TEK SERVICE MANUAL

Part No. 070-4890-01
Product Group 18

4109/CX

COMPUTER DISPLAY TERMINAL

Tektronix®
COMMITTED TO EXCELLENCE

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Please Check for
CHANGE INFORMATION
at the Rear of This Manual

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WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

MANUAL REVISION STATUS

PRODUCT: 4109, 4109A, CX4109, and CX4109A Computer Display Terminals

This manual supports the following versions of this product: Serial Numbers B010100 and up.

REV DATE	DESCRIPTION
FEB 1984	Original Issue.
OCT 1984	Revised: CX4109 Service Information added. Part number rolled to 070-4890-01.
JAN 1985	Revised: Pages 4-7, 4-70, 4-75 through 4-80, 4-82, and 4-83.
APR 1985	Revised: Pages iii through xii, 1-1, 1-3 through 1-8, 2-3, 4-1, 4-2, 4-3, 4-64, 4-65, 4-83 through 4-87, 5-1, 6-13, 6-18, and 6-26 through 6-34. Added: Pages 1-9, 10-10, 5-14, and 5-25.
MAY 1985	Revised: Pages ii through xii, 4-66 through 4-83, 5-1, 5-3, 5-14, 5-16, 5-18 through 5-25, and 11-3.
AUG 1985	Revised: Pages vii, viii, xi, xii, 1-1, 1-7, 6-33, and Section C.
FEB 1986	Revised: Pages 4-84 through 4-88, 5-8, and 5-25. Added: Pages 4-89 and 5-26.
FEB 1987	Revised: Pages 1-1, 2-2, 4-82, 4-83, 5-4, 5-16, 6-12, and E-16.

CONTENTS

Section 4 (cont) **Page**

ILLUSTRATIONS

TABLES

OPERATORS SAFETY SUMMARY

This general safety information is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

TERMS

IN THIS MANUAL

CAUTION statements identify conditions or practices that can result in damage to the equipment or other property.

WARNING statements identify conditions or practices that can result in personal injury or loss of life.

AS MARKED ON EQUIPMENT

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

IN THIS MANUAL

⚠ This symbol indicates where applicable cautionary or other information is to be found.

As Marked on Equipment

⚡ DANGER high voltage.

⏚ Protective ground (earth) terminal.

⚠ ATTENTION — refer to manual.

(!) Refer to manual.

POWER SOURCE

This product is designed to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

GROUNDING THE PRODUCT

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the power input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

DANGER ARISING FROM LOSS OF GROUND

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

USE THE PROPER POWER CORD

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

USE THE PROPER FUSE

To avoid fire hazard, use only the fuse specified in the parts list for your product, and which is identical in type, voltage rating, and current rating.

Refer fuse replacement to qualified service personnel.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES

To avoid explosion, do not operate this product in an atmosphere of explosive gases unless it has been specifically certified for such operation.

DO NOT REMOVE COVERS OR PANELS

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

DO NOT SERVICE ALONE

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

USE CARE WHEN SERVICING WITH POWER ON

Dangerous voltages may exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing the power supply shield, soldering, or replacing components.

DO NOT WEAR JEWELRY

Remove jewelry prior to servicing. Rings, necklaces, and other metallic objects could come into contact with dangerous voltages and currents.

X-RADIATION

X-ray emission generated within this instrument has been sufficiently shielded. Do not modify or otherwise alter the high voltage circuitry or the CRT enclosure.

POWER SOURCE

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

HANDLING

Due to the wieght of the Display Module, and its component subassemblies, at least two persons are required to perform installatin or service to prevent injury to personnel or damage to the Display Module.

IMPLOSION PROTECTION

Whenever the implosion shield is removed from the CRT, protection against implosion hazard is reduced. Service personnel should wear full face masks and protective clothing at any time the CRT is removed from the CRT module or the implosion shield is not in place.

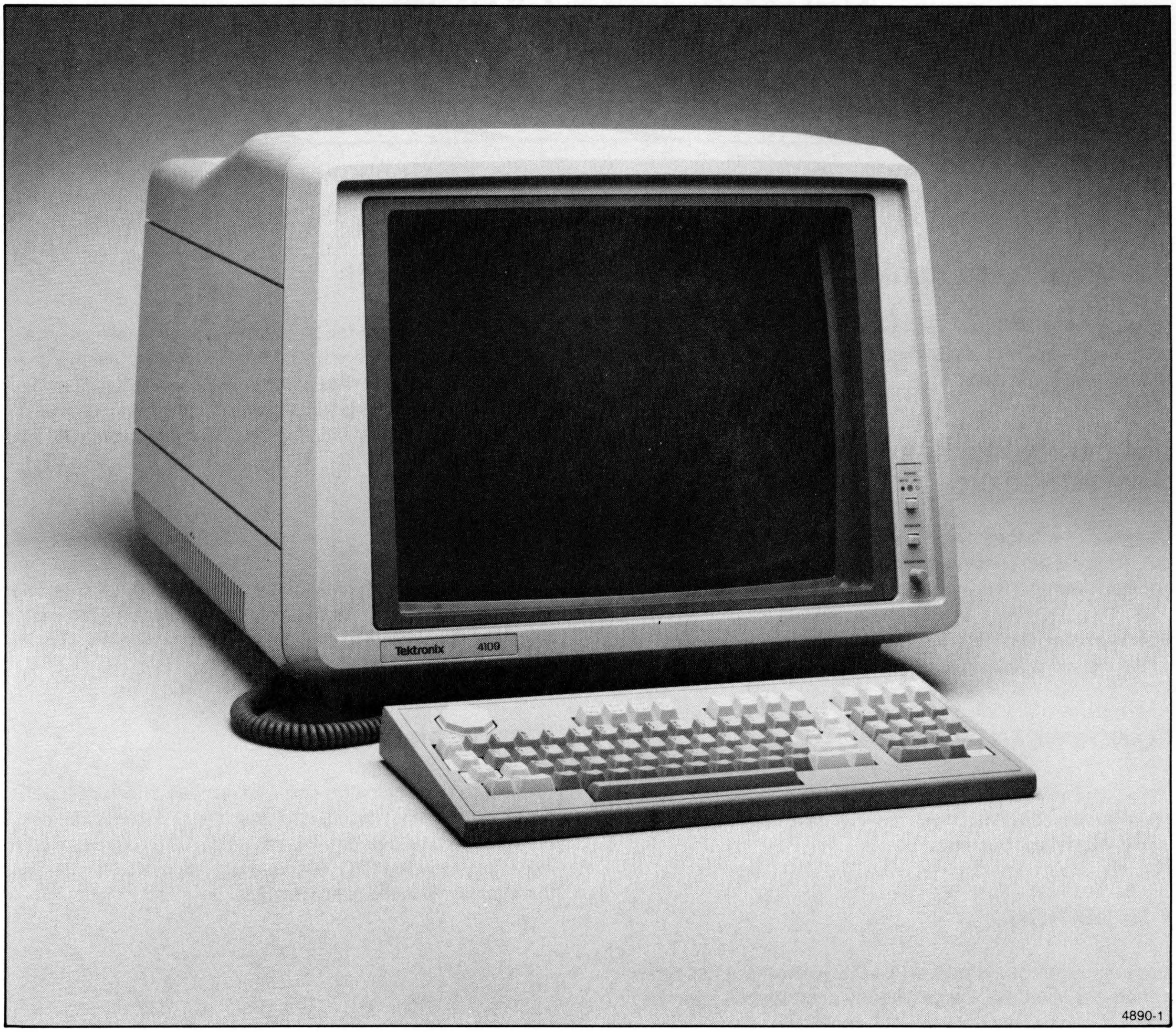


Figure 1-1. 4109 Computer Display Terminal.

Section 1

INTRODUCTION

USING THIS MANUAL

This manual contains service information for the standard 4109 and 4109A Computer Display Terminals and for the CX4109 terminal. This manual describes all parts of the terminal except the Display Module and the optional RAM4 memory board.

The 4109A is like a 4109, but the A-series terminal contains later firmware that provides additional features and supports the Option 21's RAM4 memory board. Hereafter, all references to the 4109 and CX4109 apply to the 4109A and CX4109A unless specifically noted otherwise.

The CX4109 is identical to the 4109 except that the CX terminal contains an IBM-style keyboard, an IBM interface board, and a coax connector for connection to an IBM Control Unit.

Because the 4109 Display Module is also available as an OEM product, all significant information for this module is contained in its own service manual. That manual contains theory of operation, repair procedures, parts lists and schematics. Section 5, of this manual, contains an adjustment procedure for the display in the 4109 application. Also, Section 6 contains disassembly and reassembly procedures for the Display Module in the 4109.

The terminal is compatible with the 4105, 4106, and 4107, and with Tektronix 4110-series terminals (4113, 4115, etc.). Applications designed for use with the 4105/4106/4107 can also be used with the 4109. See NOTE. Applications designed for use with the 4109 can also be used with the 4113B and 4115B terminals.

All peripherals to this terminal are covered in their separate service manuals. These include hard copy units, printers, and programmability unit.

NOTE

Like the 4107, the 4109 contains 256k bytes more processor memory than the 4105 and 4106. See the discussion of the RAM3 Board in Section 4, Theory of Operation.

RELATED DOCUMENTS

The following documents contain detailed information on the use of the 4109 and CX terminal:

- *4106/4107/4109 Operators Manual*
- *CX4100 Series Operators Manual*
- *4106/4107/4109/CX Programmers Reference Manual*
- *CX4100 Series Host Support Manual*
- *19-Inch Color Monitor for GMA301 and 4109 Service Manual*
- *119-2023-00 19" Display Module Service Manual*
- *4107A and 4109A Option 21 Service Manual*
- *An Introduction to Computer Color Graphics*

INSTALLATION INFORMATION

Section 8 provides complete instructions for installing the terminal. Immediately after receiving the terminal, unpack and inspect it for possible shipping damage. Do not throw away the shipping container until the terminal passes the damage inspection and is fully operational. Run the Self Test program to be sure the terminal works (see Section 5, *Checks and Adjustments*). Also verify that all accessories checked on the Accessories Packing Slip are included and work properly.

PRODUCT DESCRIPTION

The 4109 is a low-cost color graphics terminal. The primary applications are:

- Multiple-user CAD/CAM systems
- Text/graphics entry/editing
- General-purpose business terminal

The CX4109 is a graphics terminal that connects to any IBM system. Its primary applications are:

- Business and presentation graphics
- Dual-host engineering graphics

These terminals present graphics and text data on a high-resolution color raster-type CRT. There are 480 lines of 640 pixels (per line) on the 19V screen (about 20 inch diagonal measure). The display refreshes at the rate of 60 Hz. Both, graphics and text data, are displayable in color (selected from 64 possible hues). A total of 25 colors are displayable at one time:

- 16 colors are displayable in the graphics part of the display.
- 8 colors may be used to display text/dialog data (for character foreground and background).
- 1 color shows the crosshair graphics cursor (when present).

The character background may be a specified color or it may be transparent, thus revealing the graphics behind it. The dialog data (to/from the host) is presented in a scrollable area extending up from the bottom of the screen.

The 4109 keyboard is detached and contains an ASCII keyset, a numeric keypad, 12 special-purpose function keys, and a graphics joydisk. The joydisk controls the position of the graphics cross-hair cursor. The CX4109 keyboard uses the IBM-style layout and contains special keys for that host environment.

Figure 1-2 shows the major modules in the earlier terminals, while Figure 1-2A corresponds to the later terminals. Figure 1-3 shows the major parts of the early version (GMA 301) Display Module, and Figure 1-3A shows the major parts of the later version (119-2023-00) Display Module.

An RS-232 connector, on the rear panel connects to the host. The Two Port Peripheral Interface (2PPI) provides two RS-232 connectors on the rear panel for peripheral devices such as plotters and a graphics tablet unit. There is also a separate copier connector for the Tektronix 4690-series color copiers. The COMM connector on the back of the CX4109 accepts a coax cable from an IBM 3274/3276 Control Unit.

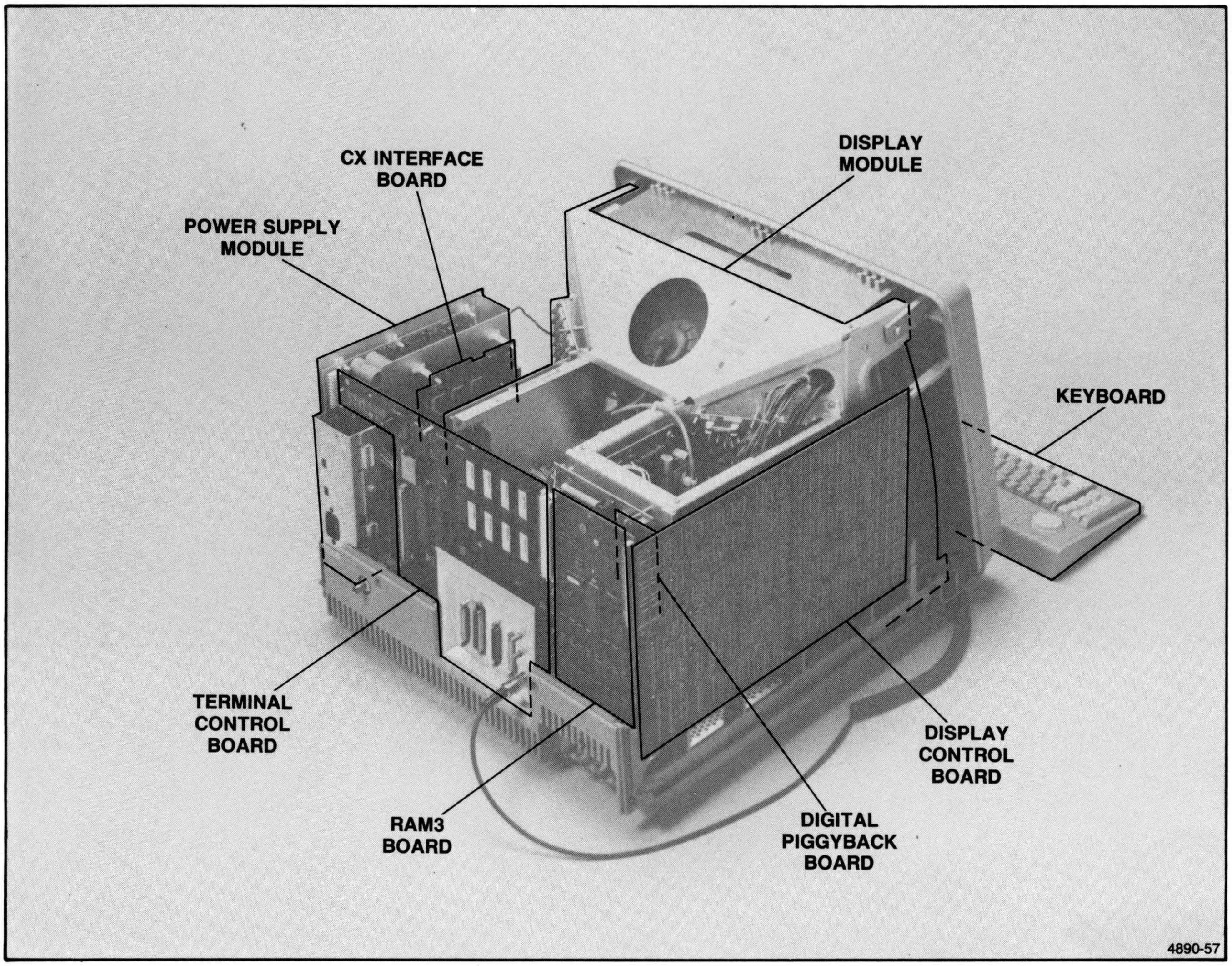


Figure 1-2. Functional Modules in Early-Version Terminals.

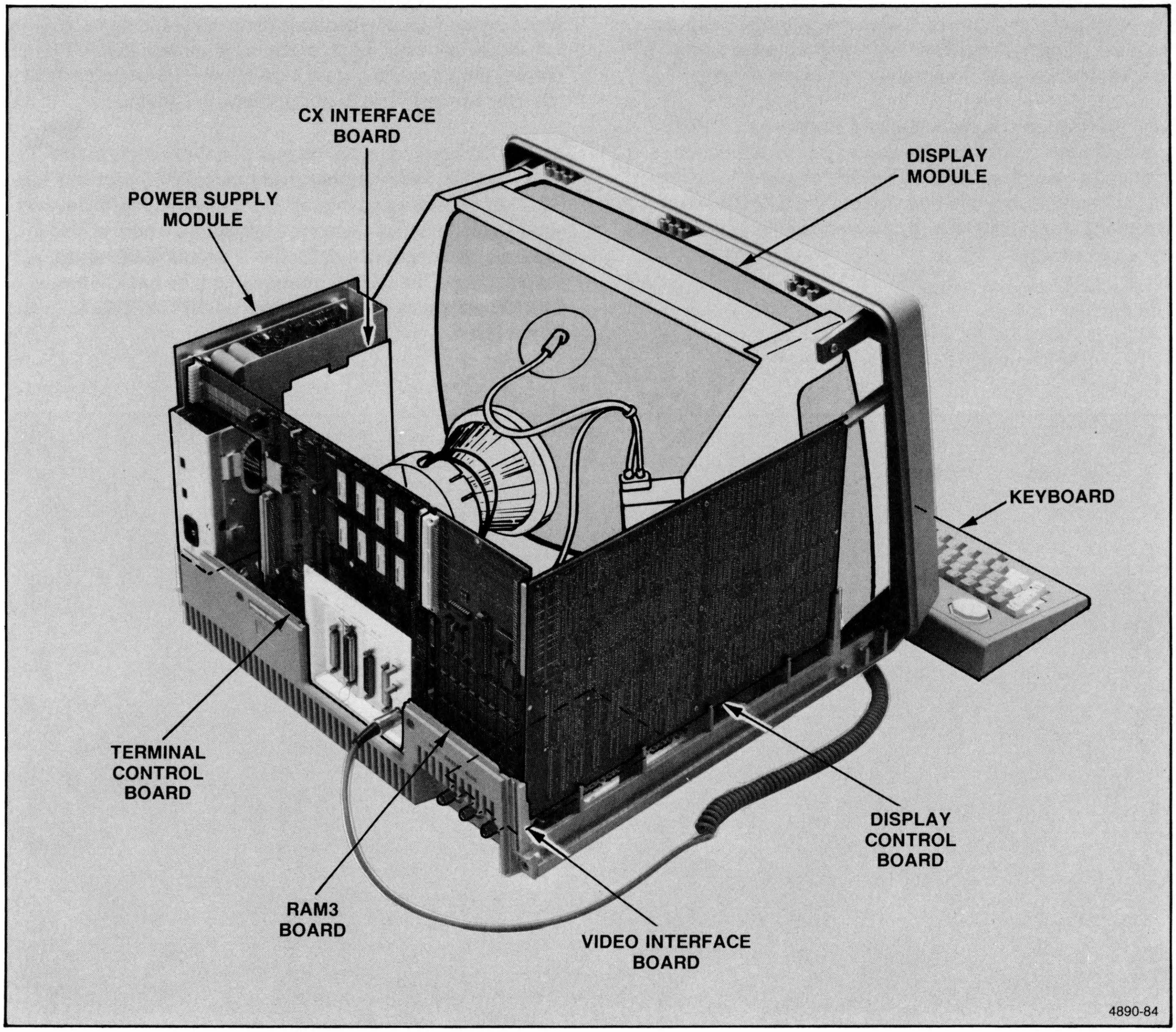


Figure 1-2A. Functional Modules in Later-Version Terminals.

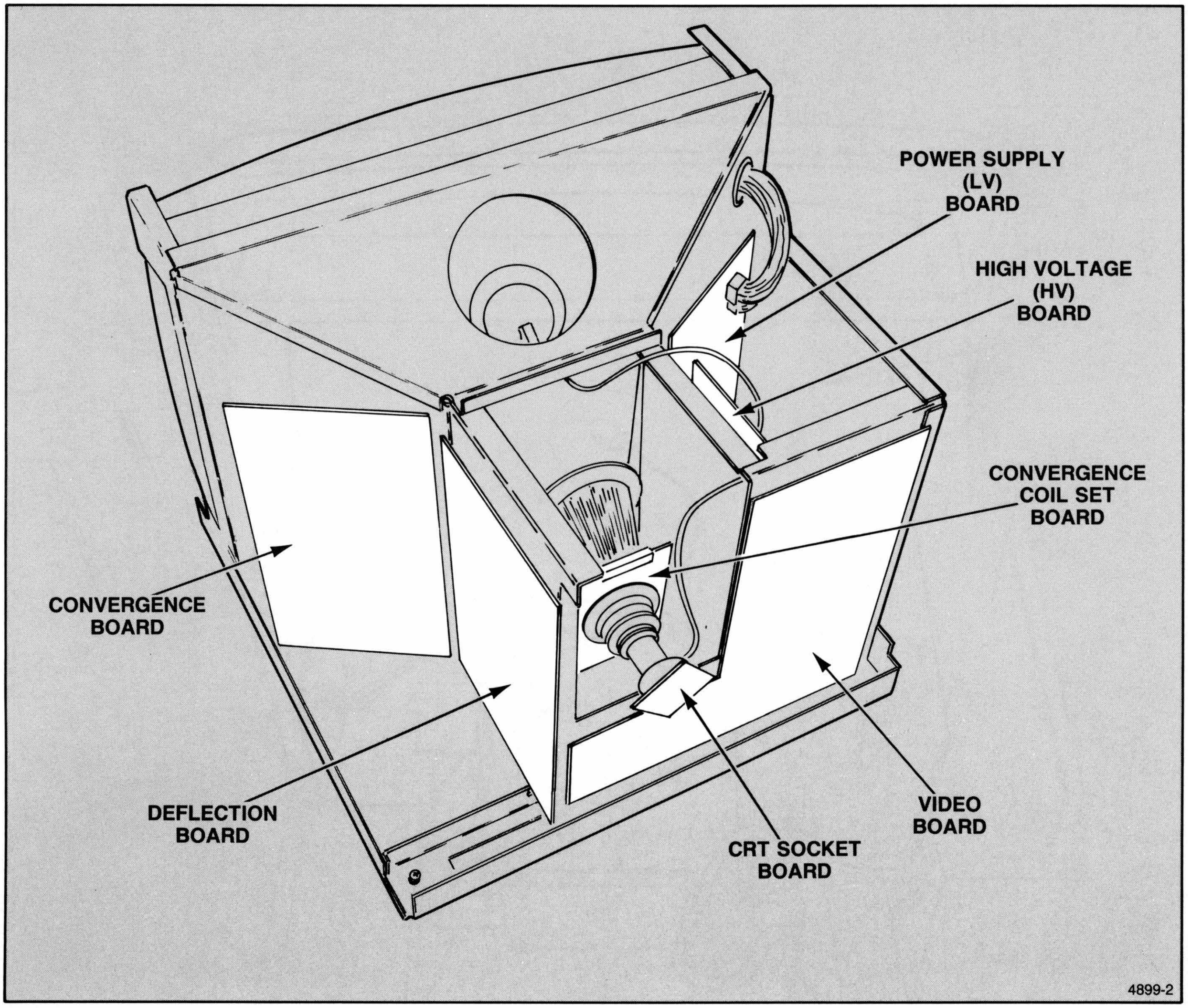


Figure 1-3. Circuit Boards in GMA301 Display Module.

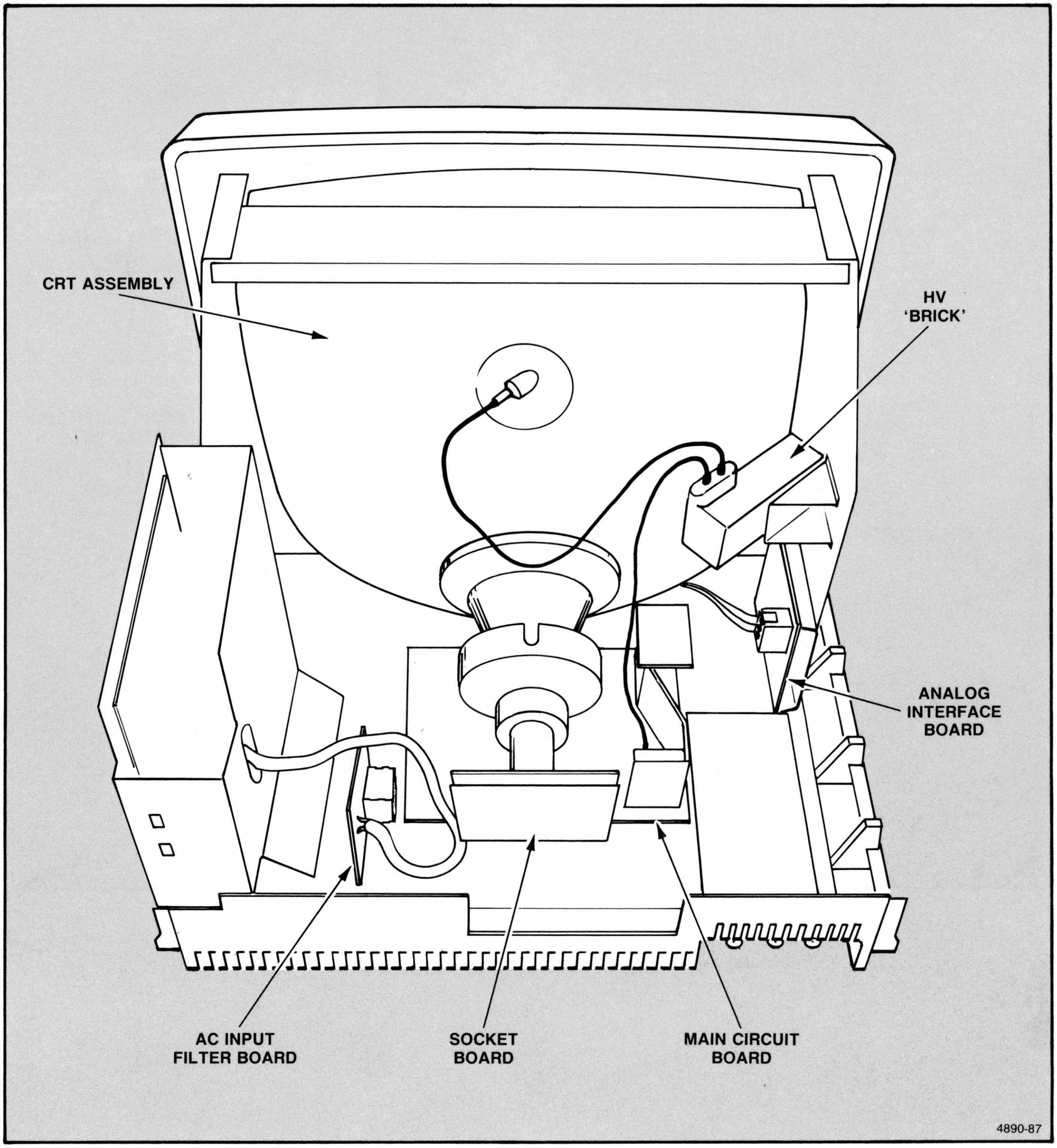


Figure 1-3A. Circuit Boards and Assemblies in 119-2023-00 Display Module.

