC component of the G4 focus voltage is set by adjusting the FOCUS control, R70. When the DYNAMIC FOCUS coil, L52, is optimized for best edge focus, a sinusoidal voltage of approximately 200V P-P is developed across C63. This mixed AC and DC voltage results in a waveform of proper phase and amplitude, which is coupled through isolating resistor R108 to the CRT focus anode.

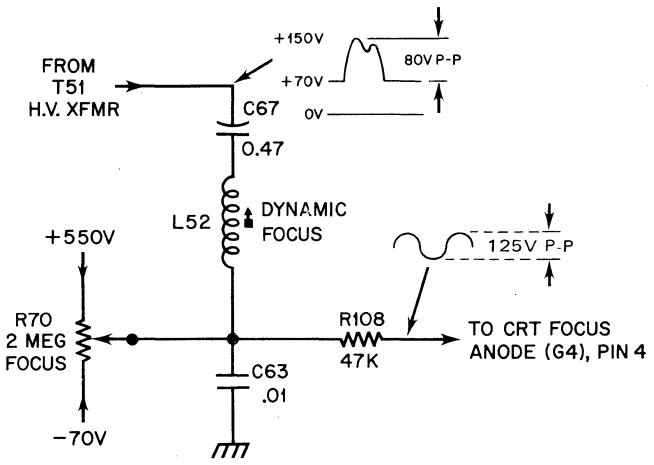


Figure 8. Simplified Dynamic Focus Circuit Diagram

VERTICAL SYNC AMPLIFIER

(Refer to Figure 9.)

The vertical sync amplifier consists of one stage, Q1, which operates as a switch. During no-signal conditions, Q1 is off. When a positive-going vertical sync signal, approximately 4.0 volts P-P, is applied (direct coupled) to the base, Q1 goes into saturation. The amplified output is developed across load resistor R3 to approximately 11 volts.

SYNC SHAPER

(Refer to Figure 9.)

The negative-going vertical sync pulses (from Q1) are direct coupled to the non-inverting input of the sync shaper stage, IC1. The combined action of an integrating network, consisting of C1, C2, C3, R5, R6, and R7, removes high frequency noise from the vertical sync pulses. Capacitor C3 performs the actual integrating, while resistors R5—R7 provide biasing for IC1. Capacitors C1 and C2 provide a bypass function.

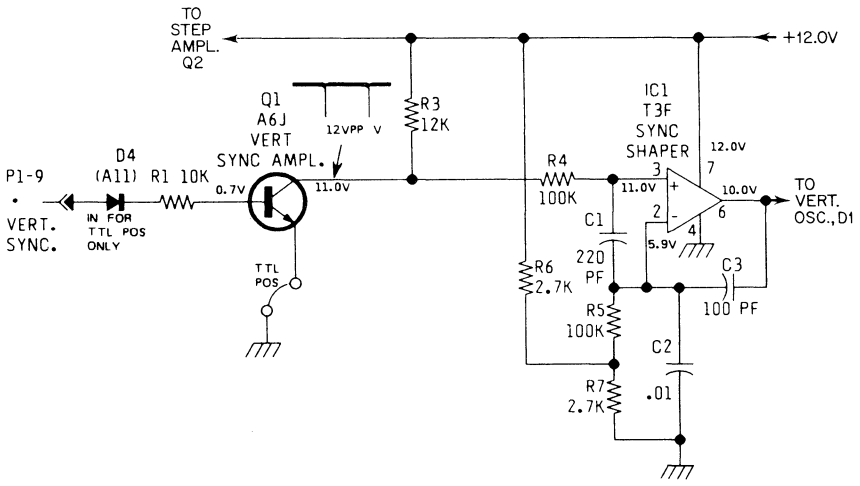


Figure 9. Vertical Sync Amplifier and Sync Shaper Circuits

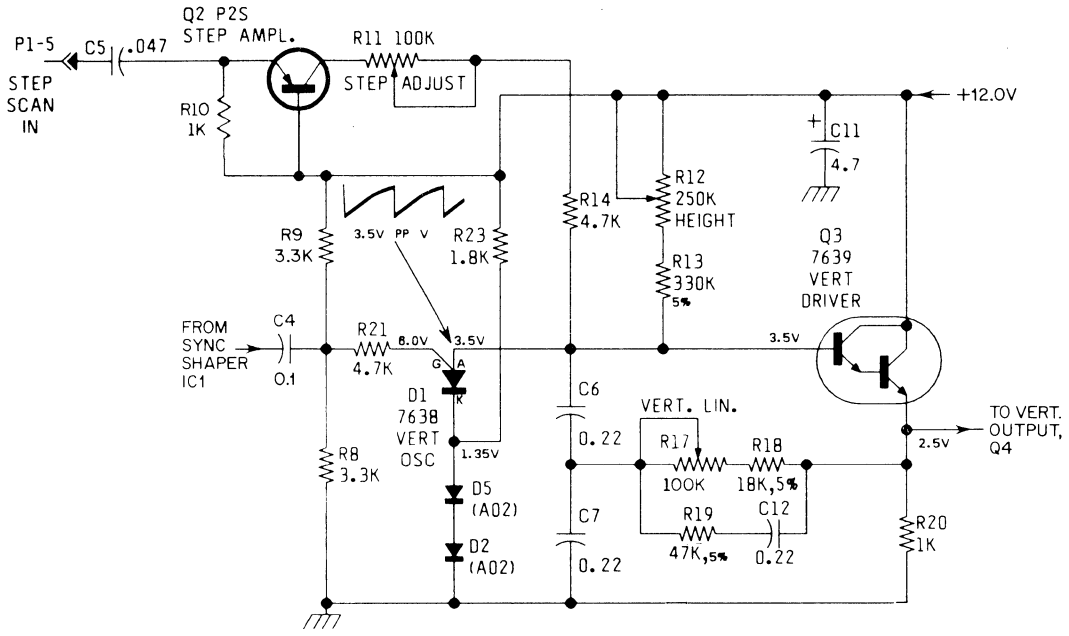


Figure 10. Vertical Oscillator/Driver and StepScan Amplifier Circuits

VERTICAL OSCILLATOR

(Refer to Figure 10.)

The negative-going vertical sync pulses are AC coupled (C4) to the gate of a programmable unijunction transistor device, D1. This device turns on with each negative-going sync pulse applied to its gate. This action permits C6 and C7 to discharge very rapidly; then recharge slowly during the period that a sync pulse is not applied to the gate. The recharge path for C6 and C7 is through R12 and R13. As soon as the next sync pulse is applied to the gate of D1, C6 and C7 discharge very rapidly again. This sequence of events produces a positive-going ramp or sawtooth waveform at the anode of D1.