CONTROLS, INDICATORS AND CONNECTORS

The terminal has the following features on the front of the terminal main cabinet (see Figure 1-4):

- POWER switch. This is a push-button switch that shows green when the power switch is pushed in.
- DEGAUSS button. This push-button degausses the CRT (neutralizes its acquired magnetic field).
- BRIGHTNESS control. This potentiometer allows the user to adjust the brightness level of the display screen.
- Display screen.

The standard keyboard has the following features (also shown in Figure 1-4):

- Alphanumeric keyset. Contains the standard ASCII typewriter/terminal keyset.
- Numeric keypad. This keyset is intended for numeric data entry in certain applications where calculations are performed.
- Predefined function keys (dialog, setup, save copy, set color).
- Function keys (F1 through F8).
- Joydisk. Moves screen position of graphics cross-hair cursor.
- CAPS LOCK indicator light. Indicates the caps key is in the upper-case condition.

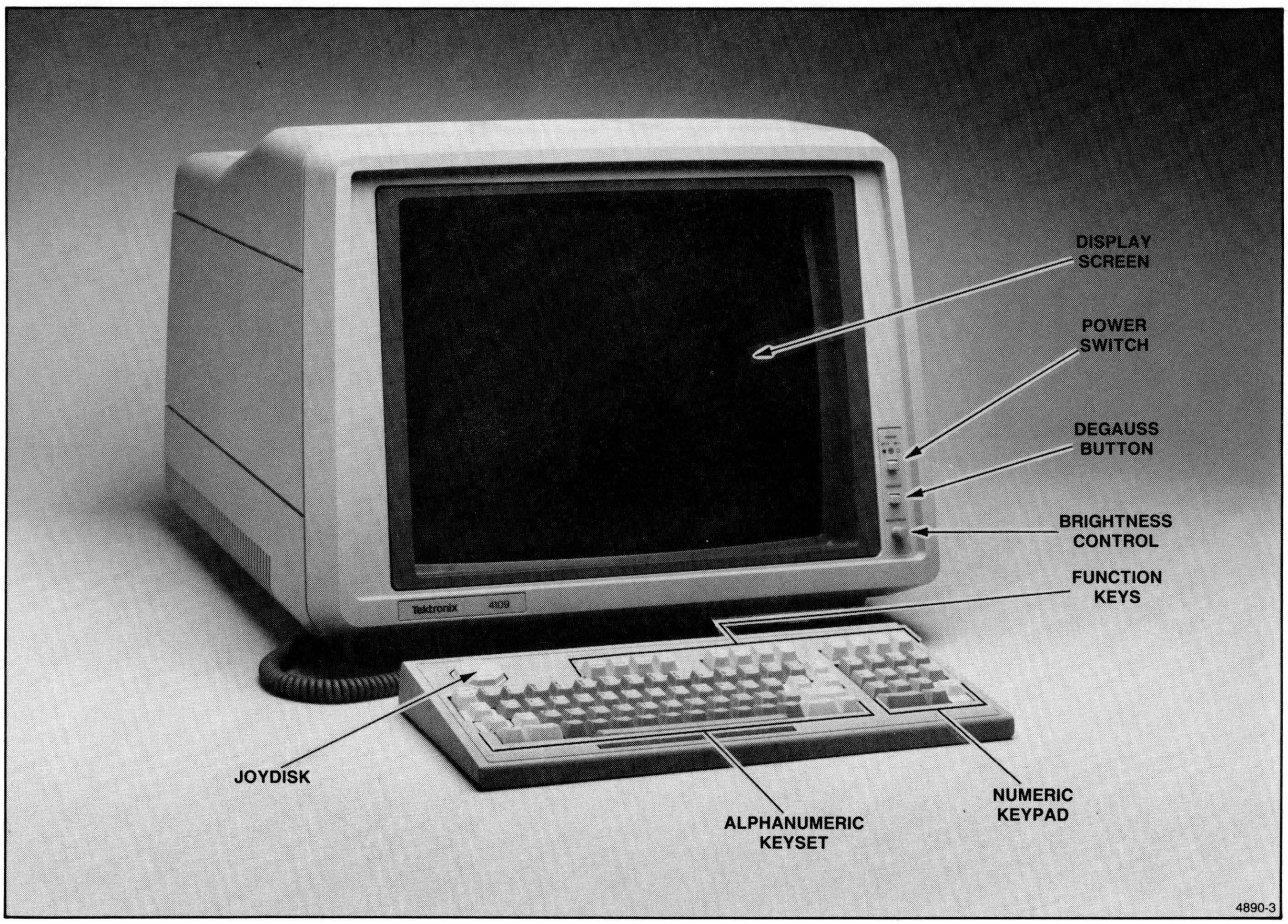


Figure 1-4. Front Panel Features.

The CX keyboard contains these key groupings (see Figure 1-5):

- Alphanumeric EBCDIC[1] keyset. Standard and IBM keys.
- System Control keys.
- Editing keys and Cursor Control keys.
- Terminal Control keys.
- Function keys.
- Program Function keys with Numeric Keypad.

[1] Extended Binary Coded Decimal Interchange Code.

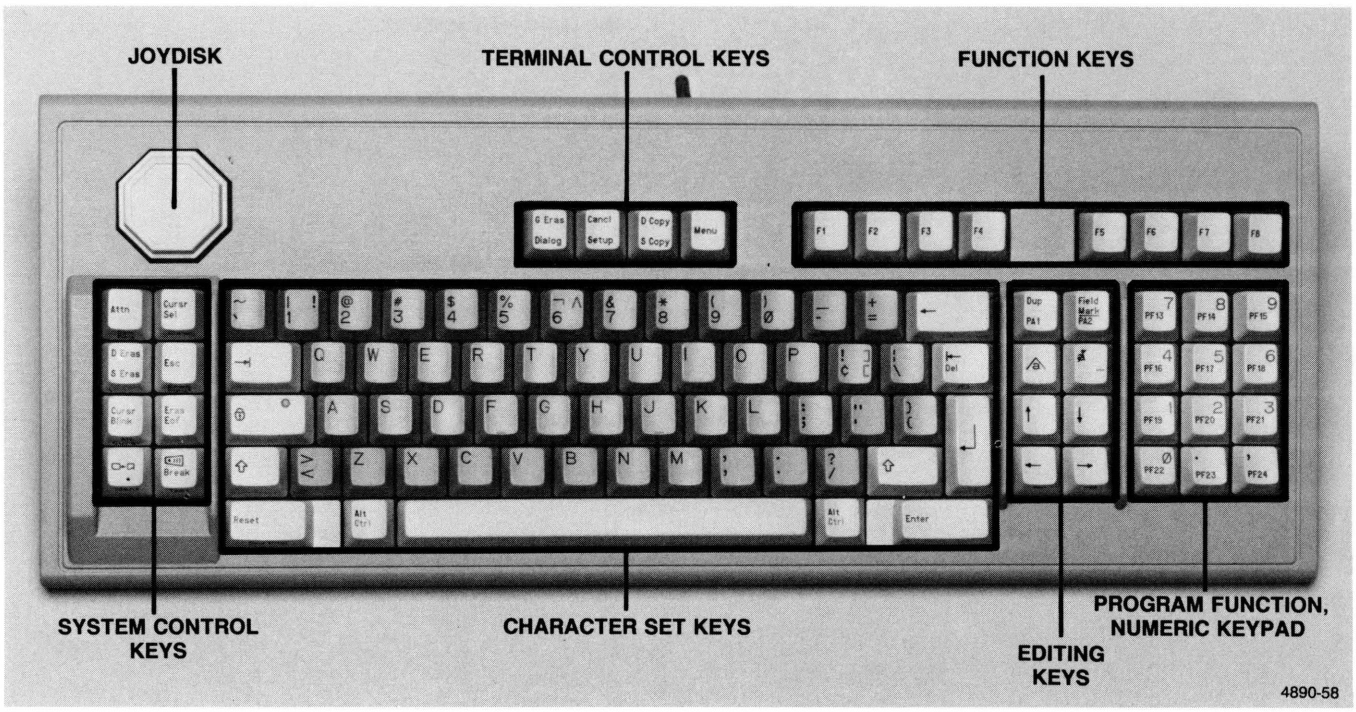


Figure 1-5. CX Keyboard Layout.

Rear panel features are (see Figure 1-6):

- AC power connector.
- Line voltage selector switches. Selects either 115V or 230V mains. Both switches must read same voltage.
- COPIER connector. Accepts connecting cord from Tektronix copier or printer.
- COMPUTER connector. Accepts an RS-232 cable from the host system.
- COMM connector. Accepts coax cable from an IBM Control Unit and host. (CX terminal only.)
- 2PPI connectors. Accepts RS-232 cables to two peripheral devices.
- KYBD connector. Accepts the 5-pin DIN connector on the keyboard cord.
- SELF TEST switch. This push-button activates the Self Test diagnostic program inside the terminal.
- RESET switch. This push-button resets the operating parameters to their default settings.
- RED, GREEN, and BLUE connectors. These BNC connectors supply three video signals for an external monitor. These outputs provide a 60 Hz non-interlaced video signal (shutting off the internal display).

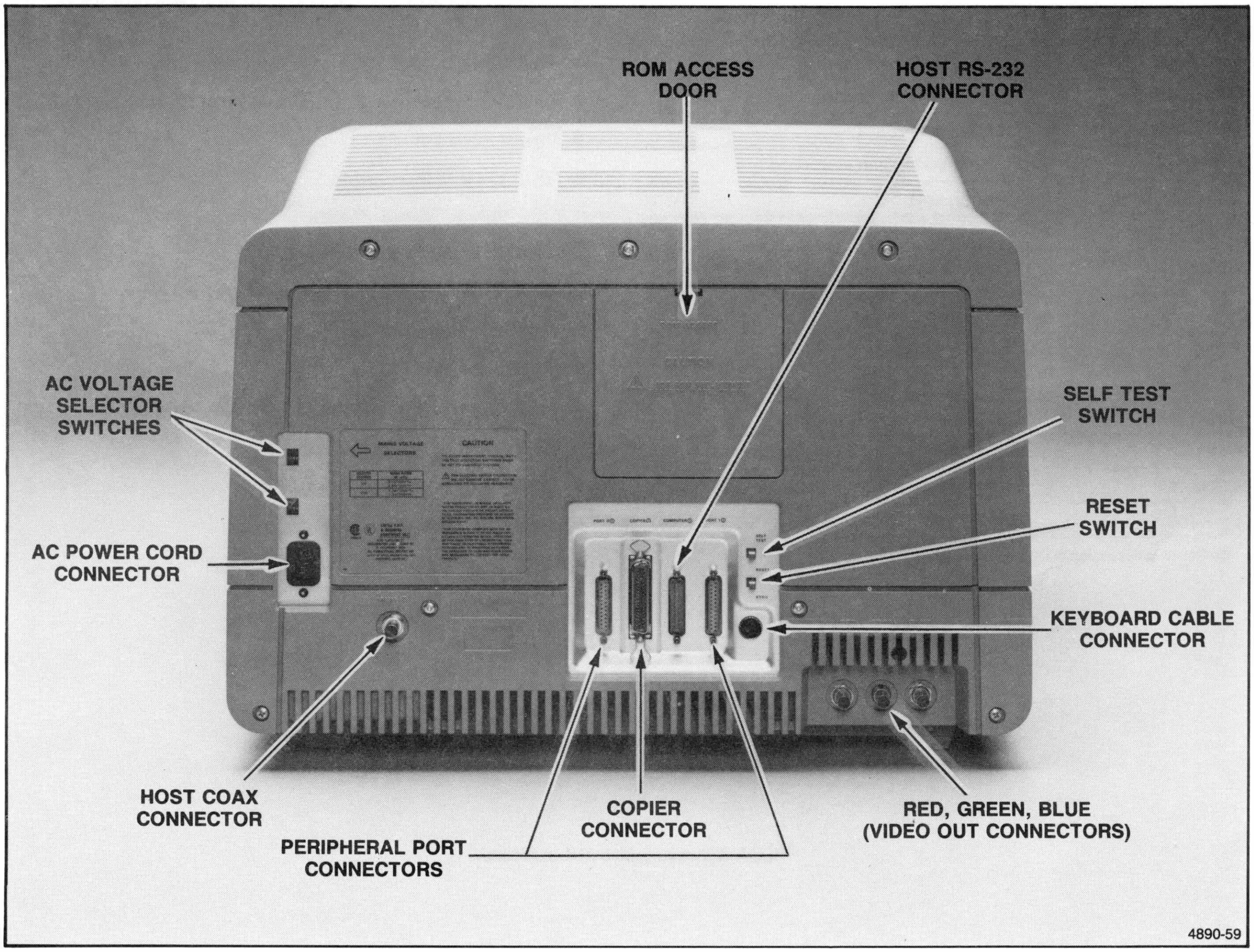


Figure 1-6. Rear Panel Features.

The terminal also contains a bell indicator that functions with Self Test and also acts as a prompt from the host.

Section 3, Operating Information, provides more detailed information about the controls and indicators.

OPTIONS

Table 1-1 lists the terminal's options in numerical order. Option numbers beginning with an alpha designation are grouped at the end of the table.

Table 1-1

TERMINAL OPTIONS

Option #	Description
Option 4A	United Kingdom keyboard option
Option 4B	French keyboard option
Option 4C	Swedish keyboard
Option 4F	Danish/Norwegian keyboard
Option 4G	German keyboard
Option 4K[1]	Katakana Keyboard
Option 21	Provides a total of 1 Megabyte of processor memory (RAM4 board) in 4109A only.
Power Cord Options:	
Option A1	European Power Cable (220V)
Option A2	U.K. Power Cable (240V)
Option A3	Australian Power Cable (240V)
Option A4	North America Power Cable (240V)
Option A5	Swiss Power Cable (240)

[1] **Option 4K is not available with CX terminals.**

ACCESSORIES

These accessories are listed in the mechanical parts list (Section 14) where part numbers are given for each item. Standard accessories are supplied with each terminal, and optional accessories may be ordered separately, and in addition to, standard accessories.

Standard Accessories

- *4106/4107/4109/CX Operators Manual* or *CX4100 Series Operators Manual*
- *An Introduction to Computer Color Graphics*
- *4106/4107/4109/CX Programmers Reference Guide*
- *CX4100 Series Host Support Manual* (with CX terminals only)
- Keyboard (detached item with connecting cable)
- Keyboard overlays (bound inside the Operators Manual)
- Power cord set
- RS-232 Host Port cable

Optional Accessories

- *4106/4107/4109/CX Programmers Reference Manual*
- *4109/CX Service Manual*
- *Display Module for the 4109, Service Manual*
- *4107A and 4109A Option 21 Service Manual*
- RS-232 loopback connector
- Copier Port loopback connector
- Display screen alignment graticule

Section 2

SPECIFICATION

This characteristics/specification section lists two different types of specifications: those that are classified as environmental, physical, or "static" specifications (specifications that cannot be verified by the user); and those that are actual operational parameters (specifications that are user verifiable). Use the checks and adjustment procedures in Section 5 to verify the user–verifiable specifications. (User–verifiable specifications are listed only in Tables 2-4 and 2-5.)

The following terms are used in these specification tables:

Characteristic: A property of the product.

Supplemental Information: Statements that describe typical performance for characteristics of secondary importance that are not usually verified by the manual's Performance Check Procedure, or statements that further explain related performance requirements.

CHARACTERISTICS/SPECIFICATION

The remainder of this section summarizes characteristics and performance specifications of the terminal. In order for these specifications to be achieved and to ensure proper performance, the following conditions must be met:

1. The terminal must be adjusted at an ambient temperature of 68 to 86 degrees F (20 to 30 degrees C).
2. The terminal must be operating in an environment as specified in Section 8, *Installation.*
3. A warm-up time of at least 20 minutes must precede operation.
4. The terminal power source must meet specified power requirements. See Section 5, *Checks and Adjustments,* and refer to Table 2-5 (Power Supply Specification). The terminal is designed to be operated from a power source with its neutral line at or near ground potential. It is not intended for operation from two phases of a multiphase system.

The following tables contain specifications and characteristics for the terminal.

Table	Description
2-1	Physical Dimensions
2-2	Electrical Specification
2-3	Environmental Specification
2-4	Display Module Electrical Specification
2-5	Power Supply Module Electrical Specification
2-6	Installation Requirements
2-7	Graphics Characteristics
2-8	Alphanumeric Characters
2-9	Communication Performance
2-10	Processor Memory Map

Table 2-1

PHYSICAL DIMENSIONS[a]

Characteristic	Performance Requirement
Weight	80 lbs (36.4 kg)
Length	22.2 in (564 mm)[b]
Width	21.8 in (554 mm)
Height	16.9 in (429 mm)
Display Area	'19V': 14.1 x 10.5 in (357 x 268 mm)

[a] These specifications do not include the Keyboard.
[b] Does not include COMM connector on back of CX4109.

Table 2-2

ELECTRICAL SPECIFICATION

Characteristic	Performance Requirement
Nominal Input Voltages:	
115V	87—128V,
230V	174—250V
Max. Input Power	320 W
Frequency Range	48—66 Hz
Fuse	4 A Slow-blow

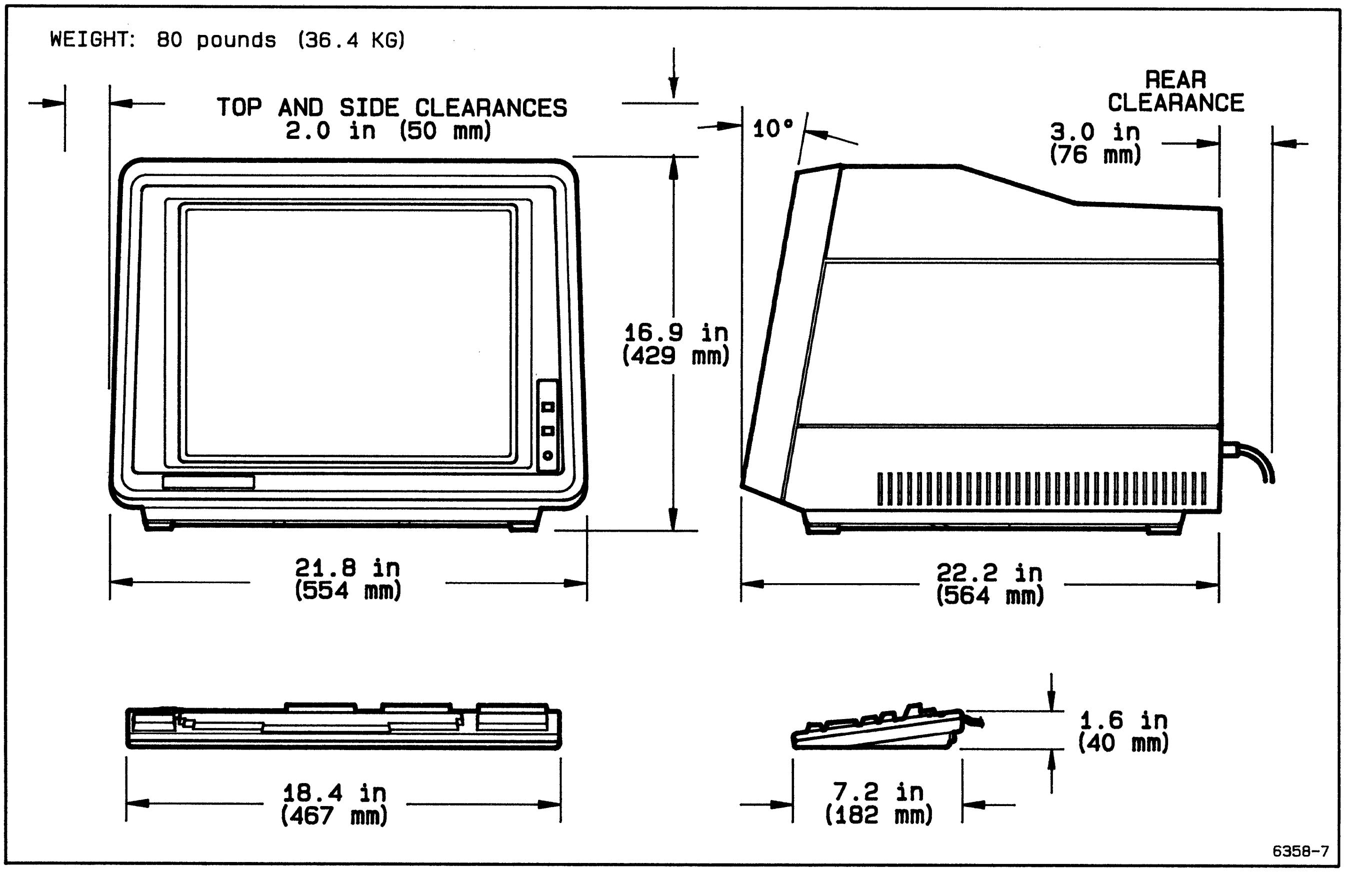


Figure 2-1. 4109 Physical Dimensions.

Table 2-3

ENVIRONMENTAL SPECIFICATION

Characteristic	Performance Requirement
Temperature	
Operating	+50 to +104° F (+10 to +40° C)
Nonoperating	−40 to +149° F (−40 to +65° C)
Altitude	
Operating	To 15,000 ft (4,575 m)
Nonoperating	To 50,000 ft (15,250 m)
Humidity	
Operating	10 to 75% rel. hum. (non–cond.)
Nonoperating	10 to 95% rel. hum. (non–cond.) Allow a four-hour drying out period, after worst-case storage conditions.
Vibration	Withstands 0 to .015 in displacement, at 10 to 55 to 10 Hz (all 3 major axes)
Shock	Main cabinet withstands a 20–g shock to all faces.
Electrostatic Immunity	
Operating	No interruption of operation, loss of data, or change of operating mode from 15 kV discharge.
Nonoperating	No damage to terminal from 20 kV discharge.

NOTE

Table 2-4 pertains only to the GMA301-type Display Module. The corresponding specifications for the 119-2023-00 Display Module are listed in the service manual for that unit.

Table 2-4

GMA 301 DISPLAY MODULE ELECTRICAL SPECIFICATION

Characteristic	Performance Requirement	
Power consumption	150 Watts (nominal)	
Vertical frequency	60 Hz (nominal) 59.97 Hz (+/–.05%)	
Active displayed lines per vertical scan	480 lines	
Horizontal pixel count per line	640 pixels	
Horizontal frequency	31.5 kHz (+/–.05% of nominal rate)	
Horizontal blanking time	6.35 µs	
Vertical blanking time	1.43 ms	
Linearity	better than +/–5%	
Sync Pulse Timing (Horizontal):	Pre-CX	CX and Later
H front porch	.79µs	.79µs
H sync pulse	2.86µs	2.86µs
H back porch	2.70µs	2.70µs
(Vertical):		
V front porch	285.7µs	222.2µs
V sync pulse	190.5µs	190.5µs
V back porch	952.4µs	1015.9µs
Phosphor	P22 medium-short persistence	
Luminance	20 ft-lamberts (for "white")	

NOTE

A slight moire effect may be visible on the screen under some lighting conditions. This effect is allowed; not out of spec.

Table 2-5

POWER SUPPLY MODULE ELECTRICAL SPECIFICATION

Characteristic	Performance Requirement
+ 5.1 V secondary:	
• Accuracy–	+/–3% nom. V @ 8.8A load,
• Regulation–	within 6% of nom. voltage,
• Rated full load current–	9 A,
• Minimum load current–	1 A
+ 12 V secondary:	
• Accuracy–	+/–0.5 V @ 350 mA load,
• Regulation–	+/–20% of nom. voltage,
• Rated full load current–	650 mA
• Minimum load current–	0 A
- 12 V secondary:	
• Accuracy–	+/–0.5 V @ 100 mA load,
• Regulation–	+/–20% of nom. voltage,
• Full load current–	650 mA
• Minimum load current–	0 A
+ 21 V secondary:[a]	
• Accuracy–	+/–0.5 V @ 20 mA load,
• Regulation–	+/–20 to 22 V,
• Full load current–	20 mA
• Minimum load current–	0 A

[a] **The later version 4109, and the CX4109, power supplies do not contain this +21V supply.**

Table 2-6

INSTALLATION REQUIREMENTS

Characteristic	Supplemental Information
Heat dissipation:	
Typical	684 BTU/hr
Max load	900 BTU/hr
Surge Current	45 A (typical) @ turn on
Cooling clearance	3 inches rear 2 inches top and sides
Distance from EMI sources	Terminal's display should be as far removed from motors, fans, or other electromagnetic devices as possible.

Table 2-7

GRAPHICS CHARACTERISTICS

Characteristic	Supplemental Information
Resolution	640 horizontal by 480 vertical resolvable pixels.
Addressability	4096 x 4096 points.
Graphics Command Syntax	Compatible with 4100- and 4010-style escape syntaxes.
Line Types	Solid, Dashed, Erase.
Graphics Primitives	Vectors, panels (polygons), and text
Number of Colors available	In graphics region, 16 colors, selected from 4096 possible color mixtures. In the dialog area, another 8 colors selected from the same 4096 possibilities.
Interactive Graphics	Joydisk (on the keyboard) controls a cross-hair graphic cursor.

Table 2-8

ALPHANUMERIC CHARACTER SETS

Character Set	Supplemental Information
Standard Character Set	Full ASCII character set. 95 displayable characters (counting "space" as a displayable character) In "Snoopy mode" all 128 characters are displayable. The graphic representations of control characters conform to ANSI x3.32.
Supplementary Character Set	This set is 94 special characters (rulings, math symbols, etc.) accessible via the SO (Shift Out) control.
Optional Character Sets	United Kingdom (Option 4A) French (Option 4B) Swedish (Option 4C) Danish/Norwegian (Option 4F) German (Option 4G) Katakana (Option 4K)
Character Format	80–columns x 32–line screen display 7 x 9 dot matrix in a 8 x 15 character cell (with descenders)

See Appendix E for details.