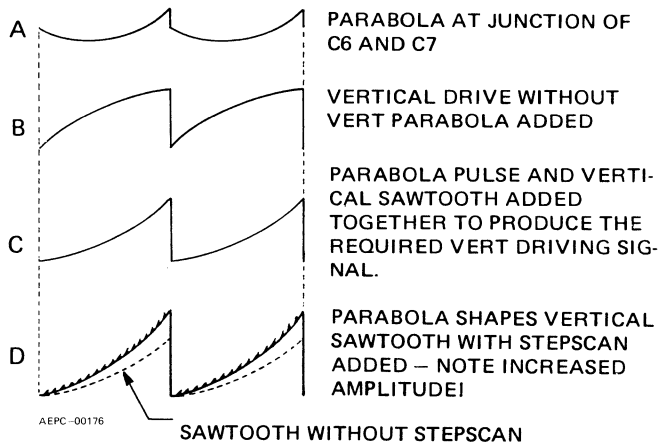
When no vertical sync pulses are connected to the monitor, vertical oscillator D1 is kept free-running to maintain a raster on the CRT. This is accomplished by biasing the gate of D1 in conjunction with the charge and discharge action of C6 and C7. Resistors R9 and R8 provide the proper bias for D1, which also determines the repetition rate for the charge and discharge action of C6 and C7.

In addition, during no-signal conditions, components D5 and D2 (in conjunction with D1), provide a small incremental voltage above ground to compensate for the base-emitter voltage drop of the vertical driver, Q3. This is necessary to keep the vertical output stage, Q4, from being driven into cutoff, which could result in distorted vertical linearity.

VERTICAL DRIVER

(Refer to Figure 10.)

The positive-going sawtooth waveform, from the anode of D1, is direct coupled to the base of vertical driver Q3, which operates as an emitter follower. The sharp fall time of the sawtooth is a result of the rapid discharge of C6 and C7 through D1. The amplitude of the sawtooth is varied with the HEIGHT control, R12.



The output sawtooth from the emitter of Q3 is direct coupled to the base of vertical output stage, Q4. Part of this sawtooth waveform, however, is also coupled back to the junction of C6 and C7 via R18 and VERT. LIN. control R17 for proper shaping. Since this path is resistive, the waveform will be integrated into a parabola waveform by C7 (waveform A). This results in a predistortion of the drive sawtooth (waveform C). (Waveform B illustrates the drive sawtooth without parabola shaping.) Parabola shaping is necessary to compensate for the non-linear charging of C6 and C7. An additional path for phase compensation is provided through C12 and R19.

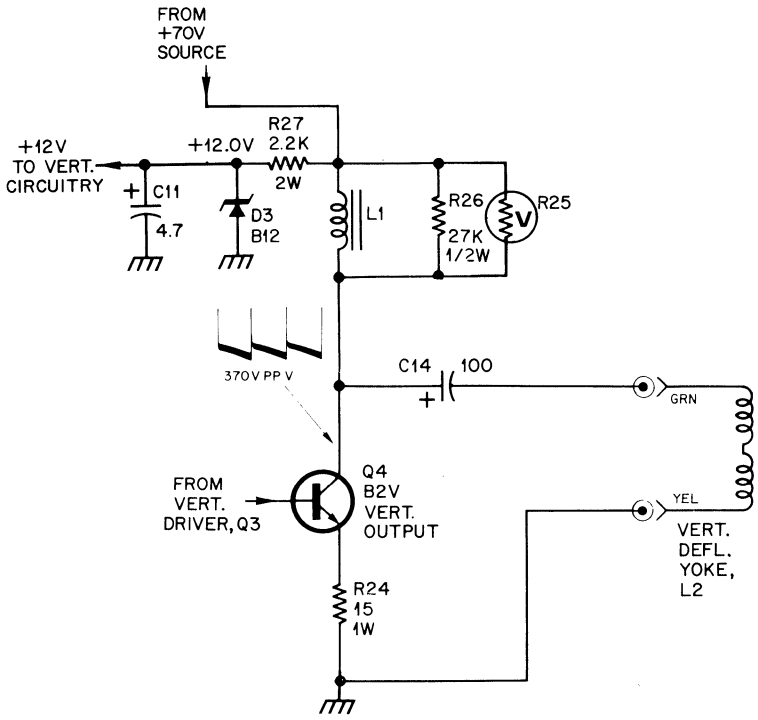


Figure 11. Vertical Output Circuit

VERTICAL OUTPUT

(Refer to Figure 11.)

The positive-going sawtooth waveform from the emitter of Q3 is applied to the base of vertical output stage, Q4, which conducts only during the ramp, or rise time, of the sawtooth waveform. The inverted ramp output (collector current) is the vertical trace period, which is AC coupled (via C14) to the vertical deflection yoke winding. The same collector current output is also applied to L1, which builds up a large electromagnetic field. This field will collapse very rapidly when Q4 turns off during the retrace time of the waveform applied to the base of Q4. The back EMF is in the form of a high voltage positive pulse, whose duration represents the vertical retrace period. To limit this pulse to a safe value, a varistor is connected across L1, with R26 providing damping.

Except for the vertical output stage, Q4, the vertical circuitry operates from a +12 volt source, which is derived from the +70 volt source. Resistor R27 drops the +70 volt source to the required +12V. Zener diode D3 holds the +12V constant while C11 provides additional filtering.

STEPSCAN FUNCTION

With existing logic, the number of characters that can be displayed is limited by logic speed. Anything that increases the speed at which the logic must work, will allow an increase in the number of characters displayed.

When a video monitor is used as a data display, the system bandwidth required (and logic speed) increases in direct proportion to the number of scan lines displayed. Since no data is written in the blank spaces between character rows, a method is required to speed up vertical deflection in the blank spaces to decrease bandwidth requirements. This makes the blank space height less dependent on scan time, allowing time to display more characters. This is accomplished by "stepping" the reference sawtooth between character rows so that a row to row space of from 3 to 5 horizontal lines equivalent height can be displayed in the time it takes to deflect one horizontal line. This is illustrated in Figure 12.

STEPSCAN CIRCUIT

(Refer to Figure 10.)

This circuit requires an external (approximately 4.0 volts P-P) TTL positive-going pulse. These pulses are applied to the emitter of the StepScan Amplifier, Q2, which is turned on when the emitter voltage exceeds the base voltage. The +12 volts stored on C5 is applied through Q2, R11 and R14, to the sawtooth forming capacitors C6 and C7. This momentarily increases the charge rate of C6 and C7, and the resultant action produces the stepping sawtooth shown as waveform D. The rate at which the vertical oscillator 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, R11, which varies the spacing from 3 to 5 horizontal scan lines. With the vertical sawtooth thus modified, the collector current of Q4 and, therefore, the yoke vertical deflection current will be "stepped" during the line between character rows chosen.

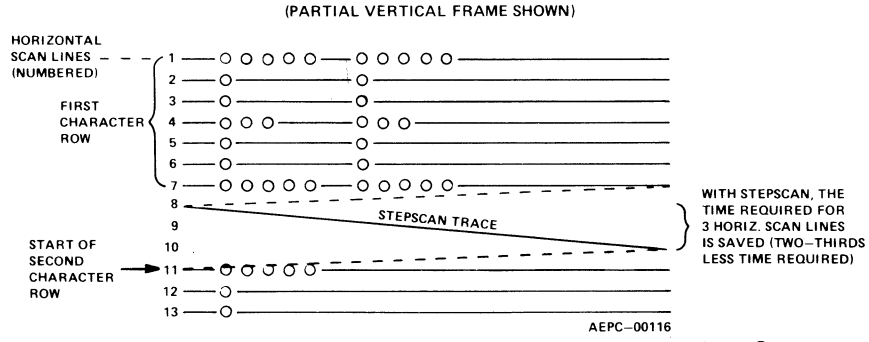
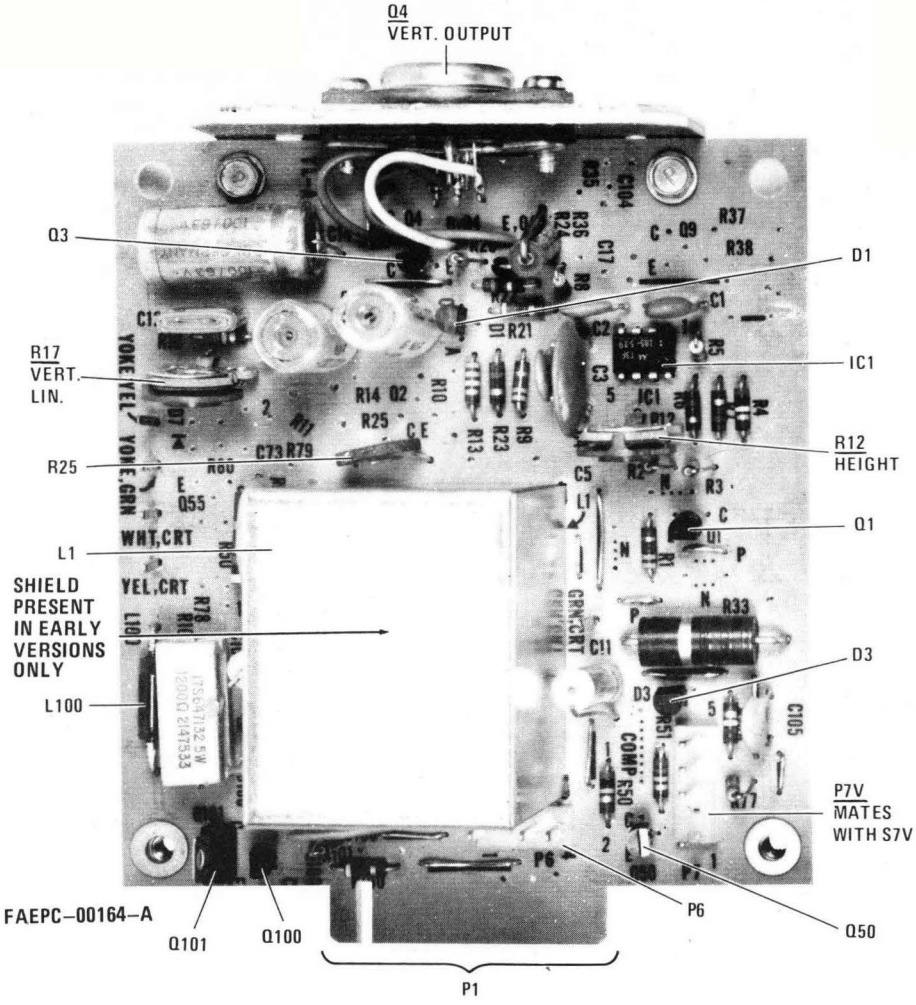
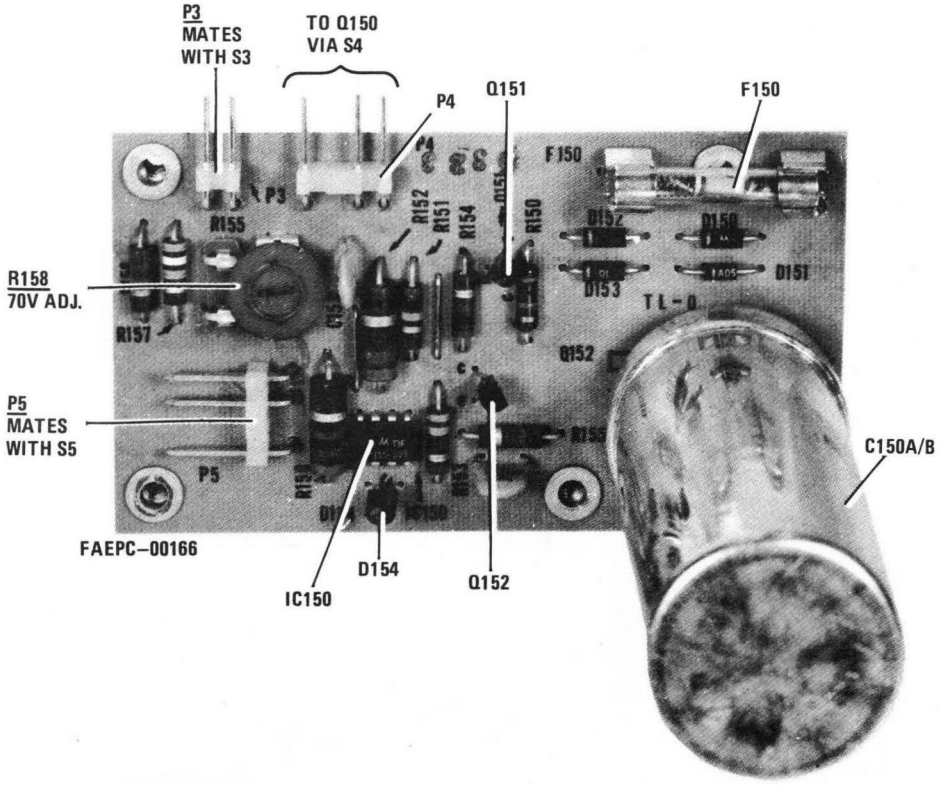