Table 2-9

COMMUNICATION PERFORMANCE

Characteristic	Supplemental Information
Alphanumeric (only) communications rate	38.4 kBaud (without H/W flagging) (RS-232 only)
Simple (line) graphics communications rate	19.2 k Baud (without H/W flagging) (RS-232 only)
Two Port Peripheral Interface (2PPI)	2 RS-232 ports, communicates with RS-232 peripheral devices such as plotters or graphics input tablets 19.2 kBaud maximum (without H/W flagging)
Hard Copy Interface	Hard copy device such as the Tektronix 4695 Centronics-style parallel interface
Video Output	60 Hz noninterlaced RGB video at RS-170 levels, sync combined with green
IBM Coax communications parameters (CX 4109 only)	Set by the device characteristics of the Control Unit. See Appendix F.

Section 3

OPERATING INFORMATION

This section provides a familiarization procedure intended to help the service person exercise the terminal and get acquainted with its overall operating characteristics. You should have a general idea of how the terminal behaves, from the operator's point of view, before attempting any extensive troubleshooting.

You should use this section when performing on-site troubleshooting. First, run Extended Self Test (Appendix C). Then, if problems persist, this may indicate improper use of the terminal. By working through this familiarization procedure, you may determine whether or not the terminal functions as expected.

NOTE

The terminal must be installed before you can complete the exercises in this session. If it has not been installed, see Section 8 before you continue. The terminal should NOT be on-line to a computer during the session.

This section contains six short exercises designed to help you learn about the terminal before you log on to a host computer.

- Exercise 1 introduces Setup mode and some of the Setup commands.
- Exercise 2 shows how to create graphics from the keyboard. It introduces some of the graphics concepts used by the terminal.
- A short discussion of the Menu key and the use of programmed keys for viewing functions and for the color interface precedes the following exercises.
- Exercise 3 shows how to modify color definitions from the keyboard with the terminal's interactive *color interface*.
- Exercise 4 introduces views, the viewing keys, and the *zoom* and *pan* functions.
- Exercise 5 introduces GIN (Graphics Input).
- Exercise 6 shows how to program keys.

Please allow about one hour to complete this session. Exercises 1 through 4 should be done in sequence, and at one sitting if possible, since each exercise assumes that the terminal is just as the previous exercise left it. If you do any exercise independently of the others, first give the **FACTORY** command (see Exercise 1); this will set up the terminal so the exercise will work as described here.

You will find information about some of the commands in these exercises in the *Setup Commands* section of the terminal's operators manual. Details on all terminal commands are found in the *4106/4107/4109/CX Programmers Reference Manual.*

NOTE

Several steps in the following exercises tell what your alternatives are BEFORE telling what action to take. Be sure to read each step all the way through before you take any action.

EXERCISE 1: SETUP MODE

Setup mode allows you to give English-style *Setup commands* from the keyboard to set a variety of terminal parameters. This exercise acquaints you with Setup mode and how to enter Setup commands.

To enter a Setup command, type the command name followed by a space, then enter any parameters (separated by spaces), then press the Return key. All command names have been spelled out in the examples, but you can abbreviate a command name to as few characters as necessary to distinguish it from other commands (usually two or three characters).

If you make a mistake typing a command, use the Rub Out key to erase characters, one by one, back to the error, then complete the command in correct form. Or you can enter Ctrl-X (hold down the Ctrl key and press X) to erase the entire line, then reenter the correct command. If you have already pressed Return, you will probably get an error message. Just reenter the command in the correct form.

1. Press the POWER switch on the front of the display unit to turn the terminal on. In a few seconds a blinking cursor (an underline) appears on the screen. If you don't see the cursor, adjust the BRIGHTNESS knob just below the POWER switch.

   When the terminal is first turned on, the entire screen is defined as the *dialog area*. This area is used to display your conversations with the terminal (and later, with the computer).

   Press the Setup key (located at the top of the keyboard) to put the terminal in Setup mode. An asterisk appears at the left margin, next to the cursor. This is the Setup mode prompt; it tells you that the terminal is waiting for your input.

   To make sure that the exercises will work as described, type in the following command after the Setup prompt, then press the Return key:

   FACTORY

   This resets all terminal operating parameters to their factory settings, erases the screen, and removes the terminal from Setup mode. Now press the Setup key again to return the terminal to Setup mode.

   You can return these parameters to their powerup values for the convenience of the next user or to run an applications program by doing any of the following:

   - Turn the terminal off, then back on again.
   - Press the RESET button on the rear of the terminal.
   - Enter the RESET command in Setup mode. (This command, like FACTORY, removes the terminal from Setup mode.)

   All commands and messages in this session are shown in upper case; to make your entries match the displays, press the Caps Lock key (at the lower left corner of the keyboard). All alphabetic characters will be displayed as capitals; numerals and other characters are not affected.

2. One of the things you can do in Setup mode is change the colors used in the dialog area. Each color is identified by a number called a *color index* (more on this in Exercise 3). The DAINDEX (Dialog Area Index) command selects the dialog area colors. Enter the following command. (Be sure to enter a space before each number. Also remember to press Return to end the command.)

   DAINDEX 1 2 4

   This command changes the dialog area colors to white letters (color 1) in red character cells (color 2) on a blue background (color 4). Note that the part of the dialog area below the * changes to blue. All new information in the dialog area will be in the new colors. At this point you may want to adjust the BRIGHTNESS knob, just below the POWER switch, for best viewing.

3. The STATUS command is another useful command. If you forget a terminal setting, or if the terminal behaves unexpectedly, the STATUS command can often help. This command has several forms. The form **STATUS command-name** gives you the status of parameters set with the given command. For example, enter:

   STATUS EDITCHARS

   The following message is displayed, showing the terminal's three *editing characters*:

   EDITCHARS. . . . . ▨ $^{C}{}_{N}$ ~

   The ▨ symbol indicates that ASCII Delete is the *character-delete* character. Pressing Rub Out generates an ASCII Delete character, which deletes the character just to the left of the cursor. To illustrate, type a few characters, *but don't press Return*. Instead press Rub Out several times to erase the characters and backspace the cursor to the * prompt.

   The $^{C}{}_{N}$ symbol indicates that ASCII Cancel is the *line-delete* character. Enter several characters, *but don't press Return*. Instead, enter Ctrl-X to generate an ASCII Cancel character, which erases the line you just typed.

   The ~ character is the *literal character*. The use of this character is explained in Exercise 6.

4. Now enter the following command:

    STATUS

    This lists all the Setup commands that set terminal parameters, and the current parameter settings.

5. Press the bottom of the *joydisk* (at the upper left of the keyboard) to scroll the list down. Notice that you can't scroll clear to the beginning of the message. The message is too long to fit in the dialog area's memory, so part of the message has been lost.

    Now press the top of the joydisk to scroll the list back up.

6. One way to avoid losing output in this way is to use *Ctrl-S* and *Ctrl-Q*. Enter the command **STATUS** again, but quickly enter Ctrl-S to halt output of the Status message. Then enter Ctrl-Q to start printing the message again. With a bit of practice at finding these keys, you can stop and start output whenever you want.

    You can also increase the number of lines in the *dialog buffer* — the part of terminal memory used to store information displayed in the dialog area. For example, enter the commands:

    DABUFFER 200
    STATUS

    Now you can scroll clear to the beginning of the Status message.

7. Notice that the complete Status message is divided into functional categories. One category is titled **DIALOG**, since it lists information about the dialog area. Enter the command:

    STATUS DIALOG

    This displays just the entries under the **DIALOG** heading (Figure 3-1). Note the line:

    DAINDEX. 1 2 4

    Here you see the dialog area color indices that you set in Step 2.

8. Finally enter:

    STATUS ED

    This displays all commands that begin with the character string ED (there are two of them). You can enter this form of the STATUS command with any character string to display the status of commands that begin with the given string.

9. Press either S Eras or D Eras (the shifted version of S Eras) at the upper left of the typewriter portion of the keyboard. Since the dialog area takes up the entire screen, either key erases the dialog area.

You have now learned how to enter Setup mode, how to modify terminal parameters, and how to find the status of these parameters. *Without making any changes to what you have done*, proceed to Exercise 2.

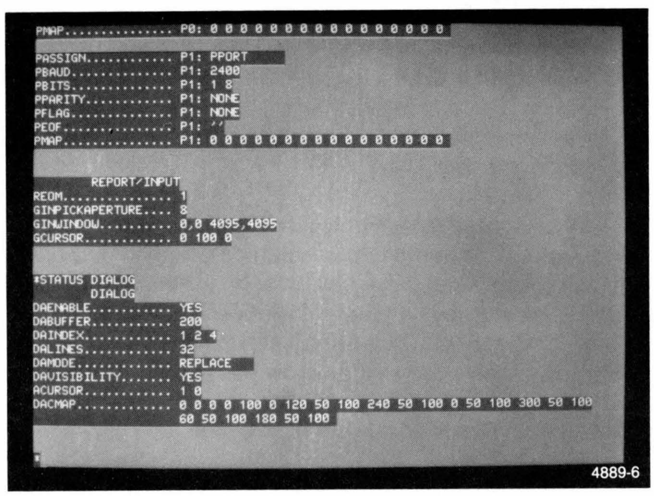


Figure 3-1. Dialog Area Display.

EXERCISE 2: ENTERING LOCAL GRAPHICS

Normally graphic displays are created by a host software package. In this exercise, however, you will create a graphic display from the keyboard. This exercise illustrates a few of the graphics capabilities of the terminal, and also prepares a display for Exercises 3 and 4.

To do this procedure, the terminal should be as you left it at the end of Exercise 1 (the terminal must still be in Setup mode).

1. Enter the following commands:

   DAINDEX 0 3 3
   DALINES 5

   The first command changes the dialog area colors to black text on a green background (both character cell and dialog background colors are set to color 3). The **DALINES 5** command sets the dialog area to the bottom five lines of the screen. The remainder of the display can now be used as the *graphics area.*

Two graphics concepts used by the terminal are those of *panel* and *segment.*

A *panel* is simply a closed polygon with one or more boundaries; examples are triangles, rectangles, outlines of buildings, etc. In terminal graphics a panel is normally used to represent one object: a house, a window on a house, a circuit board element, or a bar on a graph are just a few examples. Simple commands allow you to create a panel and fill the interior of the panel with a color or a pre-defined *fill pattern.* (You will do this in this exercise.)

A *segment* is a collection of one or more graphics objects, treated as a single unit. Often a segment is used as a kind of a subpicture. For example, on a circuit board, a block of circuit description might be defined as a segment. A segment, even though it consists of several distinct graphic objects, can be manipulated as a unit. A single command can be used to move, copy, rotate, or scale the segment, or to set segment *attributes* as keys for other types of graphic operations.

Segments, panels, and other graphics concepts are discussed in detail in the *4106/4107/4109/CX Programmers Reference Manual.*

2. Enter the following sequence of commands exactly as shown. (If you should make an error entering the commands, enter **SGCLOSE**, then **SGDELETE 1**. This will delete the segment; then you can reenter the correct commands.)

   SGOPEN 1
   FILLPATTERN -4
   BEGINPANEL 500 1000 1
   DRAW 2000 1000
   DRAW 2000 2500
   DRAW 500 2500
   ENDPANEL
   SGCLOSE

   The **SGOPEN** command opens a definition for segment number 1. All graphics commands until an SGCLOSE command (to close the segment definition) will define parts of segment 1.

   The **FILLPATTERN** command sets a *fill color* or *fill pattern* to fill the interior of each panel you define. This particular command sets the fill pattern to –4, which specifies color index 4 (deep blue).

   BEGINPANEL begins a *panel definition.* The first vertex of the panel is at the point with xy-coordinates (500,1000). The final parameter of 1 specifies that the border of the finished panel will be displayed, rather than covered by the fill pattern.

   The **DRAW 2000 1000** command draws a vector (line segment) from the previous vertex (500,1000) to the point (2000,1000). You will see this vector drawn as soon as you enter the command. Each DRAW command draws a vector from the previous point to the point with the specified xy-coordinates.

   ENDPANEL draws the last side of the panel, fills the panel with blue, and outlines it; **SGCLOSE** closes the segment definition. The display now looks like Figure 3-2.

3. Now open a segment definition for segment 2 and draw a red star inside the box with the following sequence of commands:

   SGOPEN 2
   FILLPATTERN -2
   BEGINPANEL 850 1250
   DRAW 1250 2300
   DRAW 1650 1250
   DRAW 650 1900
   DRAW 1850 1900
   ENDPANEL

   The display now looks like Figure 3-3. The middle of the star is open due to the way in which the boundary of the star intersects itself.

4. Now enter the following sequence of commands:

   FILLPATTERN 6
   BEGINPANEL 2500 1000 1
   DRAW 3500 1000
   DRAW 3500 2500
   DRAW 2500 2500
   ENDPANEL
   SGCLOSE

   A rectangle is drawn beside the blue square and filled with pattern 6 (Figure 3-4). (There are several dozen fill patterns available. You will have a chance to explore these in Exercise 6.) The final command closes the definition of segment 2. Note that this segment contains both the star drawn in Step 3 and the rectangle filled with the brick pattern drawn in this step.

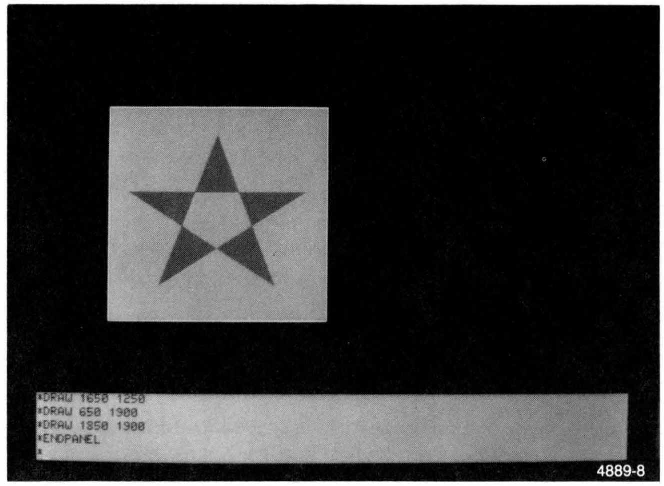


Figure 3-3. Box With Star.

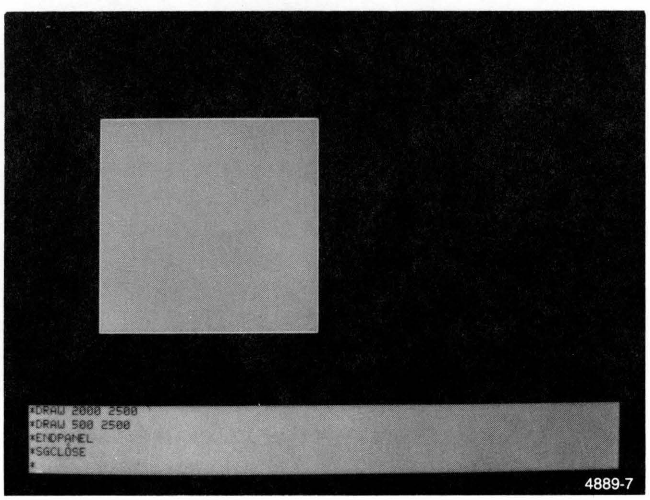


Figure 3-2. Display of One Segment.

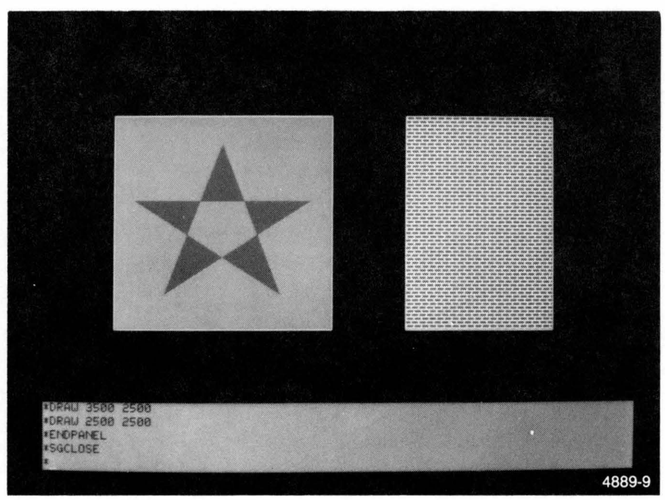


Figure 3-4. Completed Graphic Display.

5. Now let's explore some of the properties of segments. First, enter the following commands:

   FILLPATTERN 15
   BEGINPANEL 400 2600 1
   DRAW 3600 2600
   DRAW 2000 3000
   ENDPANEL

   Since no segment definition is open, this triangle is not part of a segment definition. Now press G Eras (Shift-Dialog) and note carefully what happens. The entire screen is momentarily erased, *but segments 1 and 2 are redrawn.* Information that is not part of a segment (the triangle, in this case) is lost, while segments are retained.

6. Segments can also be manipulated in various ways. For example, you can make a segment invisible. Enter the command:

   SGVISIBILITY 2 NO

   The star and brick wall that comprise segment 2 disappear; they are still defined in terminal memory, but are now invisible (Figure 3-5). Now give the command:

   SGVISIBILITY 2 YES

   and segment 2 reappears.

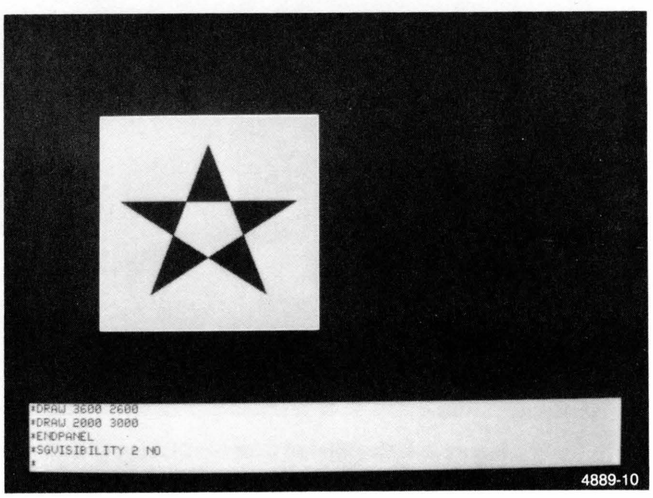


Figure 3-5. Display With Segment 2 Invisible.

7. Segments can also be made to blink on and off as a means of visual enhancement. To illustrate this, enter the command:

   SGHIGHLIGHT 2 YES

   Segment 2 begins to blink on and off. Now give the command:

   SGHIGHLIGHT 2 NO

   The blinking stops, and the display in Figure 3-4 is left on the display.

8. There are several types of segment transformations. To illustrate, enter the following command:

   SGTRANSFORM 1 1 –2 1 –2 0 0 2500 1500

   The blue square is erased and redrawn in a different size and at a different location. Note that the red star is also erased. Just press G Eras; all segments are redrawn, including the red star which is part of segment 2. (Figure 3-6).

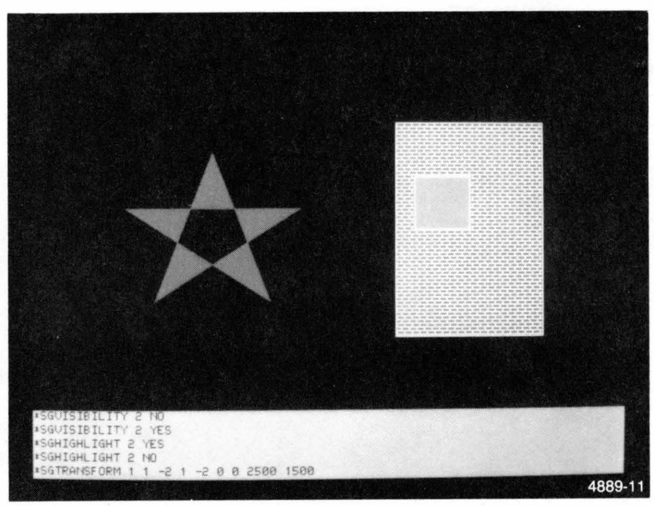


Figure 3-6. Display With Transformed Segment.

9. The SGTRANSFORM command can also change the x- and y-scales independently to alter the aspect ratio, and can rotate segments. For example, enter the following:

   SGTRANSFORM 1 1 -1 1 -4 75 0 1000 1800

   Now press G Eras to redraw the display. Segment 1 is now only one eighth as high as it is wide, and it has been rotated 75 degrees from the horizontal (Figure 3-7).

   Now return segment 1 to its original size and position with the command:

   SGTRANSFORM 1 1 0 1 0 0 0 0 0

   Note that the blue square now covers the red star. To change the display priority so the star is visible, give the commands:

   SGVISIBILITY 2 NO
   SGVISIBILITY 2 YES

A complete explanation of the SGTRANSFORM command is included in the Programmers manual. The examples here are given without explanation of the parameters, and are just to illustrate some of the graphics capabilities of the terminal.

There are many other segment operations that the terminal can perform. These include copying one segment into another segment definition, and grouping segments together into *matching classes* so that all the segments in a class can be treated by a single command. The complete set of segment operations and the complete graphics capabilities of the terminal are discussed in the Programmers manual.

Now let's look at the relationship between the graphics area and the dialog area.

10. Occasionally you may want to examine more than five lines of dialog area at a time. You can increase the size of the dialog area so that it covers all or part of the graphics area, without destroying any graphics.

    To illustrate, increase the size of the dialog area to 22 lines by entering:

    DALINES 22

    Notice that the dialog area now covers most of the graphics area.

11. Press the Dialog key. The dialog area disappears and the complete graphics display is visible. Press the Dialog key again and the dialog area reappears.

12. Now give the following commands:

    DAINDEX 3 0 0
    STATUS C

    The display now looks like Figure 3-8. The command **DAINDEX 3 0 0** sets the dialog text color to color 3 (green) and the character cell and background colors to *transparent*. As the Status message scrolls up, notice that the graphics display shows through the dialog area background as though the dialog background were a pane of clear glass.

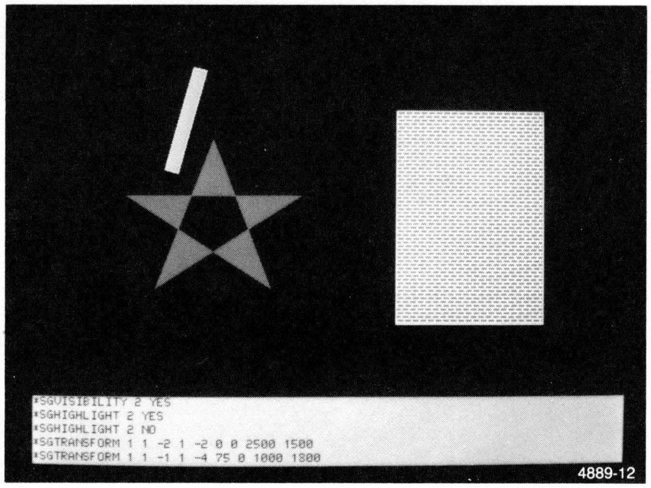


Figure 3-7. Display With Segment Scaled and Rotated.

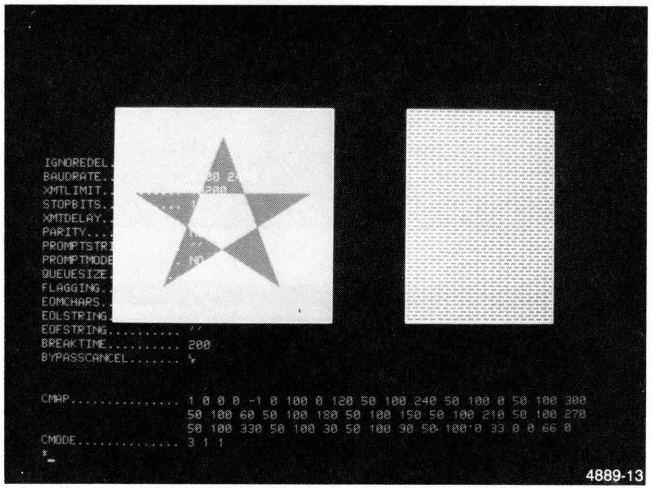


Figure 3-8. Display With Transparent Dialog Area.

13. Finally, set the dialog area back to 5 lines by entering:

DALINES 5

You are now ready to explore the use of the Menu key. The following discussion explains menu operation in general. Then Exercises 3 and 4 show how to use the color interface to modify the colors on the display, and how to use the viewing keys. Without making any changes to what you have done, read *The Menu Key*, then proceed to Exercise 3.

THE MENU KEY

In the middle of the row of function keys along the top of the keyboard is a key labeled *Menu*. This key gives you access to two sets of terminal functions:

- The color interface. This allows you to modify the colors displayed on the screen just by pressing a few keys.
- The terminal's Zoom, Pan, and View features. These allow you to select portions of a graphics display for more detailed viewing.

First press the Menu key. The terminal goes into Menu mode and displays a brief menu (Figure 3-9). In Menu mode, the terminal suspends any other activities temporarily and saves any information from the host until it can be processed (that is, until the terminal leaves Menu mode).

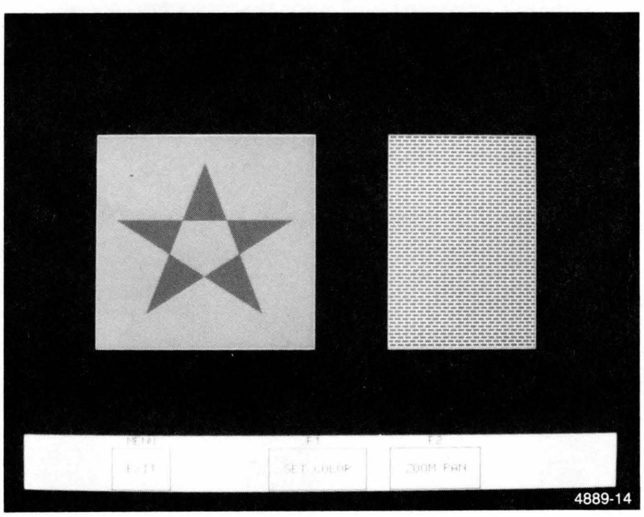


Figure 3-9. Menu Mode Display.

When you see this menu, you can do any of the following:

- Press Menu again to exit Menu mode and return to whatever the terminal was doing before you pressed Menu.
- Press F1 to activate the interactive Color Interface. Function keys F1 — F5 are programmed to modify color definitions.
- Press F2 to activate Viewing mode. Function keys F1 — F5 are programmed to perform viewing functions.

Figure 3-10 shows the mode transitions and what keys control them. In particular, note that pressing Menu in Menu mode, Viewing mode or Set Color mode returns you to "normal" terminal operation — that is, to whatever the terminal was doing before you pressed Menu.

Now press the Menu key again to exit Menu mode.

Exercise 3 explores what happens when you press F1: SET COLOR to activate the interactive color interface. Exercise 4 explores what happens when you press F2: ZOOM/PAN to activate the viewing keys menu. Without making any changes to what you have done, proceed to Exercise 3.