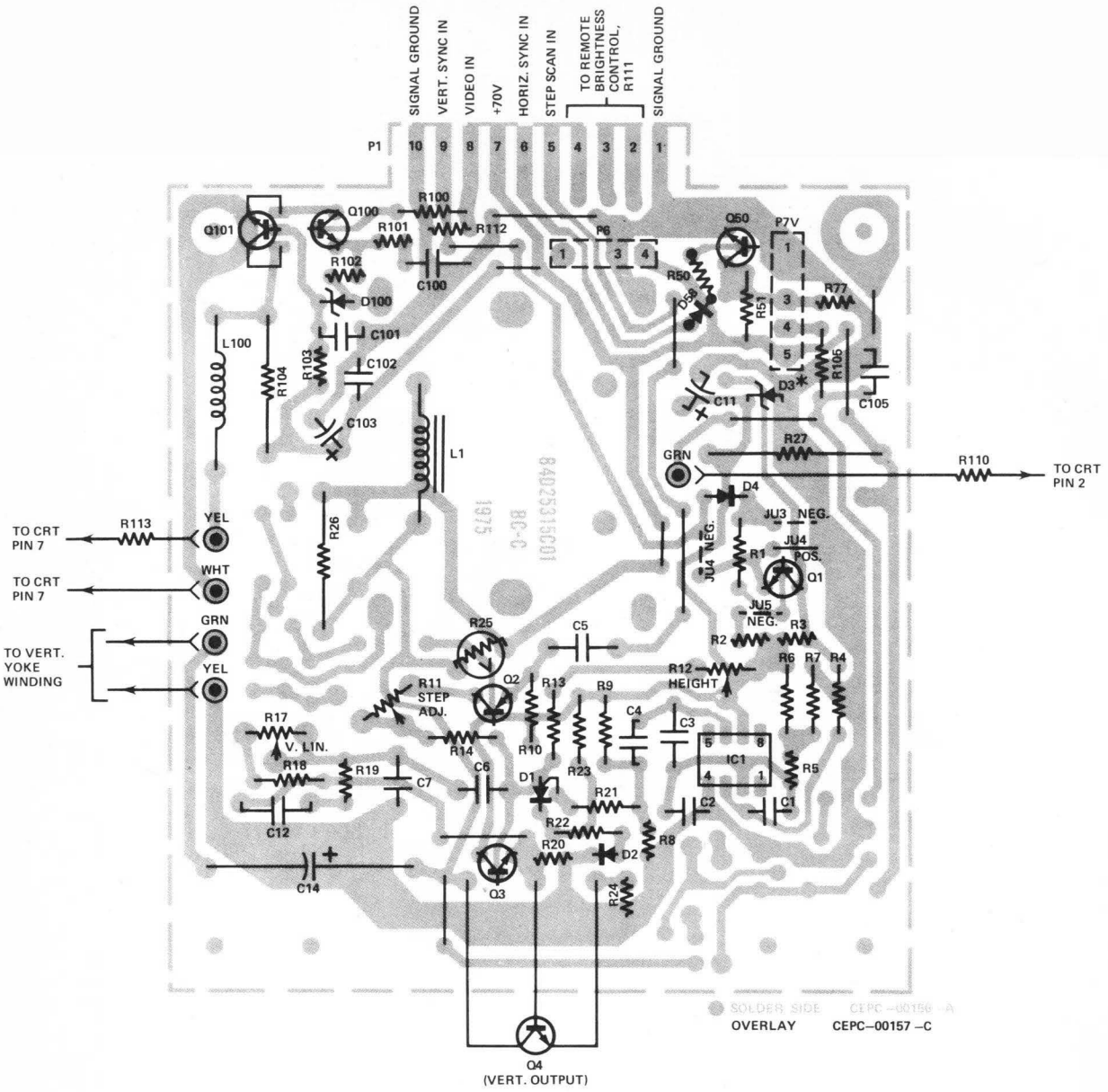
Figure 12. Displaying Characters on a Monitor with StepScan



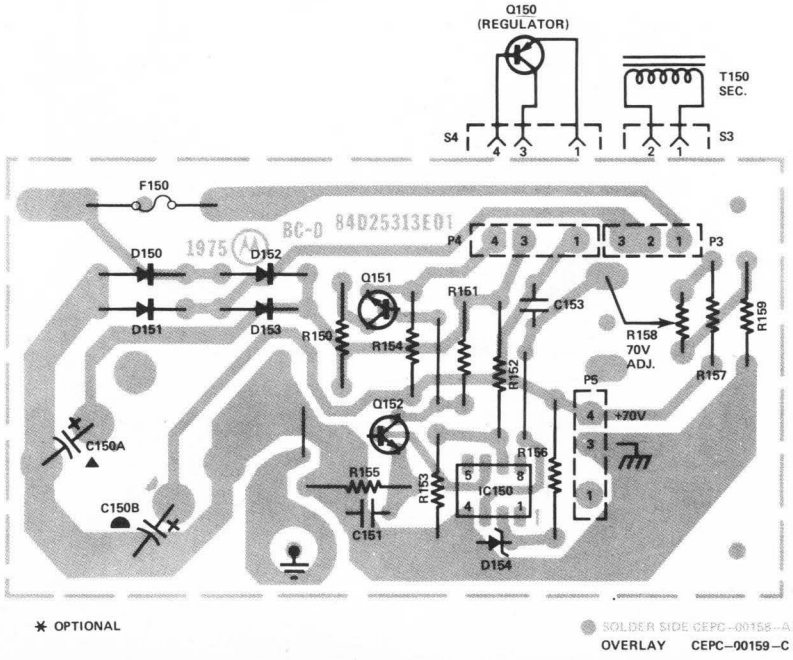
Vertical/Video Circuit Card (Component View)



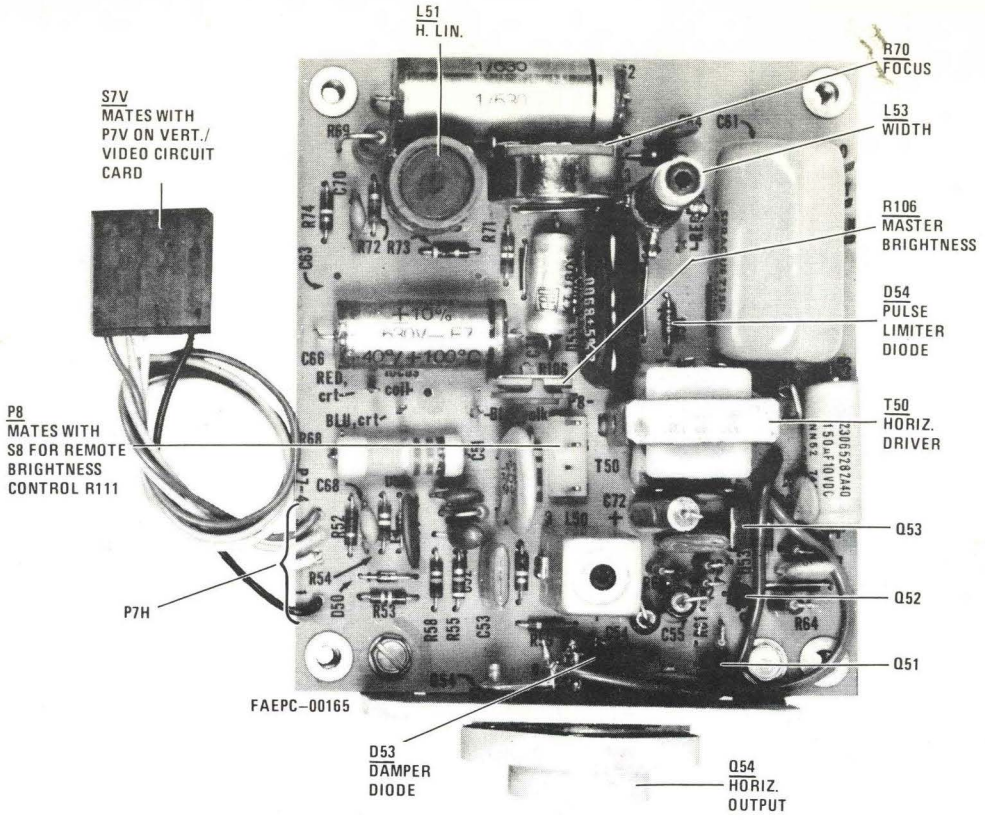
Power Supply Circuit Card (Component View)



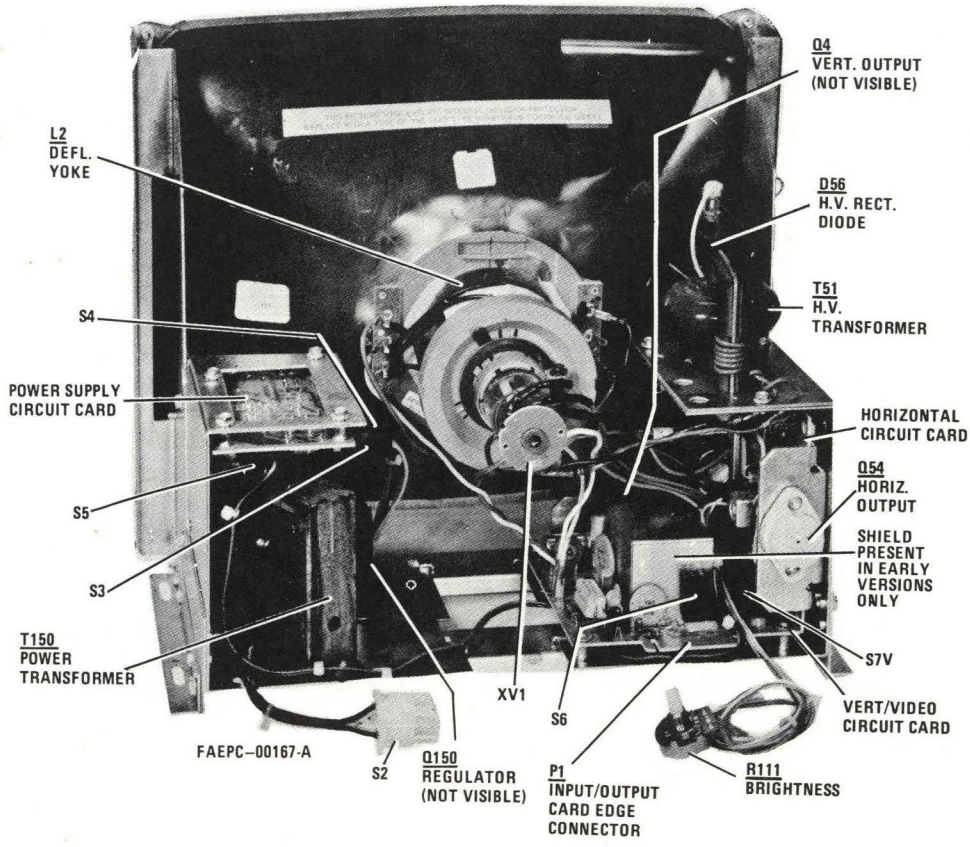
Vertical/Video Circuit Card (Solder View)



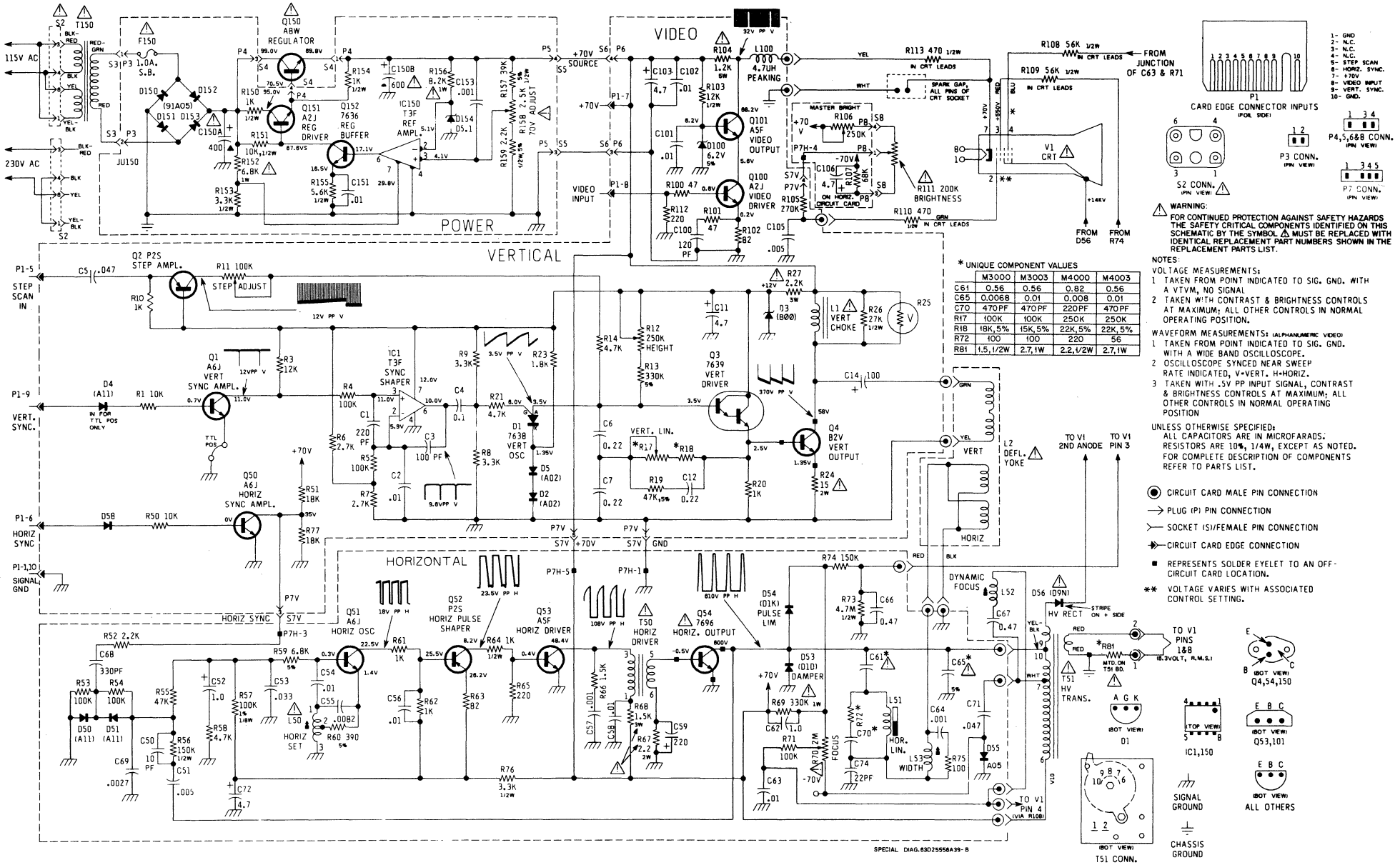
Power Supply Circuit Card (Solder View)