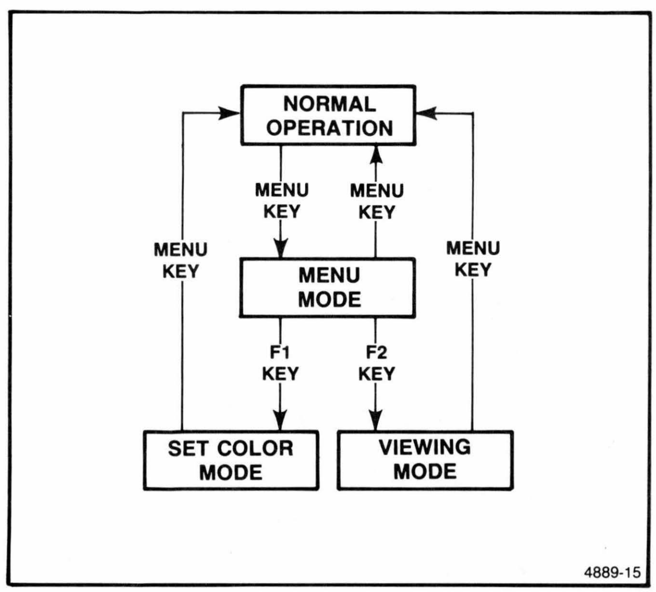


Figure 3-10. Menu Mode Transitions.

EXERCISE 3: USING THE COLOR INTERFACE

This exercise explores the terminal's interactive *color interface*. The color interface allows you to modify colors from the keyboard and to see the colors change as you modify them. Then you can keep the new colors, try others, or keep the ones you started with. Before you use the color interface, however, a bit of explanation will be helpful.

The terminal contains a *palette* of 64 distinct colors to choose from. The terminal defines each color in terms of the HLS (hue, lightness, and saturation) system of color specification, shown in Appendix F of the terminal's operators manual. With the terminal's color interface, however, you need not remember HLS parameters for the colors you want to display.

Colors for display are labeled by numbers called *color indices*. There are 16 *graphic indices* (for the graphics area) and 8 *dialog indices* (for the dialog area).

One way to change colors on the display is to change the indices. You have already done this several times. For example, the **DAINDEX 1 2 4** command in Exercise 1 set the dialog area color indices: *color 1* (or *index 1*) for text characters, *color 2* for character cells, and *color 4* for the background. Currently, color 1 is white, color 2 is red, and color 4 is deep blue.

With the color interface you can also change the actual color definition — the HLS values — assigned to any index. For example, you can change dialog index 1 from white, say, to brown. Thereafter, all text in the dialog area will be displayed in brown.

There are three ways to use the color interface to modify a color definition; for convenience these are referred to as Methods 1, 2, and 3. In this exercise you will use all three methods. First, however, let's get acquainted with the color interface itself.

Activate the Color Interface

1. Press the Menu key (located in the row of function keys across the top of the keyboard). When the menu appears, press F1 (now defined to be SET COLOR). This places the terminal in Set Color mode, activates the color interface, and displays a banner across the bottom of the screen.

   Part of the banner shows how the function keys F1 — F5 are now programmed. Set Color mode temporarily suspends any macros (special key definitions) assigned to these function keys. When you exit the color interface, the macros are automatically reassigned to the keys. (Exercise 6 shows how to program a macro into a function key.)

   Note the flashing message **Press S Eras key to erase screen and display current colors.** *DO NOT PRESS S Eras NOW.* We will explore this option later in this exercise.

2. There is a crosshair cursor centered at the bottom left of the screen. Now take a few moments to examine the white banner at the bottom of the screen (Figure 3-11). The left part of the banner indicates that the cursor is in the *dialog* area. It also displays a small square of the color under the color index (1).

   Now press the upper right of the joydisk to move the crosshair around a bit. Note that the **Press S Eras** message disappears as soon as you move the crosshair. Then move the crosshair cursor over the blue portion of the box with the star.

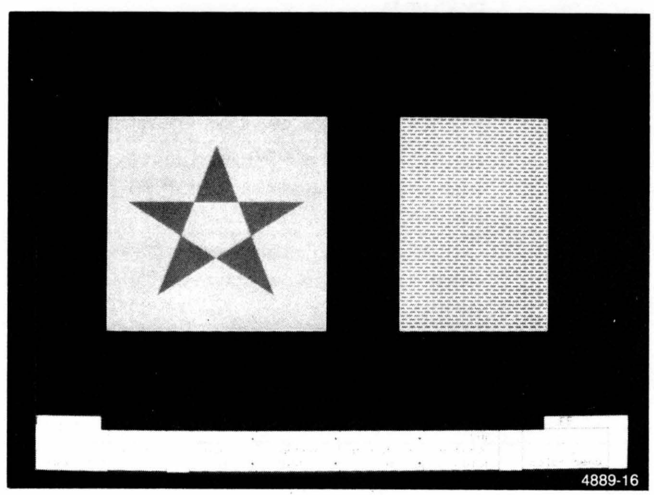


Figure 3-11. Color Interface Banner.

Note the label *Surface 1* just above the color square. This indicates that the small dot of color under the crosshair belongs to graphics surface 1. The terminal can define up to four separate graphics surfaces and use these for multilayered displays, as discussed briefly under *Features* earlier in this section. Surfaces are usually defined by the host application program, and at power-up there is always just one graphics surface defined.

The boxes labeled F1, F2, and F3 show the hue, lightness, and saturation (HLS) values for this color.

The rest of the banner shows which function keys are programmed when the color interface is active. Table 3-1 summarizes the action of the function keys.

Now press Menu to exit the color interface, and proceed to Method 1.

Table 3-1

COLOR INTERFACE KEYS SUMMARY

Key	Action
F1	INCREASE HUE. Increases hue by 10°.
Shift-F1	DECREASE HUE. Decreases hue by 10°.
F2	INCREASE LIGHTNESS. Increases lightness by 10 units.
Shift-F2	DECREASE LIGHTNESS. Decreases lightness by 10 units.
F3	INCREASE SATURATION. Increases saturation by 25 units.
Shift-F3	DECREASE SATURATION. Decreases saturation by 25 units.
F4	RESTORE COLOR. Restores the HLS values before the last cursor movement. If cursor has not moved since HLS changes, F4 restores the color; if cursor has moved, no effect.
Shift-F4	RESTORE COLOR MAP. Restores all color settings to their values before you entered Set Color mode.
F5	COLOR MENU. Displays a menu of nine predefined colors for selection via the crosshair cursor.
Shift-F5	VIEW MENU. Turns the color banner on or off. When the banner is off, the dialog area is displayed even though Set Color mode is still active.

Method 1: Modify a Displayed Color

This method allows you to modify any displayed color.

1. Press Menu, then press F1 to activate the color interface. Ignore the **Press S Eras** message. Note that the crosshair is back at the lower left corner of the screen. Move the crosshair over the blue square again.

2. The color under the crosshair (blue) has hue 0°, lightness 50%, and saturation 100%. Modify this color definition as follows:

   - Press F1 until the hue setting at the bottom of the screen reads 152°. Since the terminal's Autorepeat feature is on, you can hold the key down instead of pressing it repeatedly. If you go past 360, the hue setting just wraps around to zero.

     Note that pressing F1 *increases* the hue setting. Pressing Shift-F1 *decreases* the hue setting, with wraparound to 360 if you go past zero.

   - Now press Shift-F2 until the lightness reads 32%.
   - Leave the saturation at 100%.

3. You have redefined color 4 in the graphics area to brown, with HLS values of 152, 32, 100 (Figure 3-12). You can now do any of the following:

   - Before you move the crosshair, press F4 to restore the original color.

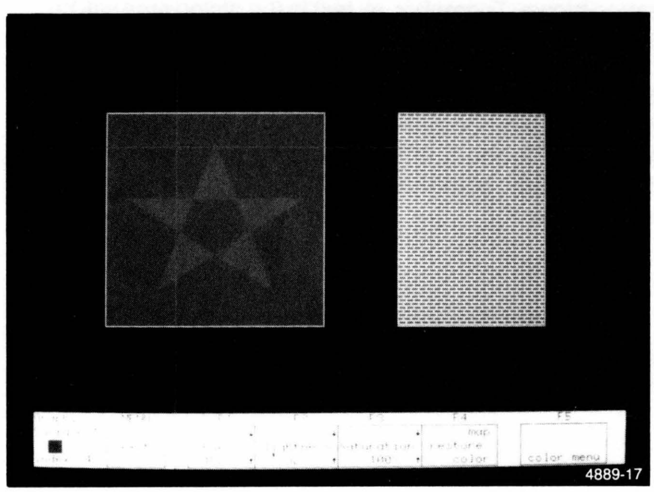


Figure 3-12. Display With Modified Color.

- Move the crosshair to another color and modify it. Note from Table 3-1 that once you move the crosshair, colors already modified are not affected by F4; however, Shift-F4 resets all colors.
- Press Menu to exit the color interface and save the modified color definition(s). These definitions are saved until you turn the terminal off or modify the colors again. (The new colors are *not* saved when the terminal is turned off.)

Now press Menu to exit the color interface and save brown (152, 32, 100) as the color definition assigned to index 4. When you exit the color interface, the dialog area reappears and the new graphics area colors remain in effect. All future occurrences of color 4 in the graphics area will be the same color as the box.

Method 2: Color Menu

Another way to modify a color is to use function key F5. This key displays a menu of predefined colors that you can select just by moving the crosshair to the appropriate color name.

1. Press Menu, then press F1 to activate the color interface. Move the crosshair to the red star.

2. Press F5 and hold it down. This displays a menu of nine color names beside the cursor (Figure 3-13A).

3. Hold down F5 and move the crosshair over the color menu. Notice that the star changes to the color whose name is under the crosshair. Move the crosshair up and down the menu. (You may also want to hold down the Shift key to slow the cursor.) Move the crosshair to the color name **olive** (Figure 3-13B). Then release the crosshair; the star remains olive.

   Notice that when you change the color of the star, the color of the brick pattern changes too. This is because the bricks have the same color index (2) as the star. When you modify one occurrence of a color in the graphics display, *all* occurrences of that color are modified.

4. Press F4 to return the star to its original color. Then press Menu to exit the color interface.

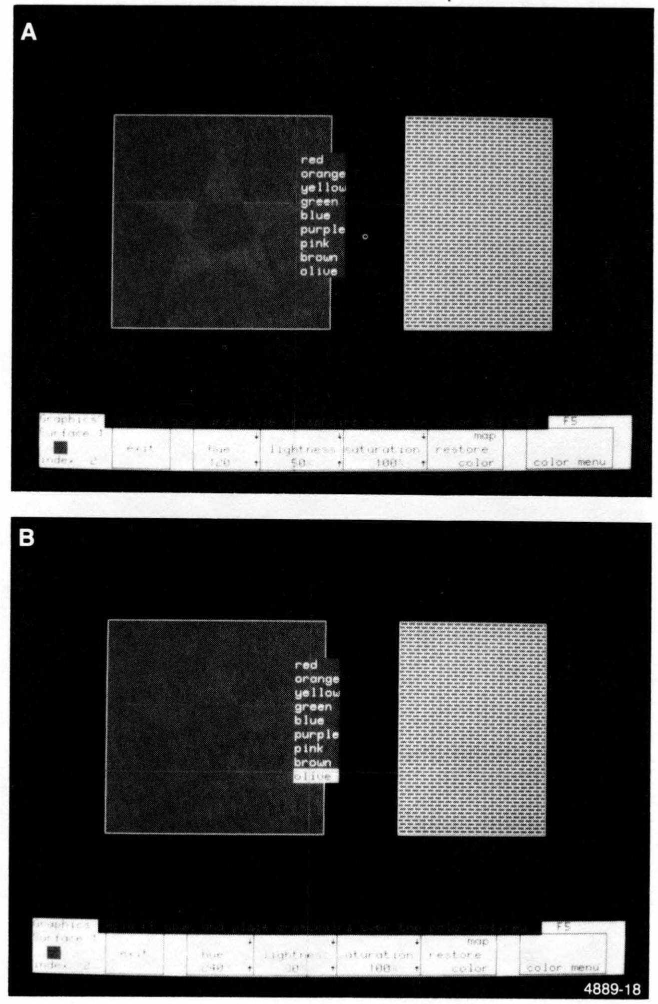


Figure 3-13. Using the Color Menu.

Method 3: Redefine the Color Map

Method 3 allows you to modify the complete *color map* (the assignment of colors to color indices).

1. Press Menu, then press F1 to activate the color interface. *Do not move the crosshair.* Instead, press S Eras and the display shown in Figure 3-14A appears. This shows the 16 graphic indices and the 8 dialog indices, along with color samples and HLS values.

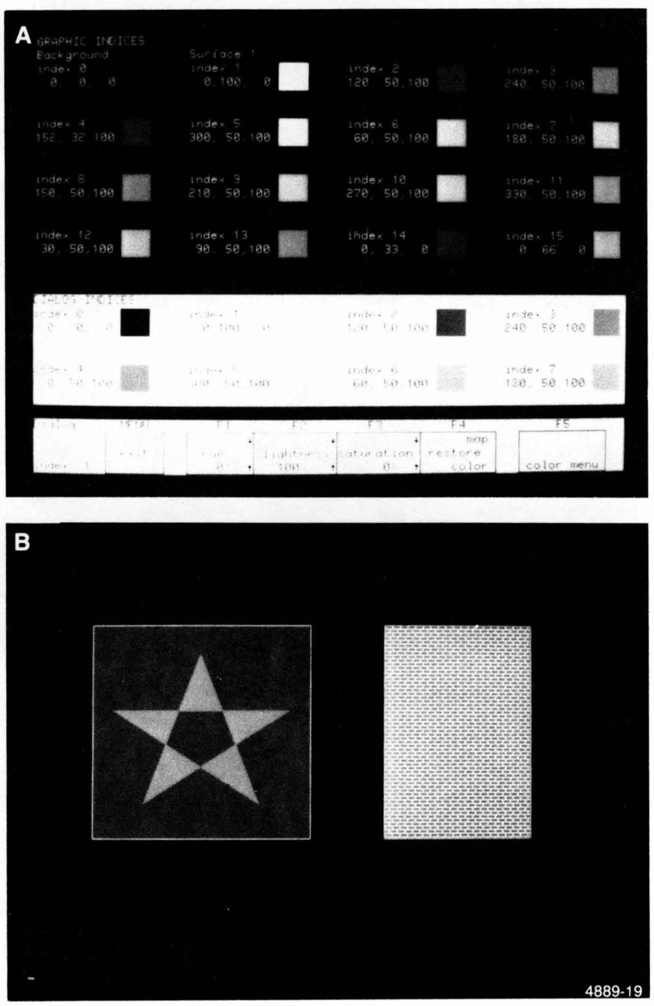


Figure 3-14. Complete Color Map.

2. Move the crosshair to the square sample of index 3 in the dialog area. Using F1, change its hue to 132. Leave the lightness and saturation unchanged.

3. Now move the crosshair to the square sample of index 2 in the graphics area. Use F1 to change the hue value to 180.

4. Now move the crosshair to index 4 in the graphics area. Press F5 and use the color menu to change index 4 to *olive.*

5. You can now do any of the following:

   - Without moving the crosshair, press F4 to restore the color you just changed.
   - Press Shift-F4 to restore *all* the previous colors.
   - Press Menu to save the new colors.

   Press Menu. The three color indices that you have just modified are saved,to their new values and the graphics display reappears.

6. Note that the new color definitions are now in effect: segment 1 (the square) is now displayed in olive, and the brick pattern in the rectangle is displayed in yellow. Now give the command:

   STATUS ED

   Dialog text is now displayed in the new dialog index 3 (Figure 3-14B).

   Look carefully at the display for a moment. Note that the bricks and the star do not appear to be the same color. Also, the reddish brown text appears almost red against the black dialog area background. How a given color is perceived depends on a number of factors, including how much of the color is displayed and the color(s) of surrounding areas. It is wise to remember this when you redefine colors.

EXERCISE 4: THE VIEWING KEYS

This exercise explores how you can control the graphic display using the terminal's viewing keys.

1. First *press Setup to remove the terminal from Setup mode*. The viewing functions will not work with the terminal in Setup mode.

2. Press Menu, then press F2: ZOOM/PAN. This puts the terminal in Framing mode and displays the viewing keys menu, shown in Figure 3-15. This menu shows the functions of F1 through F5 (at the bottom of each box) and their shifted versions (at the top of each box).

   Any macro definitions already assigned to these keys are suspended while this mode is active.

3. Note that there is a dotted border around the entire graphics area — the *framing box* — and a pair of dotted brackets that form opposite corners of a rectangle. Also notice that the word *ZOOM* is displayed on a different background in the banner at the bottom of the screen. This indicates that the terminal's *zoom* function is active.

   Press on the top or on the right of the joydisk, and the framing box (and zoom indicators) decrease in size. Then press on the bottom or the left of the joydisk, and the framing box increases in size.

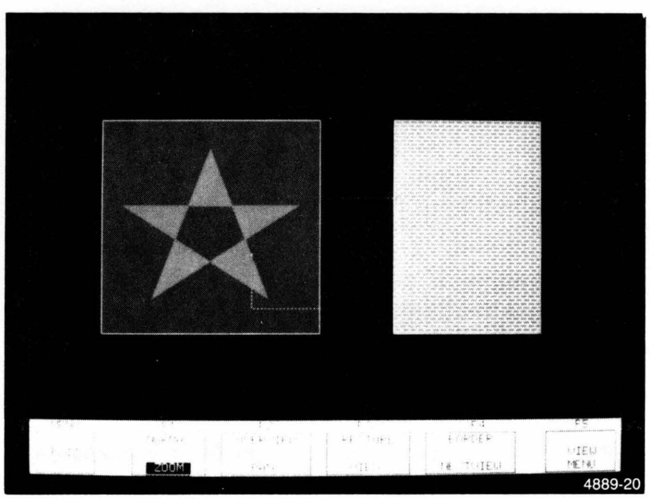


Figure 3-15. Viewing Keys Menu.

   Use the joydisk to decrease the framing box until it includes only part of the box and star. Then press F3 (UPDATE VIEW). The screen is redrawn *with the part of the picture that was in the framing box now filling the entire graphics area* (Figure 3-16). Note that the framing box now includes the entire graphics area.

4. Now press on the left of the joydisk to increase the size of the framing box. The dotted border does not appear, but the pair of framing corners expands until most of the screen is included. Press F3 again to *zoom out* to a larger window. You cannot zoom out to a larger window than the original window in effect when you created the graphics.

5. Now press Shift-F2, OVERVIEW, to return to the original view. The framing box shows the part of the original view that was displayed in the previous view.

6. Next press F2 (PAN). Without modifying the view, the terminal activates its pan function. Note that the dotted brackets in the framing box have been replaced by a crosshair, and that the word *PAN* in the banner is displayed on a different background.

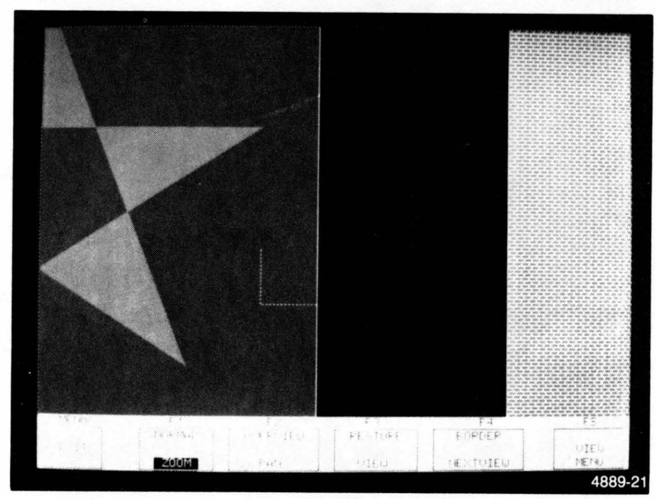


Figure 3-16. Display After Zoom and UPDATE VIEW.

7. Now press on the joydisk to move the framing box and pan indicator around. Press the top of the joydisk to move the box up; press the right of the joydisk to move the box to the right; etc. Position the framing box over the star (Figure 3-17A). You may have to increase the display intensity in order to see the framing box.

8. Now press F3, UPDATE VIEW, to redraw the display. The part of the picture inside the framing box now fills the entire graphics area, with the crosshair in the middle of the display (Figure 3-17B). If you move the crosshair around and press F3 again, you see a different part of the display, but the size does not change.

9. Now press F1 (ZOOM). The crosshair is replaced by the zoom brackets, the word *ZOOM* in the banner is highlighted, and you are now in Zoom mode. You can shift from Zoom to Pan, or Pan to Zoom, at any time just by pressing F1 or F2.

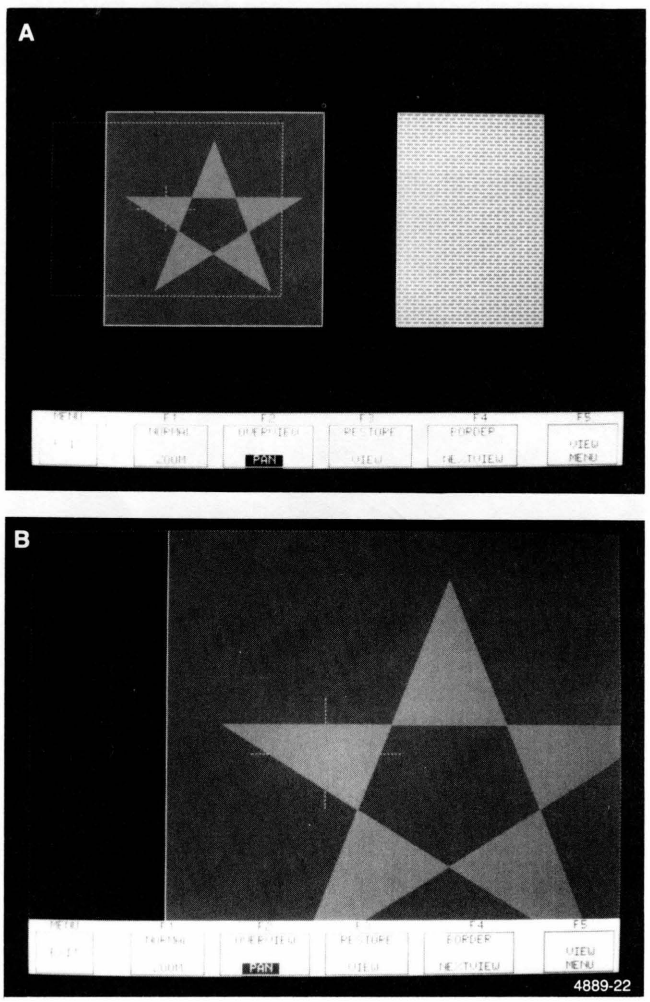


Figure 3-17. Display With Pan.

10. The terminal can define and store up to four different *views*. In fact, you have already done this. Each time you pressed F3, UPDATE VIEW, in the preceding steps the terminal saved that *view* in its memory, including the viewing mode (Zoom or Pan).

    Pressing Shift-F3, RESTORE, displays the most recent view — that is, the view that was on the screen when you pressed F3 the last time and the viewing mode (Zoom or Pan). Pressing RESTORE again displays the next most recent view, and so on, up to a limit of four views. When you have cycled through all the saved views, pressing RESTORE again takes you back to the first one.

    Try this now. Press RESTORE several times and note that the resulting displays are those that were displayed when you pressed F3, UPDATE VIEW. The original view is always saved, so you can always get back to the display you started with.

11. Now press F5, VIEW MENU. The ZOOM/PAN menu disappears and the dialog area reappears. You can press Setup to enter Setup mode; the terminal will suspend ZOOM/PAN mode until you exit Setup mode.

    Press F5 again and the ZOOM/PAN menu reappears.

    The Dialog key is also active in ZOOM/PAN mode; it toggles the ZOOM/PAN menu (or dialog area) on and off.

12. Press F5 so the ZOOM/PAN menu is not displayed. Then press Shift-F4, BORDER. A solid border appears around the edge of the graphics area, framing the entire display. Press Shift-F4 again to turn the border off.

This illustrates the basic use of the zoom and pan functions. To summarize:

- In Zoom mode you can zoom in or out to make parts of the picture larger or smaller.
- In Pan mode you can move across, up, or down the picture to display different, perhaps widely separated, parts of the picture.
- You can switch from Zoom to Pan and vice versa simply by pressing the appropriate function key.
- Pressing F3, UPDATE VIEW, saves the current view; you can cycle through the three most recent views and the original view with Shift-F3, RESTORE.

It is recommended that you experiment further with the ZOOM/PAN menu and functions to get better acquainted with them. Table 3-2 will serve as a handy reference; it lists the functions of each key, including their control versions. Note that a key, its shifted version, and its control version may have different meanings.

Table 3-2

VIEWING KEYS SUMMARY

Key	Action
F1	ZOOM. Activates zoom function and displays framing box. Joydisk changes size of framing box. Press F1 again to cancel zoom function.
Shift-F1	NORMAL. Readjusts aspect ratio to match original window of current view.
Ctrl-F1	FIXED ZOOM. Equivalent to pressing ZOOM, decreasing size of framing box, then pressing VIEW.
F2	PAN. Activates pan function and displays framing box. Joydisk changes location of framing box. Press F2 again to cancel pan function.
Shift-F2	OVERVIEW. Selects default window of entire screen (4095x3127) for current view and renews the current view.
Ctrl-F2	SUPER OVERVIEW. Selects a "super window" that includes all of 4096x4096 terminal space.
F3	(UPDATE) VIEW. Sets the window for the current view to match the framing box and renews the current view.
Shift-F3	RESTORE. Restores the current view's window and framing box to their status before the last VIEW, OVERVIEW, or SUPER OVERVIEW operation.
Ctrl-F3	UPDATE NEXT VIEW. Equivalent to pressing NEXT VIEW (F4), UPDATE VIEW (F3), then LAST VIEW (Ctrl-F4), in that order.
F4	NEXT VIEW. Saves status of the current view and makes the next higher numbered view the current one.
Shift-F4	BORDER. Turns the border around the current view on or off.
Ctrl-F4	LAST VIEW. Similar to NEXT VIEW, but selects the next lower numbered view.
F5	VIEW MENU. Turns display of the ZOOM/PAN menu on or off. When the menu is turned off, the dialog area reappears.

EXERCISE 5: GIN (GRAPHIC INPUT)

This exercise gives a brief introduction to GIN (Graphic Input) mode and two of the GIN features you may find useful: *inking* and *rubberbanding*.

The terminal can perform a variety of graphic input functions using the 4957 Graphics Tablet. Occasionally, a 4662 or 4663 plotter may be used for GIN. In this exercise, you will input a few GIN points from the keyboard.