Horizontal Circuit Card (Component View)



Rear Chassis View – Typical of M3000/M4000



* UNIQUE COMPONENT VALUES

	M3000	M3003	M4000	M4003
C61	0.56	0.56	0.82	0.56
C65	0.0068	0.01	0.008	0.01
C70	470PF	470PF	220PF	470PF
R17	100K	100K	250K	250K
R18	18K,5%	15K,5%	22K,5%	22K,5%
R72	100	100	220	56
R81	1.5,1/2W	2.7,1W	2.2,1/2W	2.7,1W

WARNING:

FOR CONTINUED PROTECTION AGAINST SAFETY HAZARDS THE SAFETY CRITICAL COMPONENTS IDENTIFIED ON THIS SCHEMATIC BY THE SYMBOL ⚠ MUST BE REPLACED WITH IDENTICAL REPLACEMENT PART NUMBERS SHOWN IN THE REPLACEMENT PARTS LIST.

NOTES:

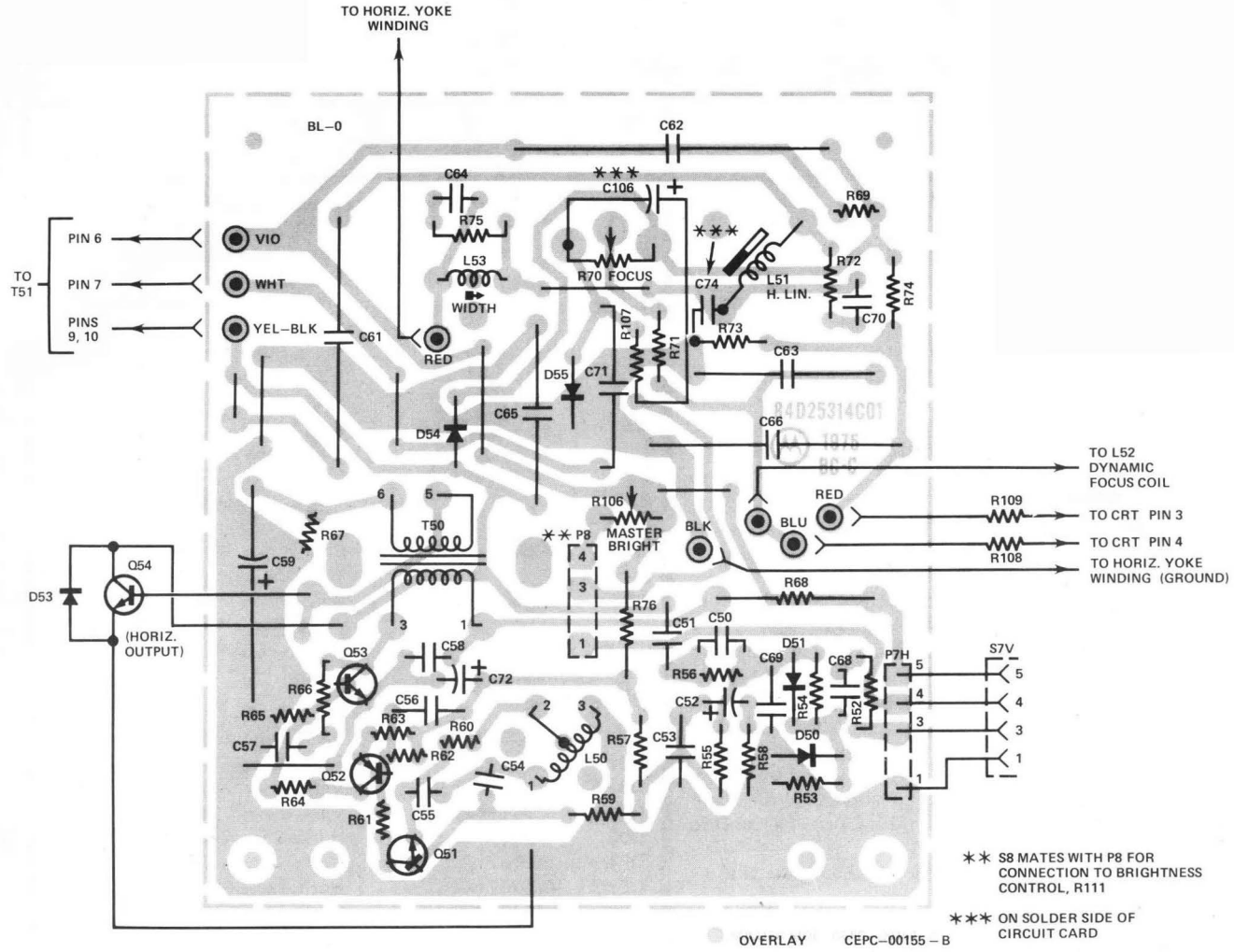
VOLTAGE MEASUREMENTS:
1. TAKEN FROM POINT INDICATED TO SIG. GND. WITH A VTVM, NO SIGNAL
2. TAKEN WITH CONTRAST & BRIGHTNESS CONTROLS AT MAXIMUM; ALL OTHER CONTROLS IN NORMAL OPERATING POSITION.

WAVEFORM MEASUREMENTS: (ALPHANUMERIC VIDEO)
1. TAKEN FROM POINT INDICATED TO SIG. GND. WITH A WIDE BAND OSCILLOSCOPE.
2. OSCILLOSCOPE SYNCED NEAR SWEEP RATE INDICATED, V=VERT. H=HORIZ.
3. TAKEN WITH .5V PP INPUT SIGNAL, CONTRAST & BRIGHTNESS CONTROLS AT MAXIMUM; ALL OTHER CONTROLS IN NORMAL OPERATING POSITION

UNLESS OTHERWISE SPECIFIED:
ALL CAPACITORS ARE IN MICROFARADS. RESISTORS ARE 10%, 1/4W, EXCEPT AS NOTED. FOR COMPLETE DESCRIPTION OF COMPONENTS REFER TO PARTS LIST.

- ◉ CIRCUIT CARD MALE PIN CONNECTION
- → PLUG (P) PIN CONNECTION
- ⟩ SOCKET (S)/FEMALE PIN CONNECTION
- ⋙ CIRCUIT CARD EDGE CONNECTION
- ■ REPRESENTS SOLDER EYELET TO AN OFF-CIRCUIT CARD LOCATION.
- ** VOLTAGE VARIES WITH ASSOCIATED CONTROL SETTING.

Schematic Diagram



Horizontal Circuit Card (Solder View)

REPLACEMENT PARTS LIST

REF. NO.	PART NUMBER	DESCRIPTION
CIRCUIT CARD ASSEMBLIES:		
	84V25554A88	Horizontal Circuit Card (Cpt.) (M3000–140, 240, 340)
	84V25553A32	Horizontal Circuit Card (Cpt.) (M3003–140, 240, 340)
	84V25552A77	Horizontal Circuit Card (Cpt.) (M4000–140, 240, 440)
	84V25554A68	Horizontal Circuit Card (Cpt.) (M4003–140, 240, 440)
	84V25554A89	Vertical/Video Circuit Card (Cpt.) (M3000–140, 240, 340)
	84V25554A38	Vertical/Video Circuit Card (Cpt.) (M3003–140, 240, 340)
	84V25553A94	Vertical/Video Circuit Card (Cpt.) (M4000–140, 240, 440)
	84V25554A69	Vertical/Video Circuit Card (Cpt.) (M4003–140, 240, 440)
	84V25019A27	Power Supply Circuit Card (Cpt.)
CAPACITORS: (ALL VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.)		
C1	21S180B87	220 pF 10%,X5F, 500V; Cer.Disc
C2	21S180E60	.01 +80–20%,Z5V,50V;Cer. Disc
C3	21S180C50	100 pF 5%, NPO, 500V; Cer.Disc
C4	8S10212D52	0.1 10%, 100V, Mtlz Poly
C5	8S10191B91	.047 10%, 250V, Polyester
C6, 7	8S10191B67	0.22 10%, 250V; Polyester
C11	23S10255B28	4.7, 100V; lytic
C12	8S10212C08	0.22 10%, 100V; Polyester
C14	23S10255A60	100, 63V; lytic
C50	21S180C02	10 pF, NPO, 500V; Cer. Disc
C51	21S180D34	.005 20%, Z5F, 1 kV, Cer.Disc
C52	23S10229A32	1.0 +40–20%, 16V; lytic
C53	8S10191B90	.033 10%, 250V; Polyester
C54	8S10299B28	.01 10%, 100V; Poly Carb
C55	8S10299B29	.0082 10%, 100V; Poly Carb
C56	8S10191B98	.01 10%, 250V; Polyester
C57	21S180B51	.001 10%, X5F, 500V; Cer.Disc
C58	21S180E60	.01 +80–20%, Z5F, 50V;Cer.Disc
C59	23S10255B81	220, 10V; lytic
C61	8S10571A23	0.56 10%, 250V, Polyprop (M3000–140, 240, 340; M3003–140, 240, 340)
C61	8S10299B27	0.82 10%, 400V; Mtlz Poly Carb (M4000–140, 240, 440)
C61	8S10299B37	0.68 10%, 200V; Mtlz. Poly Carb. (M4003–140, 240, 440)
C62	8S10212A11	1.0 10%, 630V; Mtlz Mylar
C63	8S10571A06	.01 5%, 1200V; Polyprop
C64	21S180B51	.001 10%, X5F, 500V; Cer. Disc (All models except M4003-140, 240, 440)

REPLACEMENT PARTS LIST (Cont'd)

REF. NO.	PART NUMBER	DESCRIPTION
C64	21S180C42	560 pF 10%, Z5F, 500V;Cer.Disc (M4003–140, 240, 440)
C65	8S10571A04	.0068 5%, 1200V; Polyprop (M3000–140, 240, 340)
C65	8S10571A06	.01 5%, 1200V; Polyprop (M3003–140, 240, 340; M4003–140, 240, 440)
C65	8S10571A05	.008 5%, 1200V; Polyprop (M4000–140, 240, 440)
C66	8S10212B53	0.47 10%, 630V; Mtlz Mylar
C67	8S10212B53	0.47 10%, 630V; Mtlz Poly
C68	21S131625	330 pF 10%,X5F, 500V;Cer.Disc
C69	21S180C41	.0027 10%, Z5F, 500V; Cer.Disc
C70	21S180B72	470 pF 10%,Z5F, 500V; Cer.Disc (M3000–140, 240, 340; M3003–140, 240, 340)
C70	21S180B87	220 pF 10%, X5F, 500V;Cer.Disc (M4000–140, 240, 440)
C70	21S180C42	560 pF 10%, Z5F, 500V;Cer.Disc (M4003–140, 240, 440)
C71	8S10191B07	.047 10%, 400V; Polyester
C72	23S10255B28	4.7, 100V; lytic
C74	21S180B55	22 pF 15%, NPO, 550V; Cer.Disc
C100	21S180E50	120 pF 5%, NPO; Cer.Disc
C101	21S180E60	.01 +80–20%, Z5V,50V;Cer. Disc
C102	21S132492	.01 +80–20%,Z5V,100V;Cer.Disc
C103	23S10255B28	4.7, 100V; lytic
C105	21S180A62	.005 20%, Z5V,500V; Cer.Disc
C106	23S10255B26	4.7, 63V; lytic
C150A/B	23S10255B71	400/125V, 600/100V; lytic
C151	21S180E60	.01 +80–20%,Z5V,50V; Cer.Disc
C153	21S180B51	.001 10%, X5F,500V; Cer.Disc
DIODES:		
D1	48S137638	Programmable UJT, MPU–6027 Vert. Osc.
D2, 5	48S191A02	Rectifier, Silicon; A02
D3	48R02024B00	Diode, Silicon Zener(2024B)
D4,50,51	48D67120A11	Diode, Low Power; A11
D53	48S134921	Diode, D1D, Damper
D54	48S134978	Diode, D1K; Pulse Lim.
D55	48S191A05	Rectifier, Silicon; 91A05
D56	48S137622	Diode, Silicon, D9N; H.V.Rect.
D58	48D67120A11	Diode, Low Power; A11
D100	48S10813A01	Diode, Zener 6.2V 5% (1N5234B)
D150--153	48S191A05	Rectifier, Silicon; 91A05
D154	48S10813A02	Diode, Zener 5.1V
FUSES:		
F150	65S139424	Fuse, Slow Blow 1.0 Amp.
INTEGRATED CIRCUITS:		
IC1	51S10732A01	Integrated circuit, T3F; Sync Shaper
IC150	51S10732A01	Integrated circuit, T3F;Ref.Ampl.
COILS/CHOKES:		
L1	25D25221A13	Choke, Vert.
L2	24D25261B01	Yoke, Deflection (M3000–140, 240, 340)
L2	24D25687A01	Yoke, Deflection (M3003–140, 240, 340)
L2	24D25687A02	Yoke, Deflection (M4000–140, 240, 440)
L2	24D25261B07	Yoke, Deflection (M4003–140, 240, 440)
L50	24C25448A01	Coil, Horiz. Set
L51	24D25600A06	Coil, Horiz. Lin. (M3000–140, 240, 340; M4000–140,240,440)
L51	24D25600A07	Coil, Horiz.Lin. (M3003–140, 240,340; M4003–140,240,440)
L52	24D25603A06	Coil, Dynamic Focus
L53	24D25603A03	Coil, Horiz. Width (M3000–140, 240,340; M3003–140,240,340)
L53	24D25603B09	Coil, Horiz. Width (M4000–140, 240,440; M4003–140,240,440)
L100	24D25601A02	Coil, Peaking 4.7 uH 10%
TRANSISTORS:		
Q1	48S137172	Vert. Sync Ampl; A6J
Q2	48S137127	Step Ampl; P2S
Q3	48S137639	Vert.Driver; 7639
Q4	48S137596	Vert. Output; B2V
Q50	48S137172	Horiz. Sync Ampl; A6J
Q51	48S137172	Horiz. Osc.; A6J
Q52	48S137127	Horiz. Pulse Shaper; P2S
Q53	48S137093	Horiz. Driver; A5F
Q54	48S137696	Horiz. Output; 7696
Q100	48S134952	Video Driver; A2J
Q101	48S137093	Video Output; A5F
Q150	48S137368	Regulator; A8W
Q151	48S134952	Reg. Driver; A2J
Q152	48S137636	Ref. Ampl; 7636
RESISTORS/CONTROLS:		
NOTE:	Only power or special resistors are listed. Use the description when ordering standard values of fixed carbon resistors up to 2 watts.	
R11	18D25245A15	Control, Step Adjust 100k
R12	18D25245A22	Control, Height 250k
R17	18D25245A15	Control, Vert. Lin. 100 k (M3000–140, 240, 340; M3003–140, 240, 340)
R17	18D25245A22	Control, Vert. Lin. 250k (M4000–140, 240, 440; M4003–140, 240, 440)
R25	6S10201A04	Varistor, VDR 1 mA
R68	17S10130B07	1.5k 10%, 3W
R70	18C25218A14	Control, Focus 2 Meg.
R104	17S647132	1.2k 10%, 5W
R106	18D25245A22	Control, Master Brightness 250k
R111	18D25212A39	Control, Brightness 200k
R158	18D25245A21	Control, 70V Adjust 2.5k
TRANSFORMERS:		
T50	25D25221A05	Transformer, Horiz.Driver
T51	24D25240B11	Transformer, High Voltage (M3000–140, 240, 340)