Since GIN is almost always done under host control, the full range of GIN capabilities is discussed in the Programmers manual. Also, the host program controlling GIN should generally give instructions on how to do GIN for the particular application.

1. With the terminal in Setup mode, enter the following commands:

   GINENABLE 0 5
   GININKING 0 2

   The GINENABLE command turns on GIN mode and instructs the terminal to remain in GIN mode until 5 points have been input from the terminal's keyboard, with the joydisk as the GIN device. As soon as the GINENABLE command has been entered, a crosshair cursor appears on the screen.

   The GININKING command turns on the inking feature. You will see how this operates shortly.

2. Now press Setup. The terminal leaves Setup mode and enters GIN mode.

3. Now move the crosshair around the screen with the joydisk, then press any key on the terminal keyboard. Since inking is turned on, a vector is drawn from the origin to the screen location under the crosshair (Figure 3-18A).

   When the terminal is connected to a host computer, pressing a key as you did above will send the coordinates of the point under the crosshair to the computer. These coordinates can be stored or processed in some way, depending on the applications program. This is the real purpose of GIN mode, to send coordinate information to the computer; vectors drawn on the screen are simply for visual reference.

4. Now move the crosshair to another location and again press any key on the keyboard. Each time you do this a vector is drawn from the previous location to the current one (Figure 3-18B).

   Since GIN was enabled for only 5 points, after the fifth point has been located in this way, the crosshair disappears and the terminal leaves GIN mode.

5. Now press G Eras. Since the inked GIN vectors are not part of a segment definition, they are erased.

6. Now press Setup again, then enter the commands:

   GINENABLE 0 5
   GINRUBBERBAND 0 2

   This enables GIN mode for another 5 points and turns on the terminal's *rubberbanding* feature. Now press Setup to leave Setup mode, and move the cursor around the screen. As you do, a vector — called a *rubberband line* — is continuously drawn from the last point located to the current crosshair location.

   Since the inking feature is still turned on, each time you locate a point by pressing a key, a vector is drawn to that location, just as in the steps above.

   After 5 points have been located in this way, the terminal leaves GIN mode and the crosshair disappears. Press G Eras to clear the screen of the GIN vectors that were drawn.

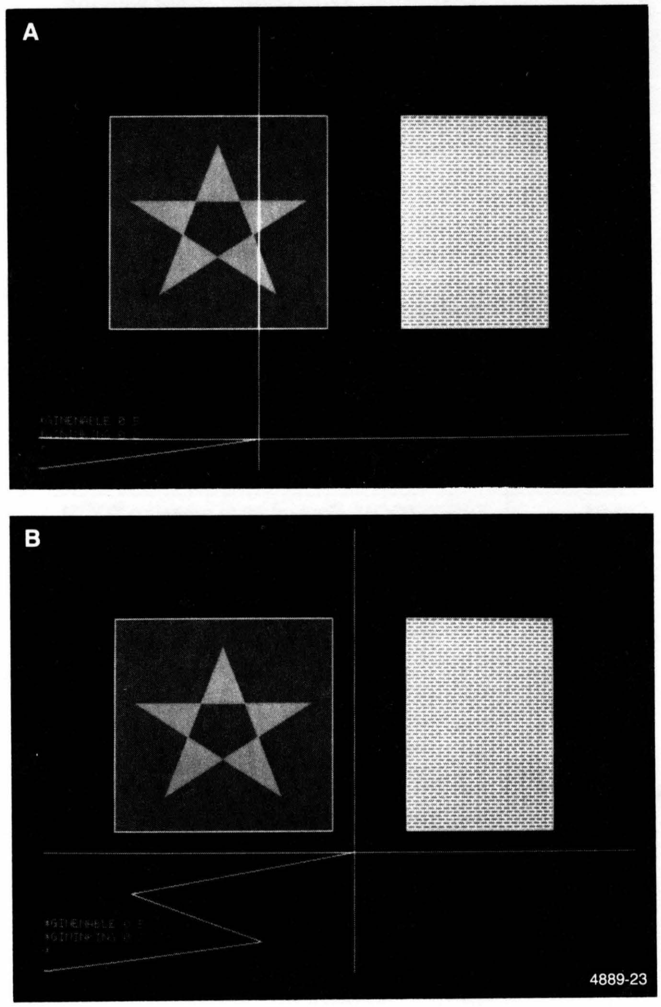


Figure 3-18. Graphic Input With Inking.

EXERCISE 6: PROGRAMMING A KEY

Each key on the terminal keyboard generates a default meaning when the key is pressed. For example, the A key generates the ASCII code for the *a* character (or *A*, when Shift is also pressed). However, you can program a key to generate a different character, or even a sequence of characters, for your convenience.

A sequence of characters programmed into a key is called a *macro*. When you press the key, the macro is *expanded* — that is, the characters are entered into the terminal just as if you typed them in one by one. A macro may contain text, commands to the terminal or host, or a combination of these.

All keys except *Shift*, *Ctrl*, and *Caps Lock* can be programmed from either the keyboard or the host.

NOTE

> *Be cautious about programming alphanumeric keys. For example, if you program the Return key, you cannot use it to terminate a command.*

Macros are identified by *macro numbers* in the range from −150 through 32767. Macros −150 through 143 correspond to keys on the keyboard (including their Shifted, Ctrl, and Ctrl-Shifted versions). Macros 144 through 32767 do not correspond to keys.

This exercise shows how to program a key, how to save the macro even when the terminal is turned off (if you wish), and how to return a programmed key to its default meaning. In addition, the exercise allows you to explore the terminal's predefined *fill patterns* at your leisure.

There are four commands that allow you to program a key:

- **DEFINE** lets you define a macro for any key or macro number (including macros 144 and up which do not correspond to any keys). A macro created with DEFINE will be lost when you turn off the terminal or reset it.
- **NVDEFINE** works just like DEFINE, but NVDEFINE macros can be saved in nonvolatile memory by NVSAVE. When you turn the terminal off, then back on again, the macro will still be defined.
- **LEARN** lets you program only keys. When you enter LEARN, the terminal prompts you as to what to do next. LEARN macros are lost when the terminal is turned off or reset.
- **NVLEARN** works like LEARN, but NVLEARN macros can be saved in nonvolatile memory by NVSAVE.

1. Exercise 2 introduced the FILLPATTERN command. Since you will use this command several times in the next few steps, program Function Key F5 to generate the command name, followed by a space:

   DEFINE F5 "FILLPATTERN "

   Be sure to type in the key name F5, not press the F5 key. Since you must separate the pattern number from the command name by a space, putting the space in the macro saves time. The quotation characters serve as *delimiters* for the defined string, and are required for the DEFINE and NVDEFINE commands.

To execute a Setup command, the command must end with a $^{C}{}_{R}$ — a Carriage Return. You can include the $^{C}{}_{R}$ character in a DEFINE macro, as follows.

2. Enter the command **STATUS EDITCHARS** and examine the message:

   EDITCHARS. . . . . . ▨ $^{C}{}_{N}$ ~

   The third character, ~, is the *literal character*. This character allows you use DEFINE and NVDEFINE to create macros containing *control characters* — that is, characters that would normally be executed. The next step shows an example.

3. Program F6 to execute the BEGINPANEL command:

   DEFINE F6 "BEGINPANEL 1000 1000 1~CR"

   The ~ before the CR within quotes tells the terminal that the next character is a literal character and not to be executed. When you press Return, the cursor backspaces over the ~ and prints the CR symbol instead of performing a Carriage Return operation. (You must press Return again to terminate the DEFINE command.)

The LEARN and NVLEARN commands let you program keys without worrying about literal characters. However, function keys F1 and F2 are reserved for displaying prompts, so if you want to program these keys, you must use DEFINE/NVDEFINE.

4. To see how LEARN/NVLEARN works, let's use LEARN to program F7 to complete the panel definition begun by F5 and F6.

   First enter the command:

   LEARN

   The terminal responds with the following prompt:

   Press the key to be defined:

   Press F7. The number 134 (the macro number for F7) is displayed and the terminal displays the next prompt:

   Enter definition. (F1 terminates definition, F2 deletes last character)

   Just enter the following definition for F7, and press F1 to terminate the definition:

   DRAW 2000 1000CR DRAW 2000 3000CR
   DRAW 1000 3000CR ENDPANELCR

   Note that you can press Return and not have to worry about the literal character, as you did with DEFINE. If you make a mistake, use F2 to back up and correct the error (just like you use the Rub Out key in Setup mode).

Notice that we have programmed one key to contain several commands. (You can do this with DEFINE/NVDEFINE also, but each time you enter CR, you must precede it by a literal character.) You can even make a key definition longer than one line: just keep typing and the text will *wrap around* to the next line.

Now that you have programmed these keys, let's use them to explore some of the terminal's predefined color patterns.

5. Press F5. The command name FILLPATTERN appears, followed by a space. Enter an integer between 1 and 16, then press Return. The fill pattern for subsequent panels is now set. This fill pattern remains the same until you change it or turn off the terminal.

6. Now press F6. The BEGINPANEL command is executed and displayed in the dialog area. You will not see anything in the graphics area yet.

7. Now press F7. The panel begun in Step 5 is completed and filled with the pattern that you selected in Step 2.

8. You can now explore the patterns that are available with Function Keys F5 — F7:

   - Press F5 and enter a pattern number, then press Return.
   - Press F6 to begin the panel definition.
   - Press F7 to draw the panel and fill it with the pattern you have chosen.

   Valid pattern numbers are:

–15— 0	Colors 0 — 15. For example, pattern –5 is the same as graphics area color 5.
1— 16	Textured patterns: stripes, diagonals, etc.
50— 174	Dithered color patterns. These patterns use closely spaced dots of different colors to simulate additional colors.

All predefined patterns are shown in Appendix H of the *CX4100 Series CDT Operators Manual.* Note, however, that these patterns use the terminal's factory default color map. Since you have modified the color map in this session, some patterns will look different on the screen.

9. The MACROSTATUS command allows you to examine a macro definition without executing it. For example, enter the following:

   MACROSTATUS F3

   The terminal prints the macro assigned to F3 on the screen, but does not execute it. You can examine all currently defined macros with the command **MACROSTATUS -1**.

10. You can delete a macro and return the key to its default meaning with the LEARN or DEFINE command. For example, to delete the macro assigned to F5 enter:

    DEFINE F5

11. You may also want to try the following:

    - Define keys to draw other boxes on the screen. Then you can compare different colors or patterns.
    - Use the color interface (Method 1 or 2) to modify the patterns. The dithered color patterns use the colors in the default color map. If you change the color map, pattern displays will be modified accordingly.

SUMMARY

This completes the familiarization procedure. Section 1 of the terminal's operators manual contains similar information but with color illustrations (instead of gray tones); that manual also contains references to the 4106 and 4107, which you may ignore. Refer to that manual for more detailed information about 4109 commands and functions.

The *CX4100 Series CDT Operators Manual* contains specific operator information for the CX4109 terminal.

Section 4

THEORY OF OPERATION

This section first describes theory of operation of the terminal as a whole. Then, it describes each of the circuit boards and modules in the terminal:

- Terminal Control board
- Display Control board
- RAM3 board
- Keyboard
- Video Interface (Digital Piggyback) board
- Power Supply Module

There are two different versions of the Power Supply Module; these are referred to in this manual as the "early version" and "later version" supplies.

The Display Module theory is covered in its own separate manual. There are two types of displays used, and each has its own Display Module service manual.

This theory write-up requires that the reader be generally knowledgeable about basic digital design. Certain abbreviations and acronyms have found their way into common use in the industry. Such terminology is used (sparingly) because most digital-service technicians are aware of these terms.

Since many people assimilate and retain pictorial information more readily than text information, this section includes many illustrations and diagrams. The block diagrams present conceptual information, while the timing diagrams emphasize operating characteristics.

OVERVIEW

The 4109 and CX4109 computer display terminals present alphanumeric and graphics data in color. They can be used for text editing, graphics display, and other general purpose input/output. The terminal's firmware decodes commands entered by the operator or sent by a host computer. The Programmer's Reference manual describes the range of firmware-related features. This theory discussion focuses on the hardware aspects of the terminal and only describes the firmware features needed for troubleshooting. The terminal contains a Self Test routine in ROM that is the principal diagnostic tool for fault isolation.

Figure 4-1 is a block diagram of the terminal (including CX). This diagram shows the main functional modules of the terminal. These are:

- Terminal Control board
- Display Control board
- RAM3 (memory) board
- Color Display Module (approx. 15″ diagonal measure)
- Digital Piggyback/Video Interface board (interfaces to the Display Module)
- Keyboard Module
- Power Supply Module
- CX Interface board (CX only)

The standard 4109 terminal communicates with its host[1] via an RS-232C data path. The host interface hardware is part of the Terminal Control board.

[1] **Non-IBM host.**

The CX4109 terminal contains both an RS-232 host port and an IBM host port. When talking to an IBM host, the terminal's CX Interface board interacts between the Terminal Control board and an IBM 3270-type Control Unit. The Control Unit then connects to the host mainframe. The terminal connects to the Control Unit via a coax cable.

Next is a simplified description of how the terminal processes data to make color graphics and text on the CRT screen. The detailed theory descriptions follow this overview (grouped under module or board headings).

GENERAL OPERATION

Let's begin by examining the general aspects 4109 operation; namely, the processing, storage, and display of data. Refer to Figure 4-2 while reading this functional description.

This scenario pertains primarily to the standard terminal. For more details about terminal to Control Unit to host interaction, see the CX theory overview at the end of Section 4.

NOTE

The term "dialog text" refers to alpha characters displayed in response to host-terminal command/data flow.

The term "pixel" (picture element) refers to the individual data dots on the display; the smallest unit of displayable information.

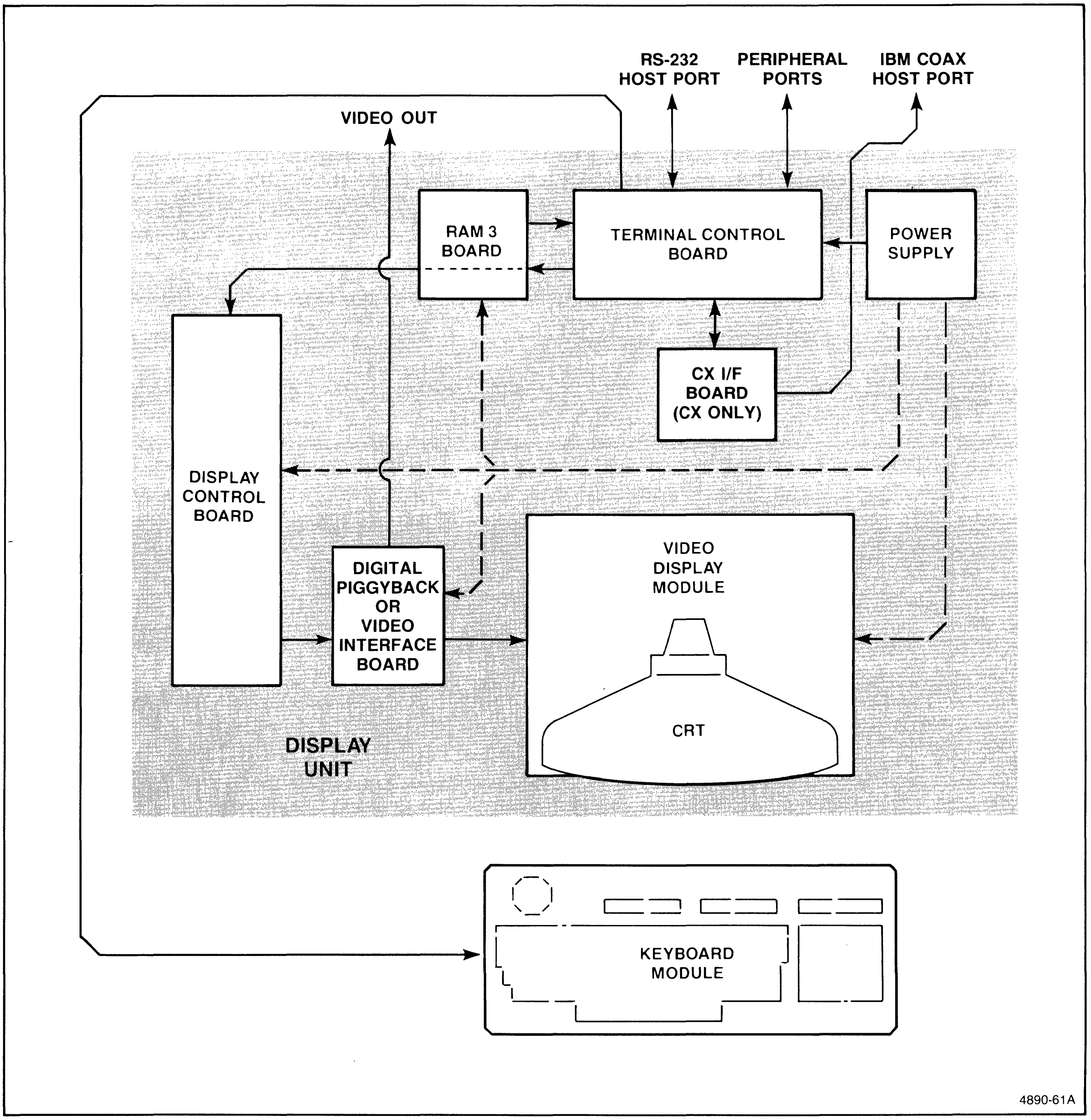


Figure 4-1. Terminal System Block Diagram.

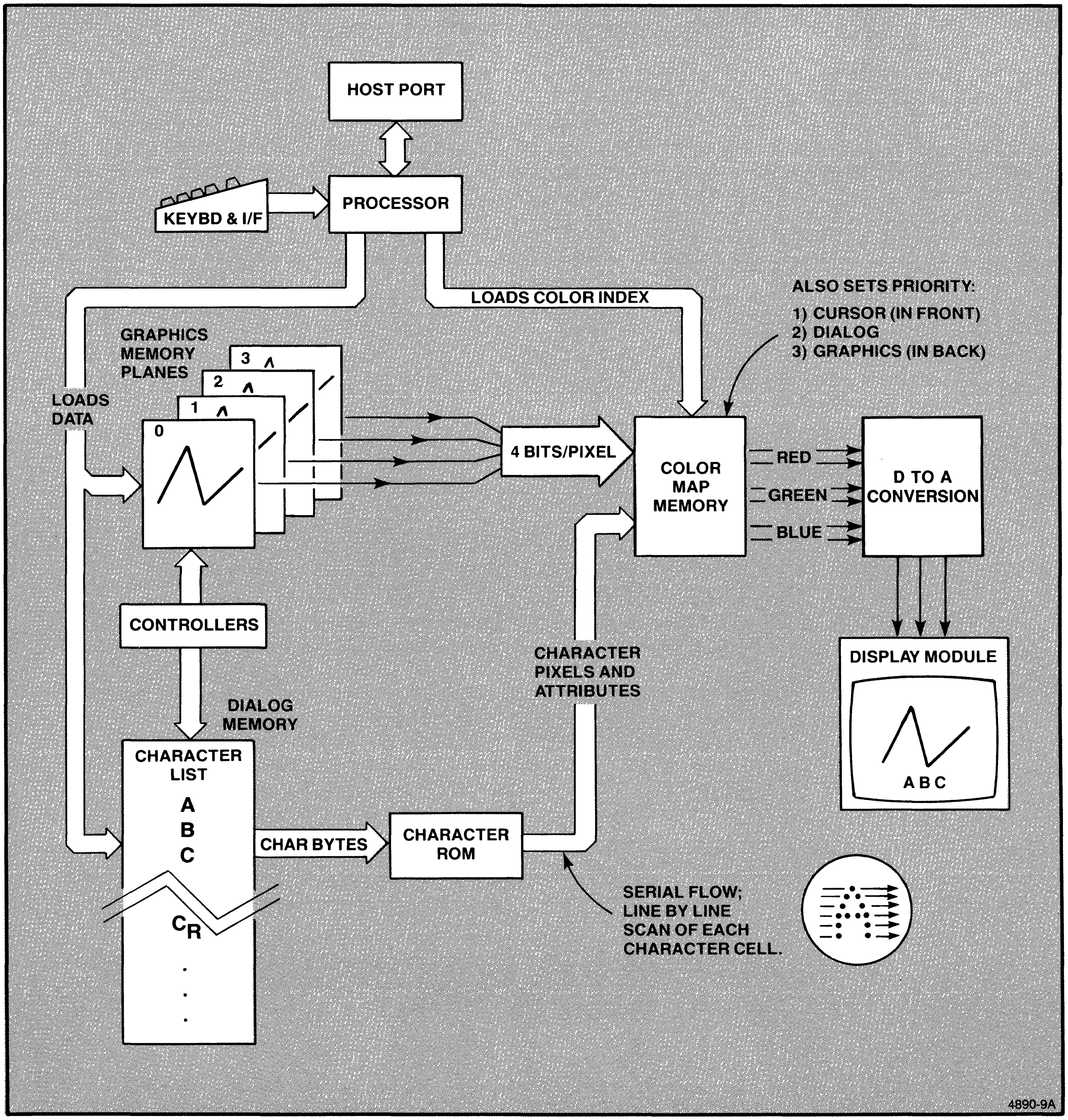


Figure 4-2. Terminal Functional Diagram.

First, the operator enters data at the keyboard. The processor and keyboard/host interfaces (on Terminal Control board) convert this data into ASCII characters which are sent to the host over the RS-232 line. The response from the host may be alphanumeric character data or graphics data. In either case, the processor takes it from the host port and sends it to the appropriate memories (both are on the Display Control board). The graphics data memory consists of four bit-planes. Each of the four bit-planes stores data for all pixel locations on the display screen. These graphics memories then write four bits of data per pixel to the Color Map. The Color Map converts each four-bit pixel into one of sixteen colors, according to the color index loaded by the processor. This Color Map then sends the color coded pixels to the three guns (red, green, blue) in the Display Module's CRT.

Dialog data passes from the processor to the Dialog Memory list. At the appropriate times this list sends its contents (character bytes) to the Character ROM. The ROM converts each character byte into a corresponding pattern of pixels. As successive scan lines are read, this creates the character within a 7 x 9 pixel area. (See NOTE below). The serial stream of character bits enters the Color Map (along with graphics data). This map adds the color value to the alpha pixels and sends them to the Display Module, where they are superimposed on the graphics data image.

The "character attributes" (blinking or not, background transparent or opaque, etc.) are programmable via firmware codes. This attribute data is added to the dialog data by custom logic arrays located just ahead of the Color Map.

NOTE

Text characters occupy a 7 x 9 area in a 8 x 15 pixel cell. This allows room for borders, underline, and special characters.

The processor requires its own random access memory, apart from the display memories on the Display Control board. Part of this processor RAM is located on the Terminal Control board. The remainder of the processor RAM is located on the separate RAM3 board.

Host-Processor-Controller Functions

The host system sends commands and data to the terminal, which enters the host I/F. The processor executes these 4109-style commands, and manages host-terminal communications. The processor manages all functions in the terminal according to its firmware in ROM. This processor also manages the operations of the Display Control board.

The processor has direct access to the graphics and alpha memories, as do other DMA devices. The Display Control board accesses memory locations and sends the data to the screen for refresh without processor intervention; this provides faster operation.

Graphics/Dialog Displays and the Color Map

Graphics and dialog data are stored in memory arrays that correspond to the display screen. Each location in graphics memory matches a pixel location on the screen. The dialog memory is a list that sends data to the screen as whole characters (not pixels). The graphics/dialog data from these memories refer to a color index map on the way to the display screen. The color map is also a memory and stores the color index values written by the processor (in response to operator commands). The color map translates pixel data into one of the defined colors for display on the screen. The color map can be reprogrammed (via the processor) to contain any eight colors from a possible 64 color combinations.

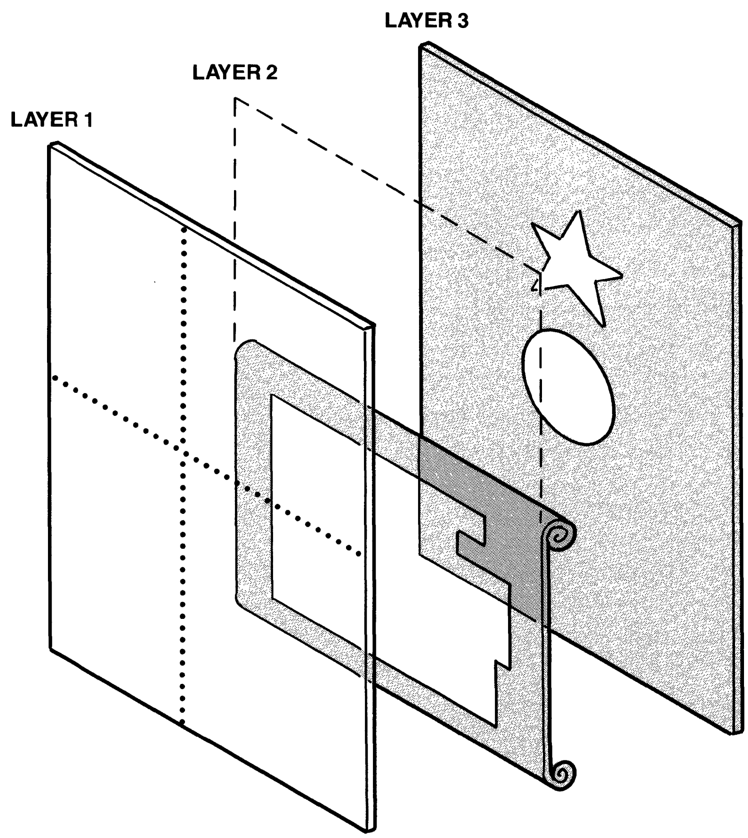
The display screen contains a fixed "graphics area", and a scrollable "dialog area." See Figure 4-3. The dialog area background index is normally transparent, so the graphics area shows through on the screen. The display also features two types of cursors: the graphics cross-hair cursor, and the dialog cursor, of which there are two types: underline and full block.

Display Image Layers

Data is displayed on the screen in three layers:

- Cursor layer (front)
- Dialog layer (middle)
- Graphics layer (back)

The unwritten pixels in each layer are called the "background." By making the background of a front layer transparent, its text or crosshair appears to be written over the top of images on back layers. This allows a foreground image to be visible, while letting the other images show through the "holes." This concept is used to display dialog text in front of graphics images. See Figure 4-3, again.



LAYER 1 (FRONT) GRAPHICS CURSOR ONLY
LAYER 2 (MIDDLE) DIALOG AREA WINDOW SHADE (SCROLLABLE)
LAYER 3 (BACK) GRAPHICS AREA (NON-SCROLLABLE)

4525-17

Figure 4-3. Display Screen Graphics and Dialog Areas Overlay Priority.