REPLACEMENT PARTS LIST (Cont'd.)

REF. NO.	PART NUMBER	DESCRIPTION
T51	24D25240B16	Transformer, High Voltage (M3003–140,240,340; M4003–140,240,440)
T51	24D25240C13	Transformer, High Voltage (M4000–140, 240, 440)
T150	25D68164A33	Transformer, Power
MISC. ELECTRICAL PARTS:		
V1	96S233A01	12" CRT; Type CE226–M12P4S (M3000–140; M3003–140)
	96S249A01	12" CRT; Type 12ST5427P4A (M3000–240, M3003–240)
	96S256A01	12" CRT; Type CE226M12P31S (M3000–340; M3003–340)
	96R2500A04	14" CRT; Type ST4730C (M4000–140; M4003–140)
	96R2500A05	14" CRT; Type ST4730D (M4000–240; M4003–240)
	96R2500A07	14" CRT; Type ST4730P31D (M4000–440; M4003–440)
MECHANICAL PARTS:		
	42B25158C01	Clamp, Deflection Yoke
	42S10240A07	Clamp (Mt. C150A/B)
	42S10122A12	Clip, Fuse
	42D25298A03	Connector, Anode
P3	28S10586A56	Connector, 2–Contact(See Fig.13)
P4,5	28S10586A25	Connector, 3–Contact
P6	28S10586A14	Connector, 3–Contact
P7	28S10586A21	Connector, 4–Contact
P8	28S10586A14	Connector, 3–Contact
	14S10550A02	Cover, Transistor (Q54)
S2	15S10183A77	Housing, Receptacle; 6–Contact (Less Contacts)
	39S10184A64	Contact, Receptacle (4 Req'd. for S2)
S3	15S10183A94	Housing, Receptacle; 2–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (2 Req'd. for S3)
S4	15S10183A87	Housing, Receptacle; 3–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (3 Req'd. for S4)
S5, 6	15S10183A87	Housing, Receptacle; 3–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (2 ea. Req'd. for S5 & S6)
S7	15S10183A88	Housing, Receptacle; 4–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (4 Req'd. for S7)
S8	15S10183A87	Housing, Receptacle; 3–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (3 Req'd. for S8)
	14A25393A01	Insulator, Hi–Voltage Standoff
	14A562353	Insulator, Transistor (Q150, Q54, Q4)
	2S10054A25	Nut, Spring
	3S136050	Screw, 6–20 x ½" Clutch Head (Mt. Q150, Q54, Q4)
	26B25137B01	Shield, Coil (L50)
	9D25470A02	Socket, CRT (Incl. leads and resistors R108–R110, R113
	9S10274A08	Socket, Transistor (Q150,Q54,Q4)
	41D65987A01	Spring, Special; CRT Aquadag Gnd
	66C68497A03	Tool, Adjust

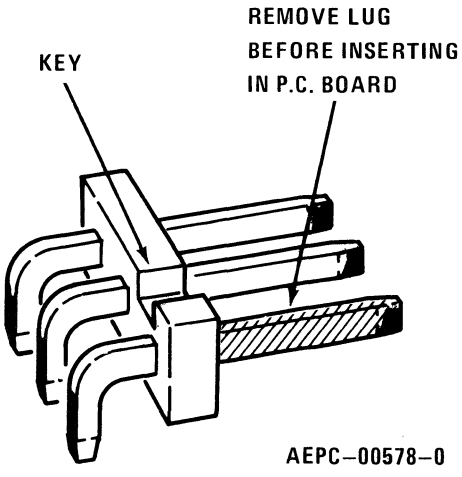


Figure 13. Part No. 28S10586A56

MODELS: M3000–140, 240, 340
M3003–140, 240, 340
M4000–140, 240, 440
M4003–140, 240, 440

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 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's 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 both software- and 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 execu-

tion, 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 movement 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's 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 device 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 location contains one word.

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