Display Characteristics

The Display Module is a typical raster-type color video monitor. The size of the display screen is 15″ (diagonal measure). The display screen area contains 480 lines of 640 pixels per line. A pixel is written by turning the electron beam on for approximately 39.6 ns during a scan line. The Display Module has fixed convergence (not adjustable) and operates at a 60 Hz refresh rate.

MEMORY AND I/O ADDRESSING

The processor's address bus and I/O bus access the connected areas of memory and various circuit modules. Figure 4-4 shows how the processor memory address space is divided between the terminal's memory areas. Figure 4-5 shows how the processor's I/O address space corresponds to the various circuit modules and peripherals on the terminal.

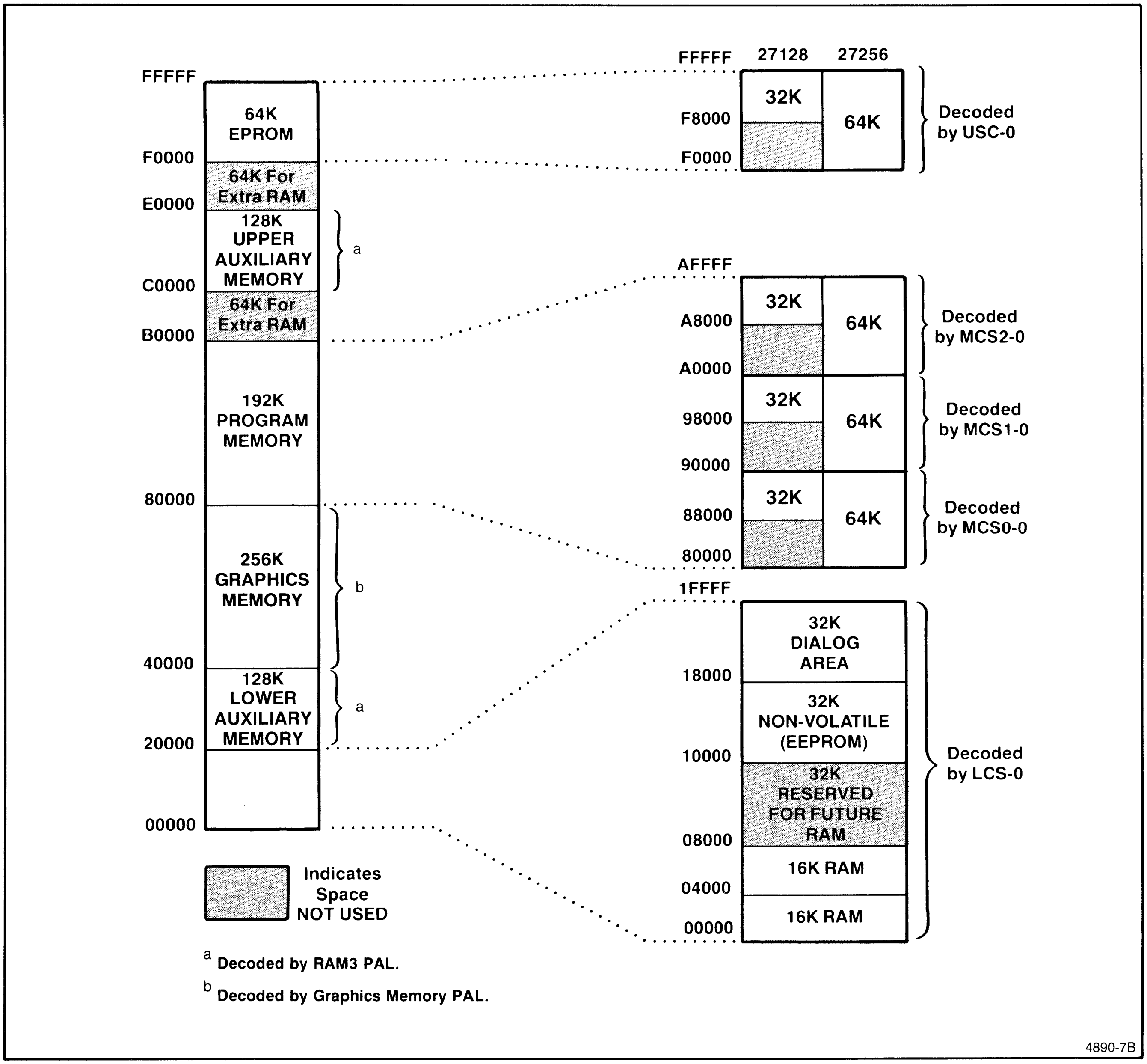


Figure 4-4. Map of Memory Address Space.

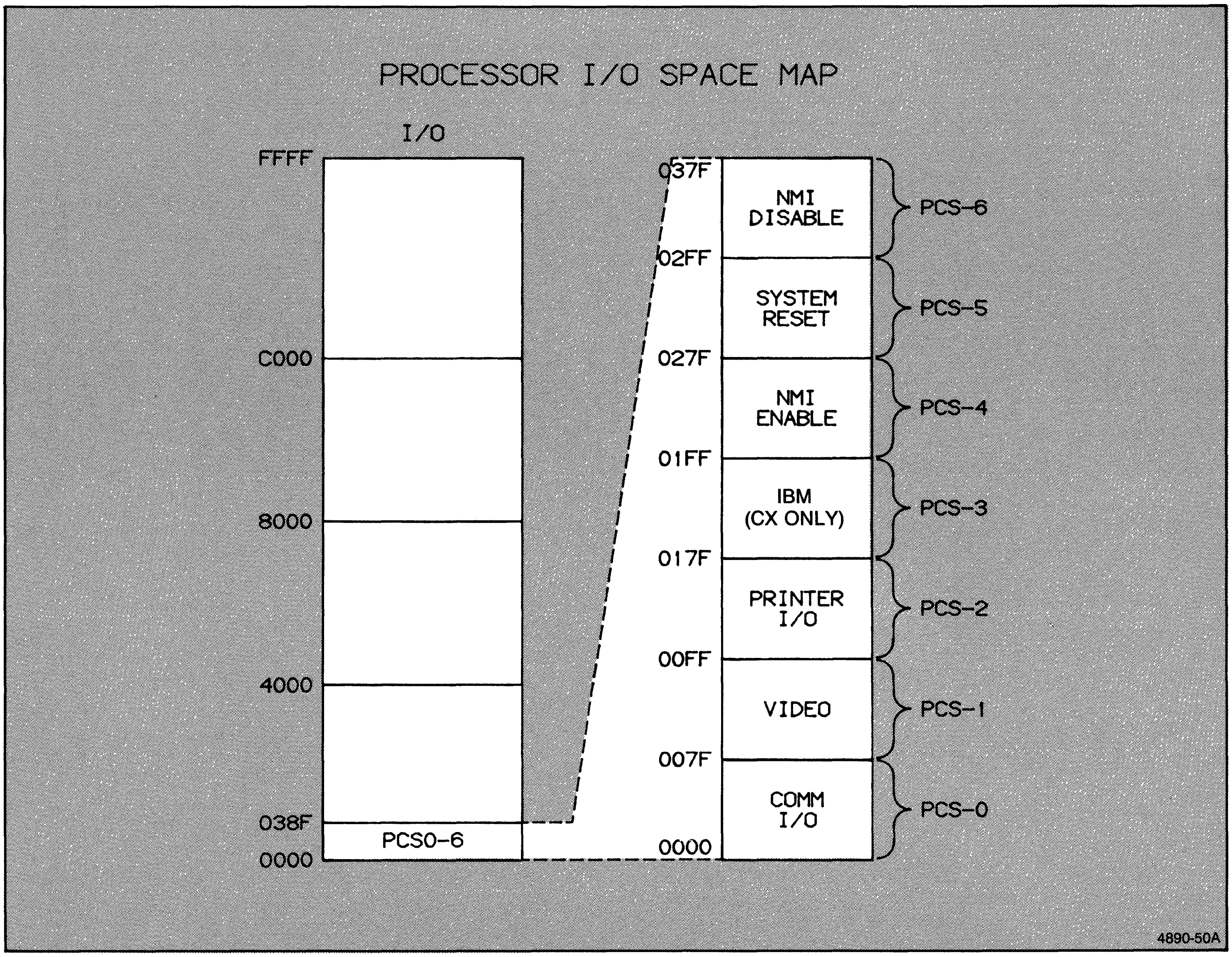


Figure 4-5. Map of I/O Address Space.

TERMINAL CONTROL BOARD

The following text describes the theory of operation of the Terminal Control board. This board contains the processor, main memory, and the interface units to the keyboard, host, and peripherals. Figure 4-6 shows the functional blocks that comprise the Terminal Control board.

GENERAL BOARD OPERATION

The Terminal Control board architecture is based on the 80186 microprocessor. The board contains two busses:

- Processor address bus
- Processor data bus

The timing for the processor, its memory, and other devices, comes from 14.7456 Mhz crystal oscillator on the Terminal Control board.

A 96-pin connector passes data and control information to and from the RAM3 board. This same connector accepts signals that pass through the RAM3 board on their way to the Display Control board.

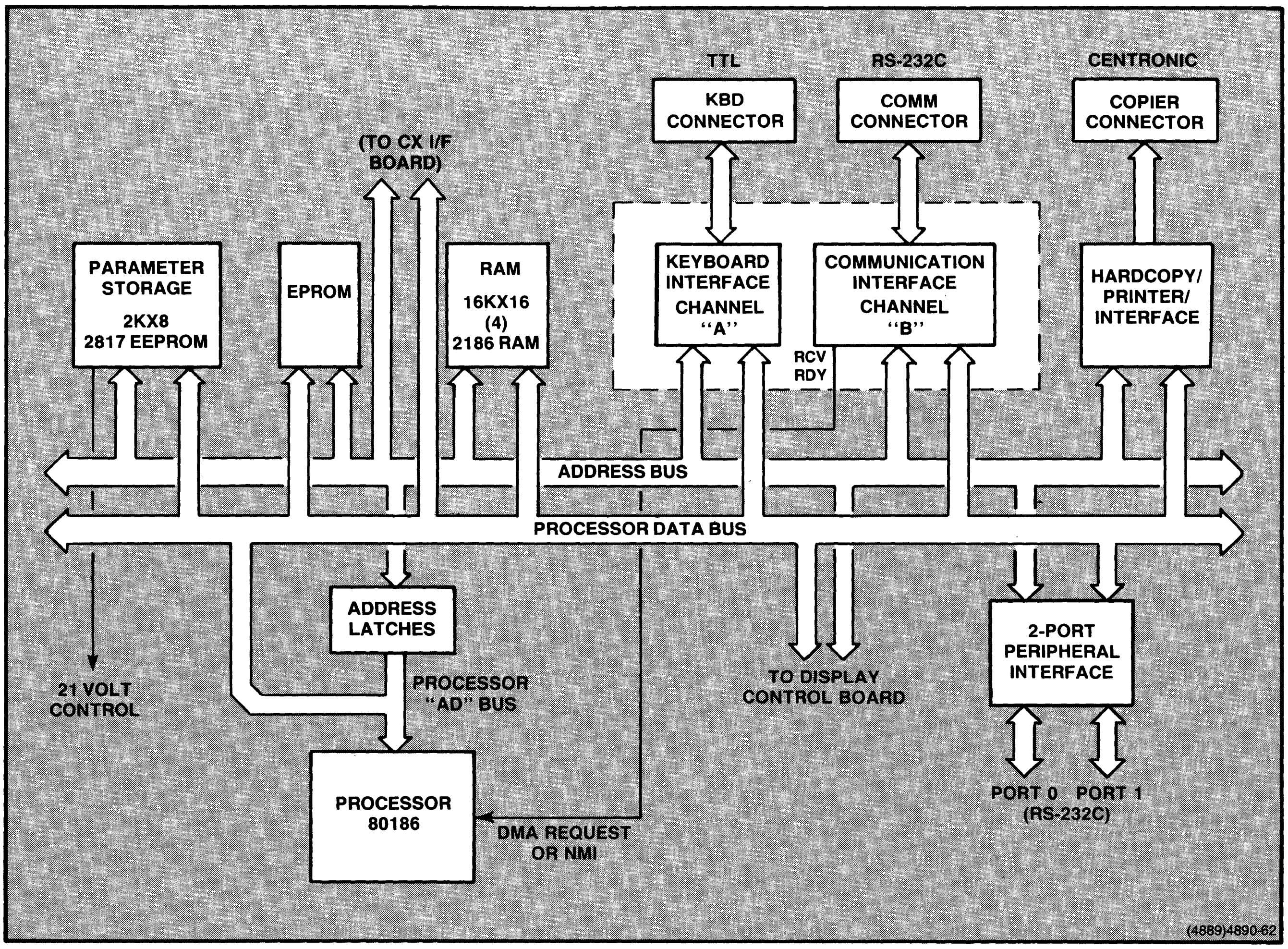


Figure 4-6. Terminal Control Board Block Diagram.

NOTE

The following text, on tinted pages, refers only to circuit blocks INSIDE the 80186 processor chip.

PROCESSOR BLOCK

The processor is an Intel 80186 16-bit high integration microprocessor. The processor can directly access up to 1 Mbyte of memory, and operates at 7.3728 MHz. (An external 14.7456 MHz crystal oscillator, on the Terminal Control board, feeds a divide-by-two counter in the processor.) The 80186 is a powerful microprocessor and also combines many peripheral functions on the single 68-pin chip. The processor contains the following functional blocks:

- Execution unit (ALU and registers)
- Clock generator
- Programmable interrupt controller
- Programmable timers
- Programmable DMA
- Chip-select unit
- Bus I/F unit

Figure 4-7 is a simplified functional block diagram of the 80186, and shows these functions as sub-blocks. The following theory discussion describes each of these sub-block. Figure 4-8 shows the 80186 pin locations and their associated signal names, which are defined in Table 4-1.

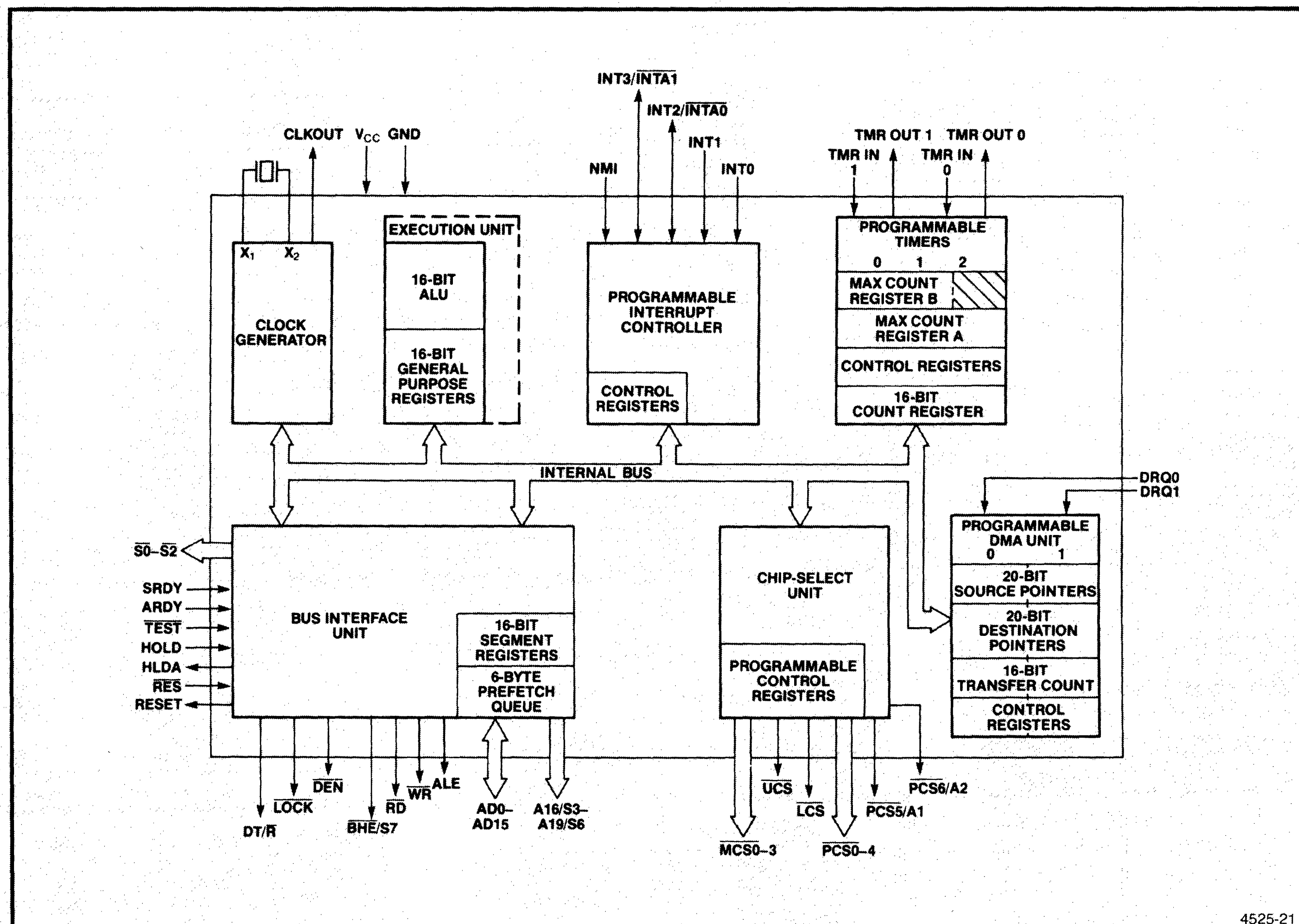


Figure 4-7. Processor Functional Block Diagram.

Table 4-1

PROCESSOR PIN DESCRIPTIONS

Pin	Name	Description
1	AD15	Address/Data Line
2	AD7	Address/Data Line
3	AD14	Address/Data Line
4	AD6	Address/Data Line
5	AD13	Address/Data Line
6	AD5	Address/Data Line
7	AD12	Address/Data Line
8	AD4	Address/Data Line
9	Vcc	+ 5V power in
10	AD11	Address/Data Line
11	AD3	Address/Data Line
12	AD10	Address/Data Line
13	AD2	Address/Data Line
14	AD9	Address/Data Line
15	AD1	Address/Data Line
16	AD8	Address/Data Line
17	AD0	Address/Data Line
18	DRQ0	DMA Request 0
19	DRQ1	DMA Request 1
20	TMR IN 0	Input to Timer 0
21	TMR IN 1	Input to Timer 1
22	TMR OUT 0	Output from Timer 0
23	TMR OUT 1	Output from Timer 1
24	RES	Reset (input)
25	PCS0	Programmable Chip Select #0
26	Vss	Ground
27	PCS1	Programmable Chip Select #1
28	PCS2	Programmable Chip Select #2
29	PCS3	Programmable Chip Select #3
30	PCS4	Programmable Chip Select #4
31	PCS5/A1	Programmable Chip Select #5
32	PCS6/A2	Programmable Chip Select #6
33	LCS	Lower bank Chip Select
34	UCS	Upper bank Chip Select
35	MCS3	Middle bank Chip Select #3
36	MCS2	Middle bank Chip Select #2
37	MCS1	Middle bank Chip Select #1
38	MCS0	Middle bank Chip Select #0
39	DEN	Data bus Enable
40	DT/R	Data Transmit or Receive enable
41	INT3/INTA1	Interrupt in #3 / Interrupt Acknowledge #1
42	INT2/INTA0	Interrupt in #2 / Interrupt Acknowledge #0
43	Vcc	+ 5V power in
44	INT1	Interrupt in #1
45	INT0	Interrupt in #0
46	NMI	Non-Maskable Interrupt enable
47	TEST	Test (procesor) enable (input)
48	LOCK	Lock (inhibit) processor activity
49	SRDY	System Ready enable (input)

Table 4-1 (cont)

PROCESSOR PIN DESCRIPTIONS

Pin	Name	Description
50	HOLD	Hold processor in present state
51	HLDA	Hold Acknowledged output
52	S0	Processor Status line #0
53	S1	Processor Status line #1
54	S2	Processor Status line #2
55	ARDY	Acknowledged peripherals Ready
56	CLKOUT	CLock output signal
57	RESET	Reset processor (input)
58	X2	Crystal clock input
59	X1	Clock input
60	Vss	Ground
61	ALE/QS1	Address Latch Enable / Cue Status 0
62	RD/QSMD	Read enable / Cue Status of Memory Devices
63	WR/QS1	Write enable / Cue Status 1
64	BHE	Byte High Enable
65	A19/S6	Address line 19 / Status line 6
66	A18/S5	Address line 18 / Status line 5
67	A17/S4	Address line 17 / Status line 4
68	A16/S3	Address line 16 / Status line 3

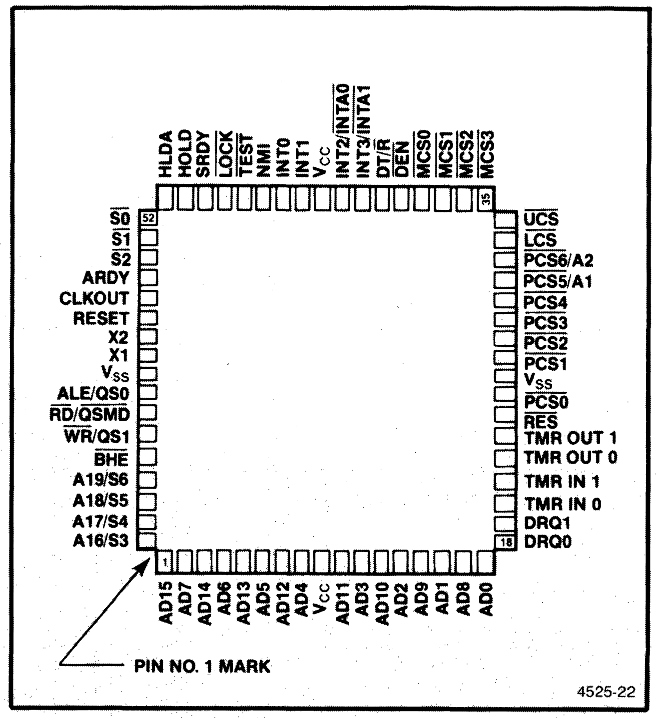


Figure 4-8. Processor Pin Descriptions.

Execution Unit

The Execution Unit consists of the 16-bit Arithmetic Logic Unit (ALU) and a collection of registers. The registers contain data, instructions, addresses, status and control information. The ALU is the heart of the chip, performing calculations and processing the instructions and data according to the system firmware. The manufacturer's data sheet provides detailed information about processing power and the 80186 instruction set. Such information is related more to design than maintenance and is not included in this manual.

Registers. The Registers are divided into the following catagories:

- General registers
- Segment registers
- Base and index registers
- Status and control registers

The general registers store arithmetic and logical operands. The segment registers store locations (memory "segments") in processor memory. Such segments are immediately accessible for code, stack, and data. The base and index registers contain base addresses and indexes to particular locations within a segment. The status and control registers contain instruction pointers and the status word. The purpose of the status word is covered following the Memory Segments discussion.

Memory Segments. Processor memory is organized into pieces of memory called segments. Segmented memory is a means of dividing memory into functional units thus simplifying programming. Each segment is a linear unbroken memory space. Segment size is variable and may be as large as 64K.

Memory is accessed by a two-part address: a pointer, and an offset. The pointer is a 16-bit base address for a segment. The base address is contained in one of four registers (code, data, stack, extra). The actual physical address is obtained by shifting the base address left by four bits, and then adding the 16-bit offset. This results in a 20-bit physical address for accessing the 1 Mbyte addressable space.

Status Word. The processor records certain results of logical and arithmetic operations in the "status word" register. This word controls other aspects of processor operation. The status word is 16 bits wide and resides at location F002(X) immediately following the RESET condition. The manufacturer's data sheet contains detailed status bit definitions.

Clock Generator

This circuit block provides the timing for the processor and peripheral circuitry. Refer to the external clock circuit block description for more details.

Programmable Interrupt Controller

This block within the processor prioritizes and services the many interrupts received by the processor. Some interrupts are generated by external circuitry, while other (internal) interrupts come from blocks in the processor itself. This circuit block ranks these requests for service by the CPU. The internal interrupt sources (Timers and DMA channels) may either be enabled/disabled by their own control registers or by mask bits in the interrupt controller. The Interrupt controller has its own control registers that set its operating modes. Figure 4-9 depicts the logical layout of the interrupt controller.

The timing and interrupt signals enter the Interrupt Priority Resolver. Four interrupt inputs (INT1 to INT3 and NMI) enter the Resolver and the output goes to the "Interrupt" input of the CPU. A bank of control registers connects to the internal address/data bus and provides firmware information to the Priority Resolver. Several housekeeping registers (right side of diagram) store: interrupt requests, masks, and status. These registers pass information back and forth to the resolver as needed. The Interrupt Status register also makes interrupt status available to the rest of the processor via its internal bus. The block labeled Vector Generation Logic creates address vectors so interrupts trigger the proper service routine.

The functions of the interrupt controller are controlled by programming in firmware. One item of interest is that the interrupt routines may be nested. This means that it is possible for an interrupt routine to be interrupted by another higher priority interrupt routine.

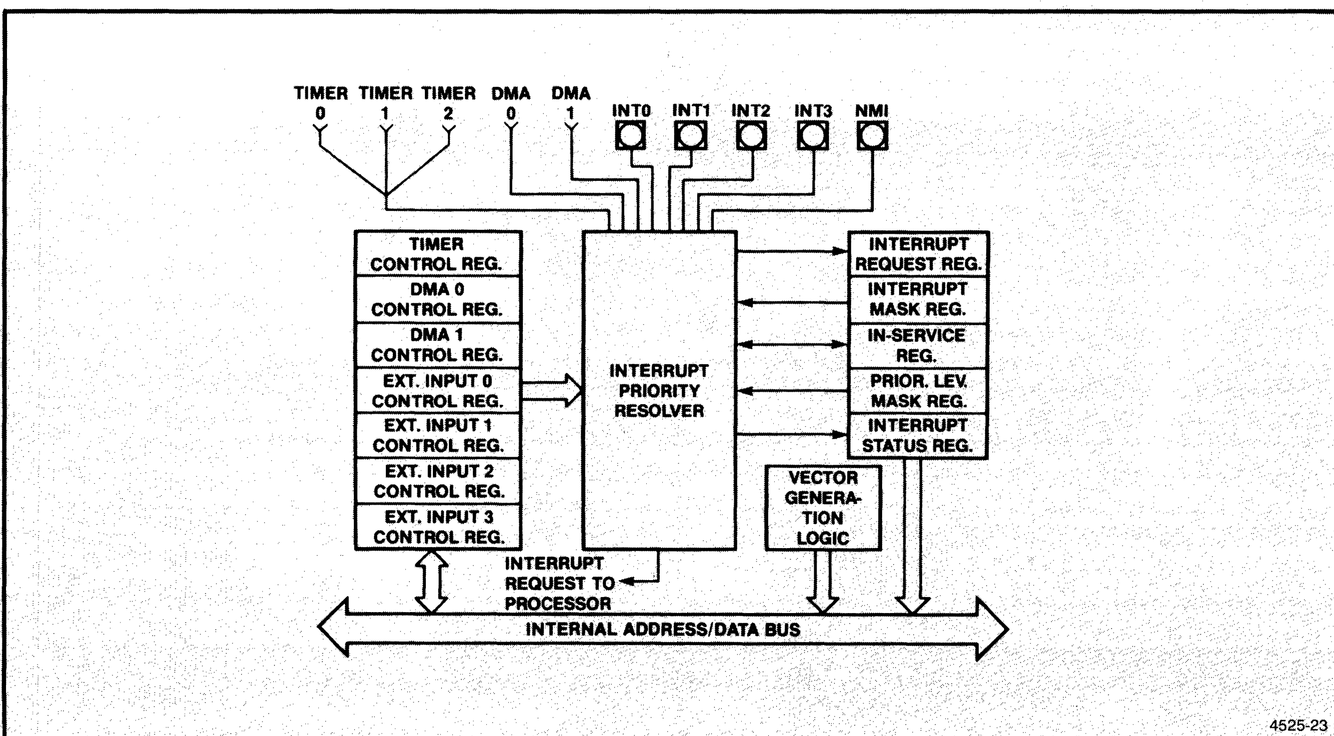


Figure 4-9. Programmable Interrupt Controller Block Diagram.

Programmable Timers

The processor includes three, 16-bit, programmable timers. See Figure 4-10.

Timer 0 rings the bell. Timers 1 and 2 detect when and how long a keyboard key is held down. A 500 msec initial delay occurs before key repeats take effect. Then, the character/key is repeated every 100 msec while the key is pressed. A fast repeat (10 msec) takes effect when the Shift key is used with key repeat. The timer circuits determine all these repeat times.

Programmable DMA

The processor's Programmable DMA block allows fast DMA data transfers between the following system areas:

- Memory to I/O
- Memory to memory
- I/O to I/O

DMA requests come either from the CPU (via the Internal Bus), or come from the Communications Interface block (via the external DRQ0 and DRQ1 input lines).

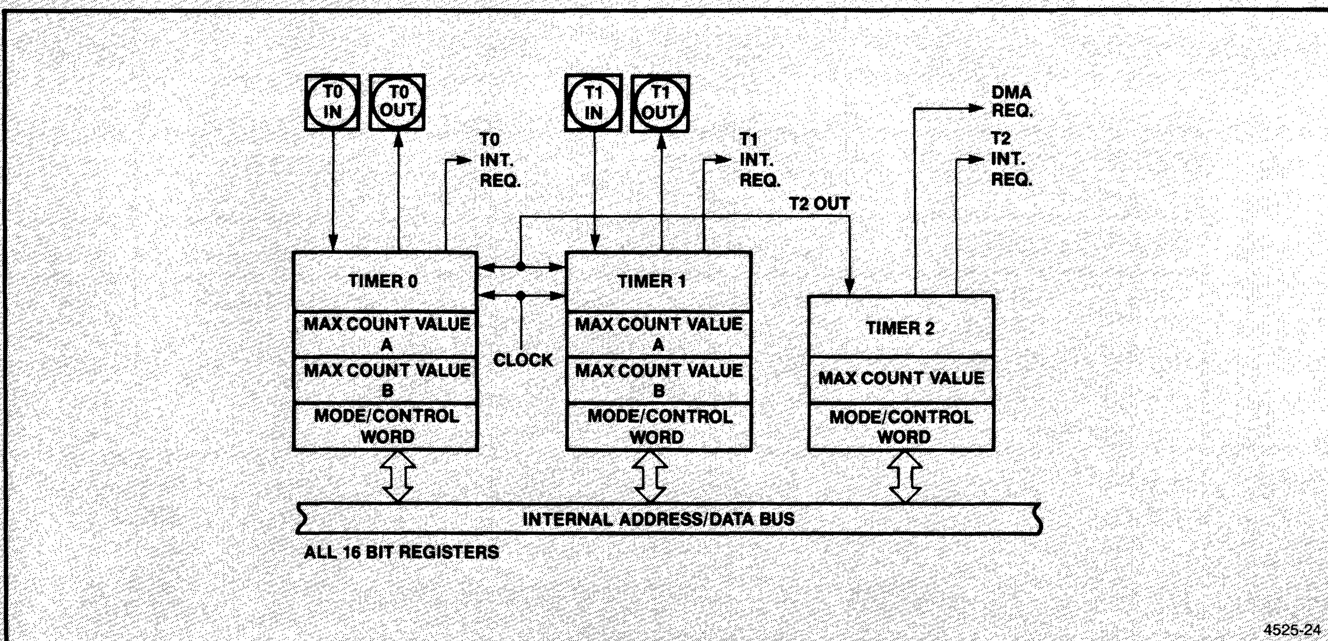


Figure 4-10. Timer Block Diagram.

The DMA allows data transfers in either bytes or words, and to or from even or odd addresses. This circuit block provides two DMA channels, and each contains a 20-bit source pointer and a 20-bit destination pointer. Each DMA data transfer occupies two bus cycles: one to fetch data, and the other to store it. Figure 4-11 shows the functional parts within this DMA circuit block.

Chip Select/Ready Generation Block

This block allows the firmware to select several peripherals and memory sections via the procesor's chip select lines. This block also works with the Bus Interface block to generate the READY signals (via firmware and the Internal Bus). The chip select lines are used as follows:

- PCS0 – controls/selects the Keyboard/Comm I/F chip
- PCS1 – selects the VIDIO (video input/output) on the Display Control board
- PCS2 – selects the Printer/Copier I/F chip
- PCS4 – selects the NMI (non-maskable interrupt) Enable Flip-Flop
- PCS5 – disables NMI and turns off system reset
- PCS6 – performs system reset.

This block also generates the Memory Chip Select lines: MCS0 –MCS2, LCS, and UCS. The MCS0 – MCS3 lines operate in conjunction with the UCS (Upper Chip Select) to control four areas of program memory; see Figure 4-3, again. The LCS line selects the following areas in lower memory:

- EEPROM
- 32K System Memory
- Dialog RAM (on Display Control board).

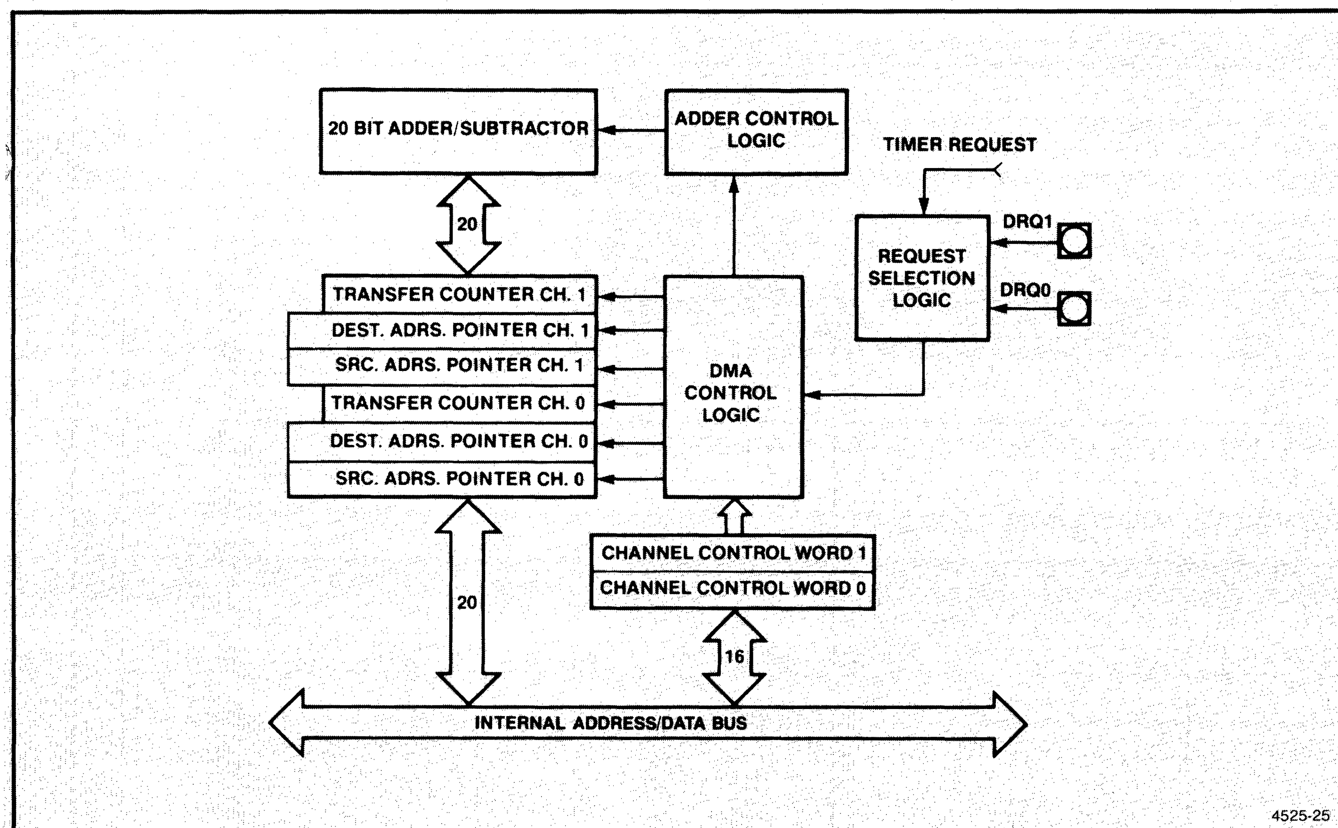


Figure 4-11. DMA Unit Block Diagram.

Bus Interface Unit

This part of the chip operates between the internal bus (inside the chip) and the Terminal Control board bus (outside the chip). The functions of this block come under four general catagories:

- Memory/peripheral control
- Transceiver control
- Internal bus acquisition and arbitration
- Internal bus controller and reset.

The RD, WR, and ALE lines control the bus and strobe data between memory and the microprocessor. The ALE (address latch enable) line strobes the address latches on the multiplexed address/data lines.

The transceiver control subblock drives the DT/R and DEN control lines. These lines control the data bus transceivers in the Processor Interface portion of the Display Control board.

The Hold and Hold-acknowledged features of the processor are not used. These pinouts go to the Display Control-Terminal Control ribbon cable, but are not connected on the Display Control board. Therefore, the processor's internal bus is not acquired by outside masters and no arbitration circuitry is required.

The remaining function of this block is to handle housekeeping chores required following a bus reset. After an RES input, this block performs the following actions:

- drives DEN, RD, and WR high for one clock cycle, after which they float
- drives S0-S2 high (passive), then allows them to float
- drives LOCK high, then it floats
- tristates AD0-15, AD16-19, BHE, and DT/R
- drives HLDA low.

NOTE

The remaining processor circuit block headings describe the blocks located OUTSIDE the processor chip.

Clock Circuitry

The 14.7456 Mhz crystal oscillator on this board clocks the processor. The processor's X1 (clock) input sends this clock signal to an internal oscillator that makes the processor clock waveform. A divide-by-two counter derives the signal for the processor's own use. A CLKOUT signal, from the processor, makes this clock signal available for peripheral circuits. The Clock circuitry also amplifies the crystal clock signal, TERMCLK-1, to the non-TTL level required by the processor.

Address Latches

The Terminal Control address bus connects to the processor's internal address/data bus via a set of three Address Latches. These transparent latches store (demultiplex) the processor's 20 bits of address and four bits of status information. The outputs of these latches are the buffered processor address lines of all the system devices (on both, the Terminal Control board and the Display Control board).

Read/Write Control

The read and write lines are buffered through this set of gates. The MDEN-1 (Memory Data Enable) line is only used for internal testing. This line prevents the processor from reading or writing to other devices. The BRW-1 signal indicates to other bus devices that a read or write is in progress.

The processor does not necessarily produce valid data at the beginning of a write cycle. The LATERW-1 (Late Read/Write) signal, which is BRW-1 delayed one clock cycle by a flip-flop, signifies valid data to RAMs on the Display Control board.

Reset Block

The processor's input RESET line uses a switch and typical RC-type reset circuit. The diode discharges the capacitor when power is turned off; this circuit assures a proper processor reset when power is turned on again.

RESET Control

The processor's reset output line is controlled by the programmable select lines PCS5 and PCS6. These lines disable NMI and turn off the system reset via a set of cross-coupled AND gates.

NMI Logic

This set of logic controls the Non-Maskable Interrupt control line. The AND-OR gate pair, in the NMI line, allows this line to work for both testing, and actual system use. A test pin on the test connector controls the NMI line. Also, the Keyboard/Communications interface (a type-2681 DUART) requests NMI if the host sends a character while the NMI-Enable Flip-flop is enabled.

Ready Logic

A pair of AND-OR gates, in the ARDY (ready) line, combines the ready signals from various inputs. READYOR comes from the Test Connector and forces the processor ready regardless of the states of the other ready signals. RAMRDY (RAM ready), DISPRDY (display ready), and RDYAND (another test connector signal) are ANDed together, then ORed with RDYOR, to drive the processor's ARDY input.

Other Circuitry

Other assorted gates, in the the input control lines to the processor, function as follows. The inverter in the HOLD line allows this line to be used by an external device; otherwise, the line would have to be grounded.

System Address Decode

This circuit block accepts address lines from the processor and decodes them into memory/peripheral selector lines. This block consists of a "custom gate array" chip and several discrete gates. The gate array's address inputs are A14 through A19 (except A17). This chip also accepts several status and control lines from the processor: ALE/QS0, LCS, BHE, A0, BWR, LATERW, and LS2. The selector outputs are listed in Table 4-2.

Table 4-2

ADDRESS SELECTOR OUTPUTS

	Signal Name	Selected Area
Memory Addresses	RAMCS0-0	Memory; 0 – 3FFF (EVEN)
	RAMCS1-0	Memory; 0 – 3FFF (ODD)
	RAMCS2-0	Memory; 4000 – 7FFF (EVEN)
	RAMCS3-0	Memory; 4000 – 7FFF (ODD)
	2817CS-0	Erasable ROM; 10000 – 17FFF
	ALPHACS-0	Alpha Memory; 18000 – 1FFFF
	GRAPHCS-0	Graphics Memory; 40000 – 80000
	TESTCS-0	Memory test area; 20000 – 40000
Byte&/Word Write Enables	HIWR-0	Late High Write decode
	LOWR-0	Late Low Write decode

NON-VOLATILE MEMORY

The Non-Volatile Memory block consists of a 2K x 8-bit EEPROM memory chip. This chip is an Elecrically Erasable Programmable ROM. (It replaces a CMOS RAM with battery backup, thus eliminating a battery and increasing reliability). The EEPROM is used to store non-volatile parameters such as: baud rates, prompt mode strings, and definitions for keys.

The inputs and outputs of the EEPROM block are: address, data, and control. See Figure 4-12, a functional block diagram. The address inputs connect to the board address bus lines: A0 through A10. The data inputs and outputs connect to the Processor Data Bus lines, AD0 to AD7. The control lines are connected to:

- 2817CS – chip select
- BRD – read command (buffered)
- LOWR – write command (to low memory)
- 21 Volts - required to read or write to the chip (see NOTE)

NOTE

Only the early version board uses the 2817 chip; the later version board has the 2817A. The 2817A does not need a +21 volt supply (uses +5 volts instead) therefore the cut-strap, W30, is also different on the later board.

The chip's status output, which is labeled RDY/BUSY, becomes the signal: 2817RDY. The processor checks this line, prior to reading or writing, to be assured that a previous write cycle is not still in progress.

Because the chip has limited write cycle life, the system writes to the 2817 only as necessary. Before writing a parameter into the chip, it checks to see if the value has actually changed from the already stored value. If no change is detected, then no write operation occurs.

The EEPROM timing and wait states are set for a relatively slow operating cycle. Since the EEPROM is only read at power up or when parameters are updated, access can be slower. Consequently, the chip operates on a 450 nsec cycle. The WAIT states are determined by the status of the READY line.

The following are some constraints regarding wait states:

- To read the chip, two 80186 wait states are required.
- To write to the chip, no wait states are required.
- Other devices, independant of the processor, must always check BUSY status, if they do not know the previous activity of the processor.

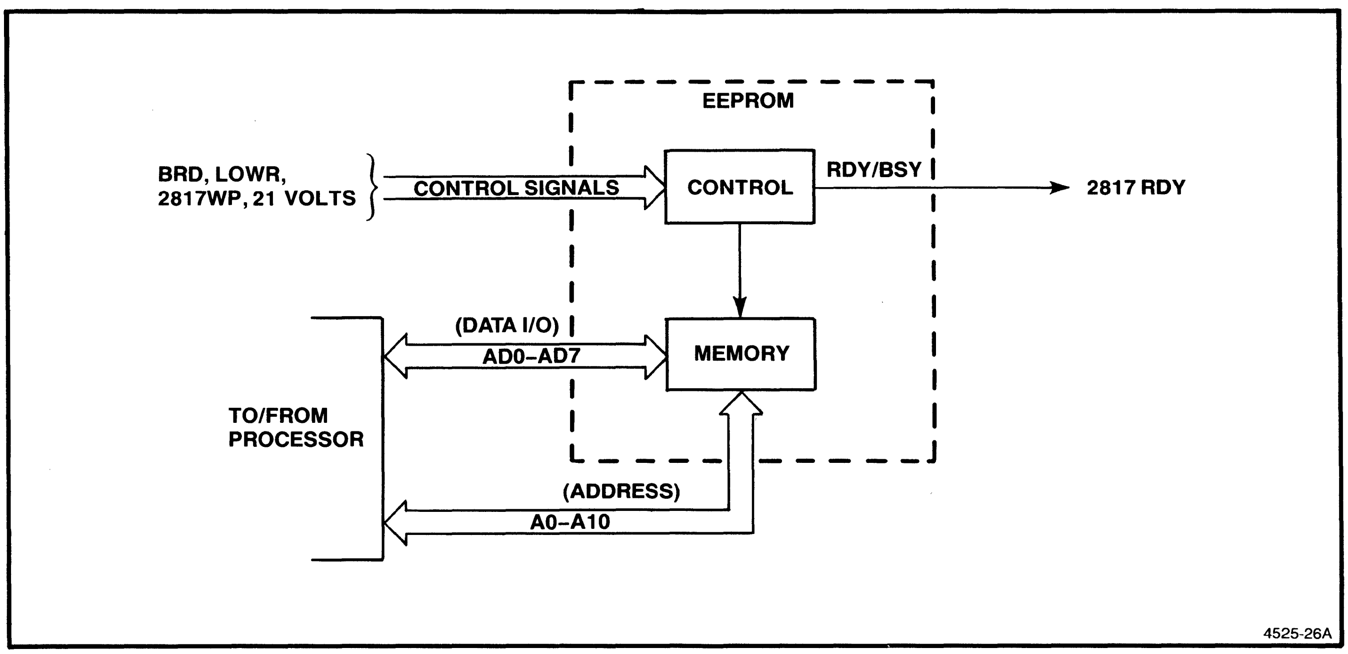


Figure 4-12. Non-Volatile Memory Block Diagram.

PROGRAM MEMORY BLOCK

The Program Memory block contains the system firmware. The design will accomodate several types of EPROM chips but the 27128 and 27256 are the most likely to be used.

Figure 4-13 shows the arrangement of the eight EPROMs that comprise this circuit block. The odd and even addresses are assigned to alternate EPROMs in four pairs. The lower three pairs are enabled by processor select lines: MCS1, MCS2, and MCS3. The last pair of EPROMs is selected by the processor select line, UCS. At power-up the UCS signal is the only chip select that is active. This automatically selects the upper bank, which contains the power-up codes. This also assures that all other ROMs are inactive until power-up is completed and the system is fully initialized.

When 27128 and 27256 EPROMs are used, the bank size is 64K words. System firmware (rather than hardware) manages the addressing of EPROMS and allocation of bank sizes (in processor address space). Consequently, straps are not needed to change address bounderies or chip types.

The processor clock sets the length of time for a read and write cycle. The 14.7456 MHz clock results in a clock period of 135 nsec. The chip select access time requirement is 3 clock periods (405 nsec). The address access time for these chips is 314 nsec, and the read enable access time is 143 nsec.

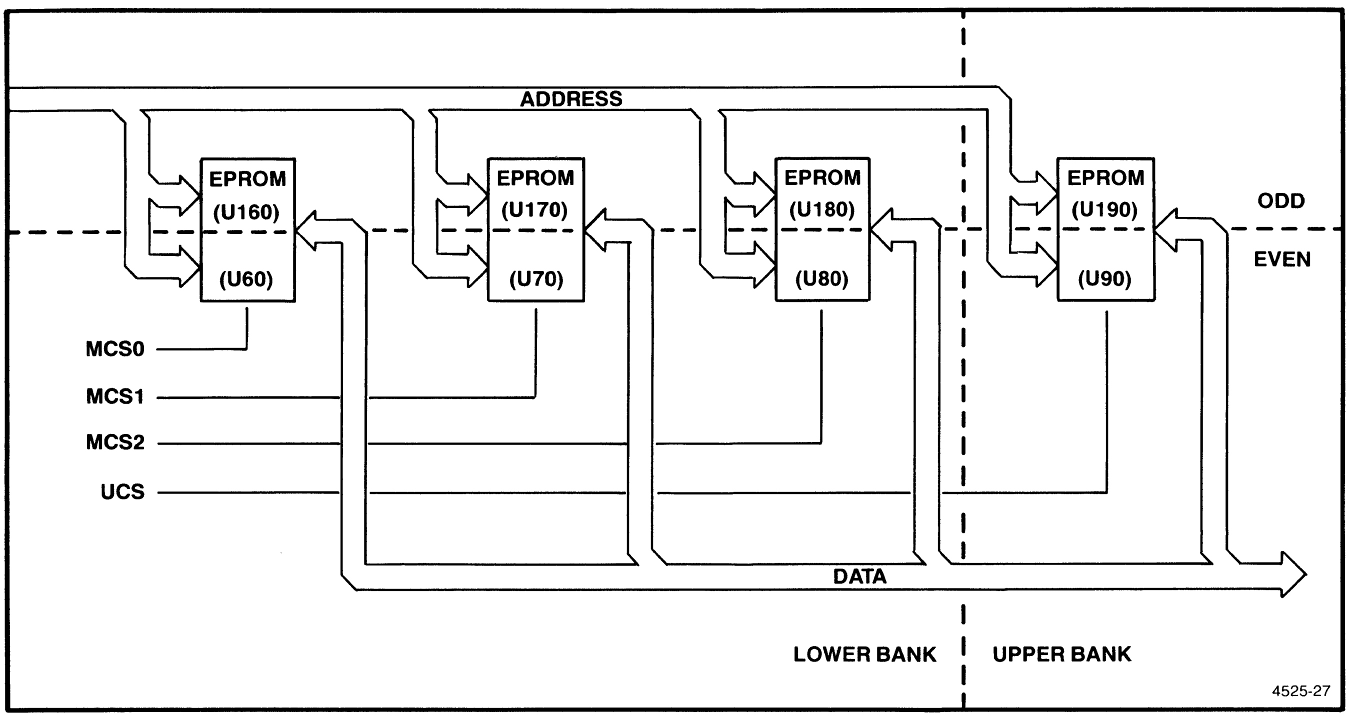


Figure 4-13. Program Memory Block Diagram.

SYSTEM RAM BLOCK

The RAM block consists of four 8K x 8 bit RAM chips. The 2186 RAM is designed to operate with the 80186 and is the principal component in this circuit block. This RAM stores firmware related data, user-defined key definitions, etc. Figure 4-14 shows the functional arrangement of these RAMs and their signal lines. The four RAMs are divided into two pairs. Each pair is divided between odd and even addresses. One pair is "low" RAM (addresses 0000 – 3FFF), while the other is "high" RAM (addresses 4000 7FFF). Notice that the "chip selects" are separate for each RAM.

The 2186 is called a "pseudo static" RAM chip, because it provides its own refresh for the dynamic cells. This self-refreshing feature is desirable, but could result in unstable data if an access were to occur while such a refresh were in progress. To avoid this problem, the RAM "ready" lines go false during static refresh, causing the system to wait until the refresh cycle is complete. The 510 ohm pull-up resistor on the READY line provides current for the open-drain output.

There are no straps associated with these RAMs because their parameters are fixed.

The Display List (segment) Memory is located on the RAM3 board for the 256k bytes of RAM (address 20000 – 3FFFF and C0000 – DFFFF).

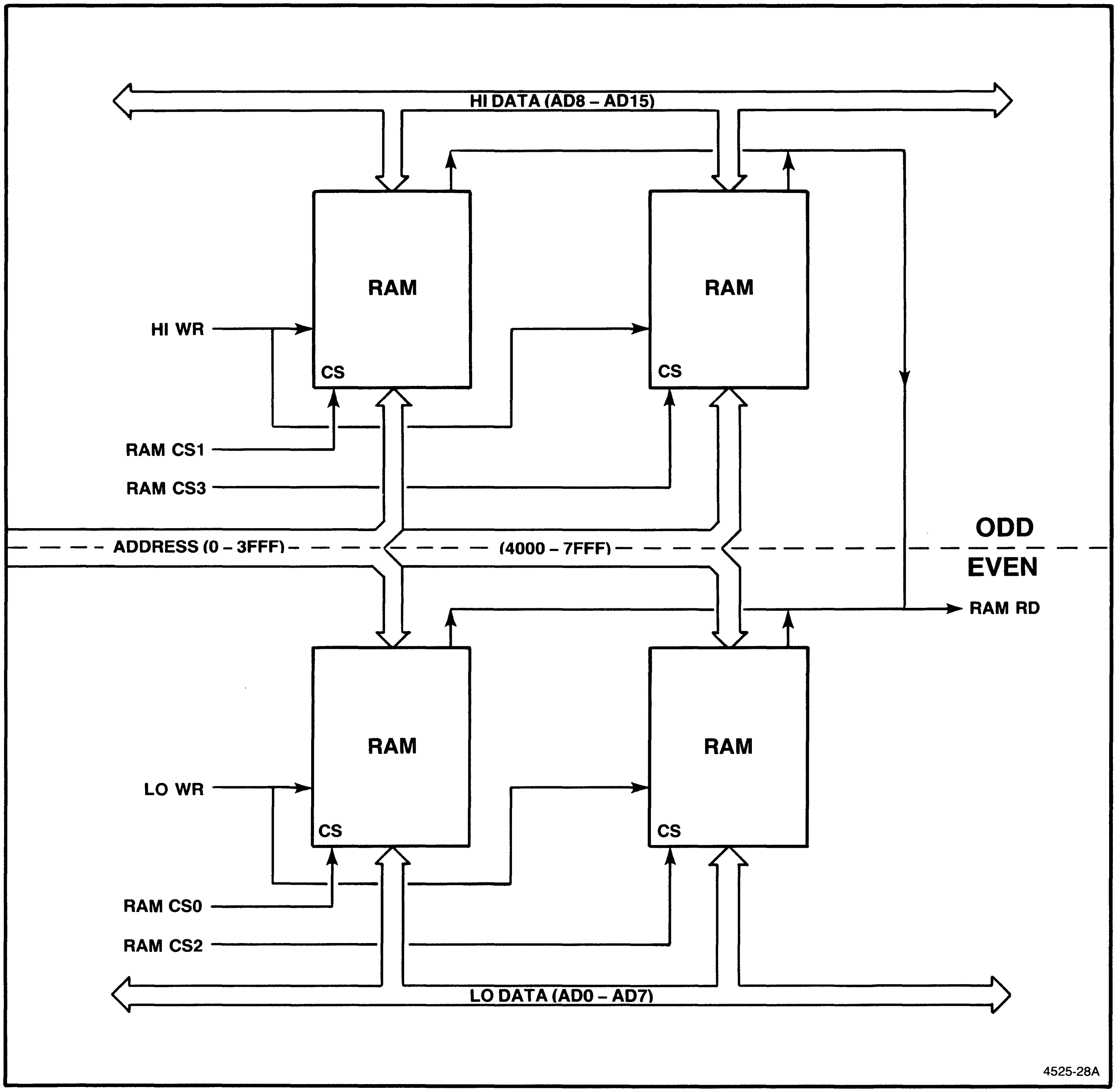


Figure 4-14. RAMs Block Diagram.

KEYBOARD AND RS-232 HOST COMMUNICATIONS PORT BLOCKS

The Keyboard-to-Processor Interface and the Host Communications-to-Processor Interface are both handled by a single two-channel chip (a DUART). The basic functional arrangement of these circuits is shown in Figure 4-15.

Notice that both channels connect to the Processor Data Bus and Address Bus. Also the processor may receive DMA requests, or non-maskable interrupts, directly from the Host Communications Port via the RCV/RDY line.

DUART Transceiver Chip

The DUART (Dual Asynchronous Receiver/Transmitter) is a 2681 chip. Figure 4-16 is the generalized block diagram for this DUART chip. In this diagram the two channels are called channels "A" and "B." Channel A shows its functional details. Since channel B is identical in hardware composition to channel A, the diagram omits the detail in Channel B. Channel A functions as the Keyboard I/F, and Channel B is the Host Port I/F for the terminal.

The 2681 possesses the following features:

- Both channels are full-duplex asynchronous
- Quadruple buffered receiver data registers
- Programmable data format
- Programmable baud rates for each channel

The chip contains a multi-purpose, 7-line input port, and a multi-purpose 8-bit output port. The chip also contains a timing block that either provides timing for the chip, or accepts external timing (as from the processor). An Interrupt Control and an Operation Control block manage the read, write, interrupts, and address decoding functions.

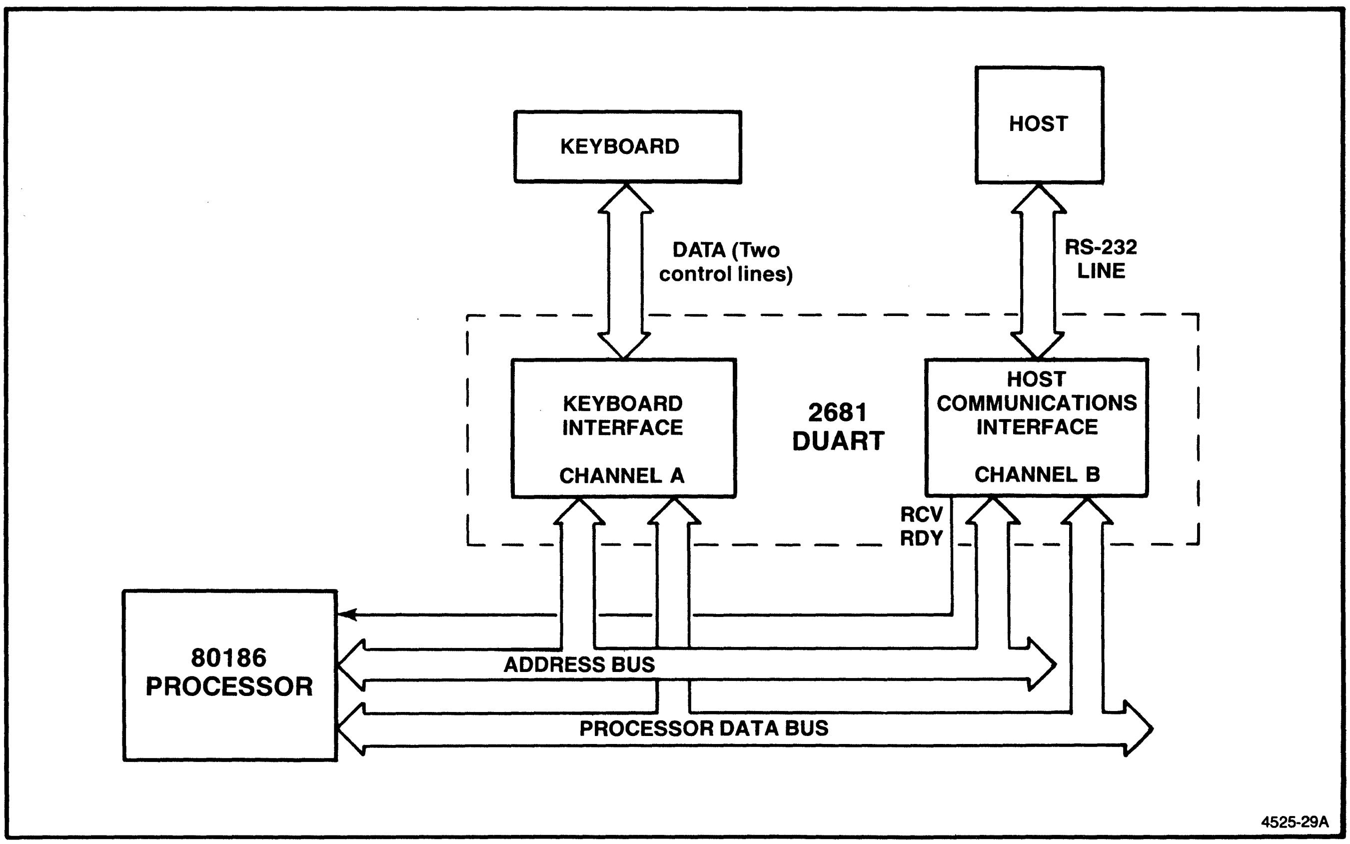


Figure 4-15. Keyboard and Host Comm I/F Blocks.

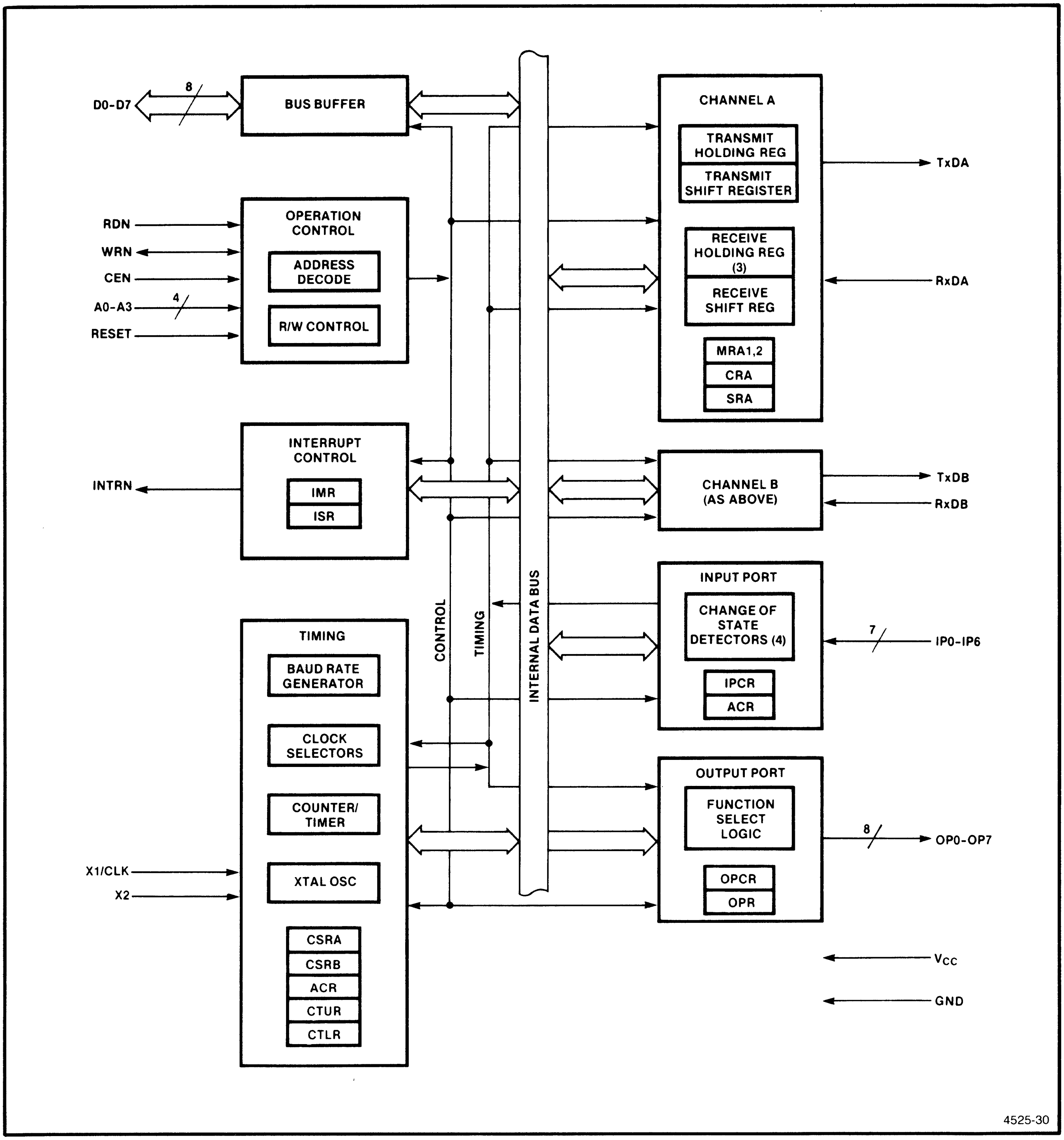


Figure 4-16. DUART General Block Diagram.

Keyboard Interface

This circuitry provides the data input, data output, reset, and power supply to the keyboard. This description covers both the external circuitry and the internal DUART functions. This circuitry is described first as it functions when the keyboard generates data; next, the same circuits are described during information flow to the keyboard.

As a key is pressed, data flows from the keyboard toward the RXDA (Receive data, channel A) input of the DUART. This data path flows through two intermediate circuit blocks shown in Figure 4-17. The first circuit is a set of diodes and resistors that function as a level shifter; this circuitry also provides termination for the keyboard driver circuit. The second circuit is called the clamping gate; it prevents the keyboard from overrunning the 2681.

The DUART's OP4 output makes the RXRDA-0 (receive ready channel A) signal. When the DUART receives a character from the keyboard, it asserts this line, which activates the clamping gate. The clamping gate holds KBRDATA-1 low, which is monitored by the keyboard. The keyboard will not send any more characters to the DUART until this line goes high. The clamping gate also forces the DUART's RXDA line inactive, so the DUART cannot interpret the clamp as a character. After the processor has read the data out of the DUART, the DUART negates the RXDYA line; this releases the clamp, which alerts the keyboard that it is again free to send. This implements the keyboard-to-processor handshake protocol.

Before the processor sends a command to the keyboard, it first reads the DUART's IP4 status line. If the keyboard is not ready to receive a command, it clamps KBTDATA-1 low; this makes IP4 go high. While this condition is true, the processor waits to send the next command until the keyboard releases KBTDATA-1. This implements the processor-to-keyboard handshake protocol.

During Self Test, the keyboard is held in a reset condition (via OP3 of the DUART) while the local interface circuitry is being tested. The KBTEST-1 signal enables the 74LS38 (U275C); this causes the transmitted data on KBRDATA-1 to loop back into KBRDATA-1, where is is received by the DUART as if it had come from the keyboard. This allows both the input and the output data paths to be verified by Self Test.

The 14.7456 MHz DISPCLK signal clocks the DUART. The system clock passes through a pair of flip-flops configured as a divide-by-four counter, which provides the 3.6864 MHz clock required by the DUART.

The general purpose output, OP3, is programmable to reset the Keyboard.

RS-232 Host Communications Interface

Channel B of the 2681 DUART is the host communications interface. The external circuitry to the chip is minimal, consisting of buffers and a combinational logic chip for the DTR signal. Table 4-3 relates the RS-232 connector pin numbers to their corresponding DUART pin numbers. The table also gives both RS-232 names and DUART names.

The OP7 output from the DUART is used with Self Test to light an LED for certain error codes.

The DTR (Data Terminal Ready) condition is derived from the logic states of three DUART output lines. The first line, OP5 is the same as the RXDB (buffered receive data available) input to the DUART. The states of the other two lines, OP2 and OP6, are determined internally, by programming of the DUART.

The timing and other general DUART functions were covered under the Keyboard Interface heading.

Table 4-3

HOST PORT INTERFACE PIN NUMBERS

RS-232 Connector			DUART Connector	
Pin	**Name**	**(to/from Host)**	**Pin**	**Name**
1	Chassis	Ground		
2	TDATA	(to)	11	TXDB
3	RDATA	(from)	10	RXDB
4	RTS	(to)	12	OP1
5	CTS	(from)	4	IP1
6	DSR	(from)	36	IP2
7	Signal	Ground		
8	DCD	(from)	7	IP0
11	SRTS(A)	(to)	W493	(pin 29 OP0)
12	SDCD	(from)	2	IP3
15	TC	(from)	38	IP5
17	RC	(from)	37	IP6
19	SRTS(C)	(to)	W493	(pin 29 OP0)
20	DTR	(to)	14	OP5
			26	OP6 > combined
			28	OP2

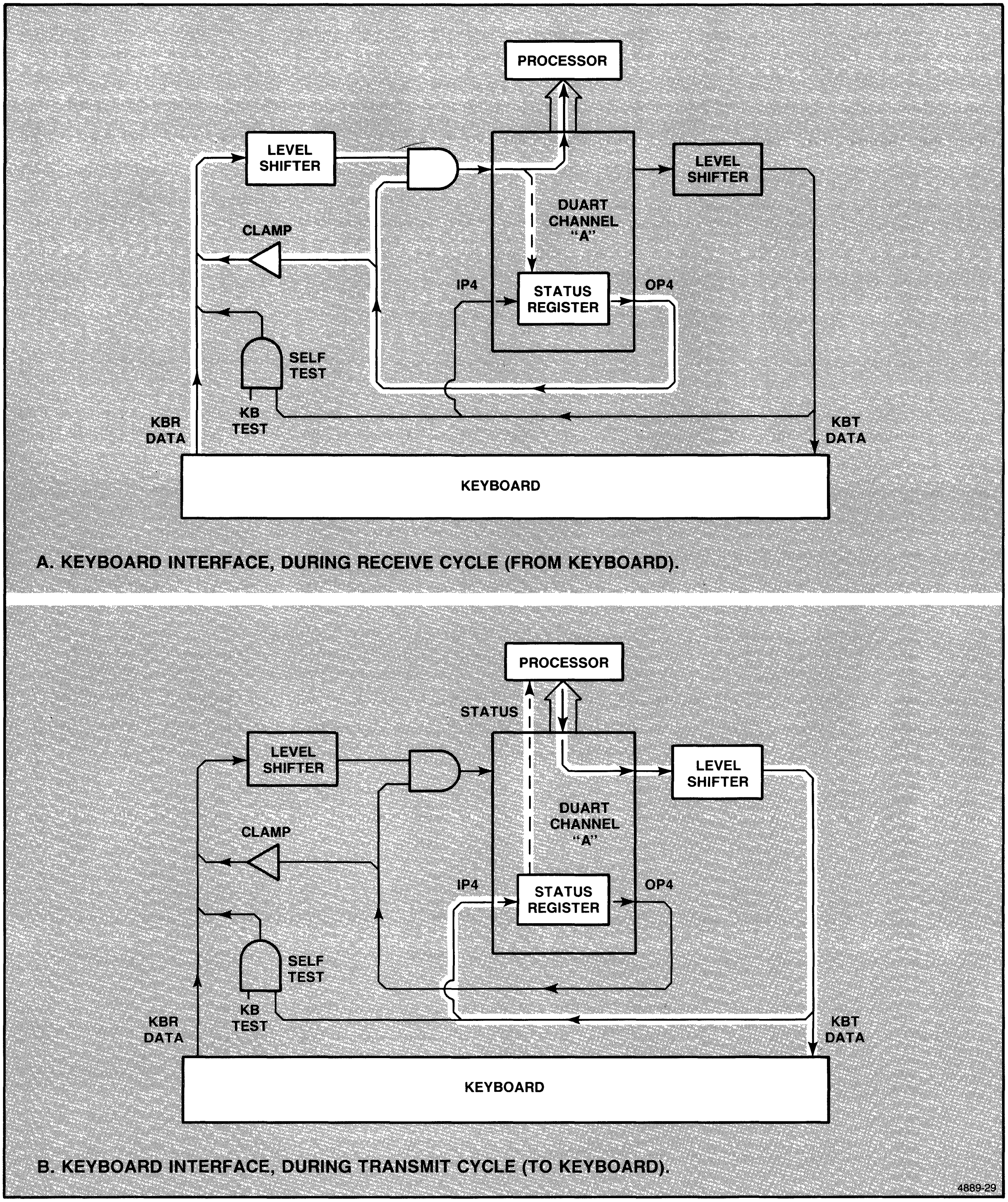


Figure 4-17. Keyboard Interface.

HARD-COPY/PRINTER INTERFACE

Terminal-to-printer interfacing is provided by:

- an 8255A interface chip,
- a 10-bit buffer, and
- a schmitt trigger.

Figure 4-18 is a functional representation of the I/F chip and the supporting circuitry that together form the Printer I/F block. The 8255A is a programmable chip with three I/O ports, an input data buffer, and a control block. The three ports may be programmed for various uses depending on the particular application. As used in this circuitry, the A Port functions as a data output port (supplying the data lines to the printer). The B Port functions as a feedback input, from the printer, and other system status. The C Port handles the lines that control the printer, and other system functions.

The A Port output passes through a buffer on its way to the printer's data input connector. The data input, to the 8255A I/F chip, is buffered by an internal buffer. The schmitt trigger circuit, outside the chip, regulates and inverts the feedback lines between the printer and the I/F chip. The acknowledge line enters Port C, instead of Port B, so this feedback line is not inverted as the others are. The schmitt trigger still clamps/regulates this acknowledge line.

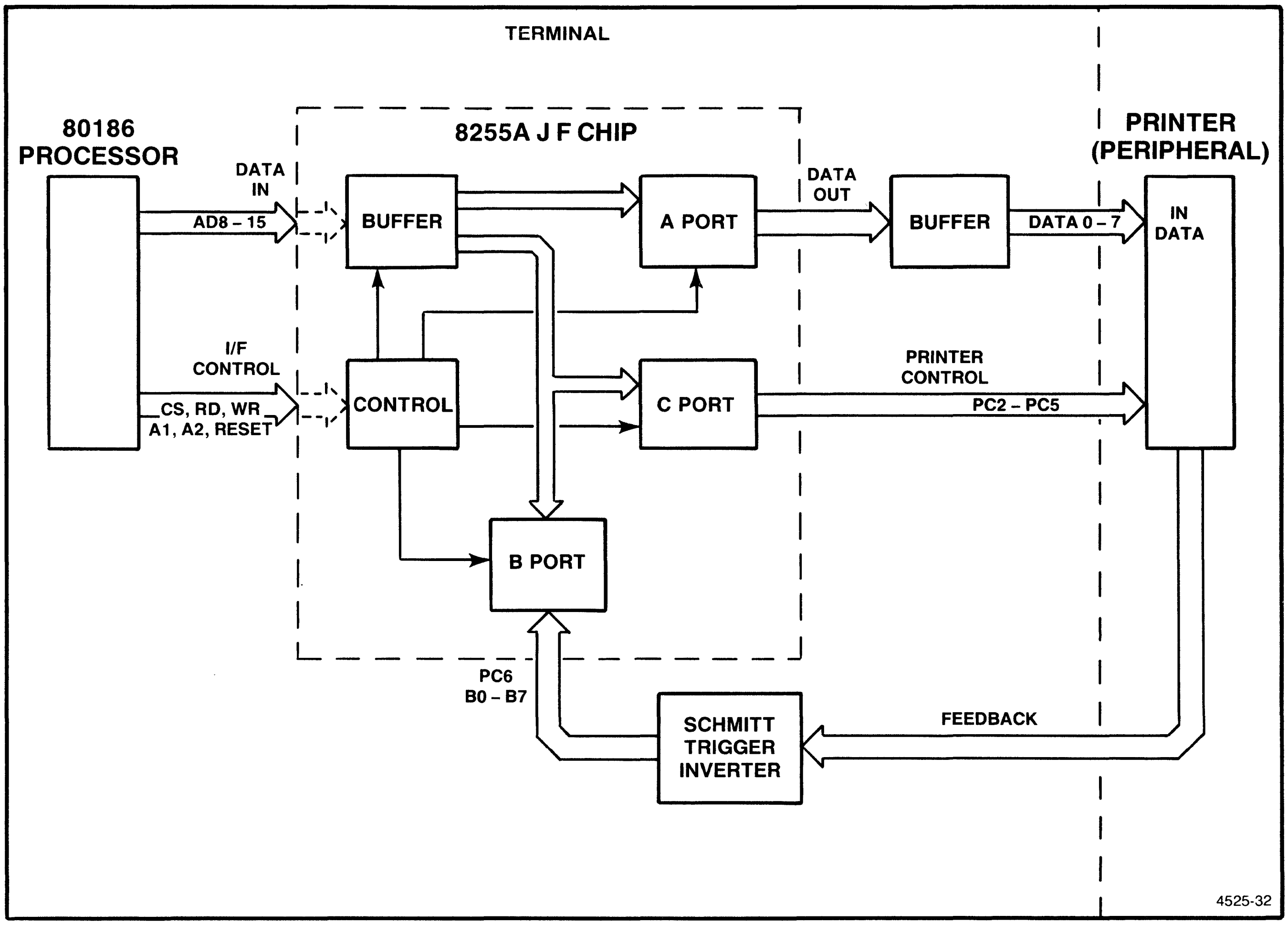


Figure 4-18. Printer Interface Block Diagram.

2-PORT PERIPHERAL INTERFACE

The terminal has two RS-232 ports, through which it communcations with RS-232 peripheral devices such as plotters or graphic input tablets. These two ports, and their associated firmware, are known as the 2PPI, 2-Port Peripheral Interface. The 2PPI uses the 2681 DUART (Dual Asynchronous Receiver/Transmitter) chip, shown in Figure 4-16. The 2681 contains a multipurpose, 7-line input port, and a multipurpose 8-bit output port. The chip also contains a timing block that either provides timing for the chip, or accepts external timing from the processor. An Interrupt Control and an Operation Control block manage the read, write, interrupts, and address decoding functions.

There is also an 8-line data buffer to minimize the potential of receiver overrun. It is controlled by the operation control block to allow read and write operations to take place between the controlling CPU and the DUART. Each channel A and B have a Transmit Holding Register, Transmit Shift Register, Receiver Holding Register, Receiver Shift Register, Mode Register, Command Register, and a Select Register.

The operating frequency for each receiver and transmitter can be selected independently from the baud rate generator, the counter timer, or from an external input.

The transmitter accepts parallel data from the CPU, converts it to a serial bit stream, inserts the appropriate start, stop, and operational parity bits and outputs a composite serial stream of data on the TxD output pin. The receiver accepts serial data on the RxD pin, converts this serial input to parallel format, checks for start bit, stop bit, parity bit (if any), or break condition and sends an assembled to the CPU.

The 2681 possesses the following features:

- Both channels are full-duplex asynchronous.
- Quadruple buffered receiver data registers.
- Programmable data format.
- Programmable baud rates for each channel.

The DUART, that drives the two RS-232 style connector peripheral ports, is chip-selected by PCS-0. The chip uses address lines A1 through A4. It also connects to data lines AD8 through AD15 (high byte). The write enable is driven by BHE and BWR. The read enable is controlled by BRD. The interrupt output is ORed with PRINTERINT-1 and they drive INT2-1.

The 2PPI has the following RS-232 output pins:

- FGND (pin 1) – frame ground or chassis ground.
- TDATA, transmitted data (pin 2) – The terminal receives data from the peripheral device on this signal line.
- RDATA, received data (pin 3) – The terminal transmits data to the peripheral device on this signal line.
- RTS, request-to-send (pin 4)
- CTS, clear-to-send (pin 5) – Used for DTR/CTS flagging between the terminal and its peripheral device. By asserting CTS, the terminal grants permission for the peripheral device to send data to it.
- DSR, data-set-ready (pin 6)
- SGND, signal ground (pin 7)
- DCD, data-carrier-detect (pin 8)
- DTR, data-terminal-ready (pin 20) – Used for DTS/CTS flagging between the terminal and its peripheral device. By asserting DTR, the peripheral device grants permission for the terminal to send data to it.

BELL CIRCUIT

The "speaker" for this terminal is a small audio transducer that provides the bell tone (prompt). This circuit is driven by one of the timer outputs from the processor. Firmware determines the output frequency, which in most cases will be about 2000 Hz.

KEYBOARD MODULE THEORY

The Keyboard Module is physically separate from the terminal, the only connection is by a cable. The Keyboard Module contains:

- the alphanumeric keyset
- the numeric keypad
- graphics joy-disk
- twelve special-purpose function keys
- a keyboard controller chip
- Two character decoder chips
- Other associated circuitry (drives CAPS LOCK key LED, etc.)

Figure 4-19 depicts the arrangement of the various functional parts of the keyboard module.

The keyboard operates through a full duplex serial interface. The data protocol is 1200 baud asynchronous. The timing and data transmission is typical of a standard DUART, and is a serial data stream as depicted in Figure 4-20.

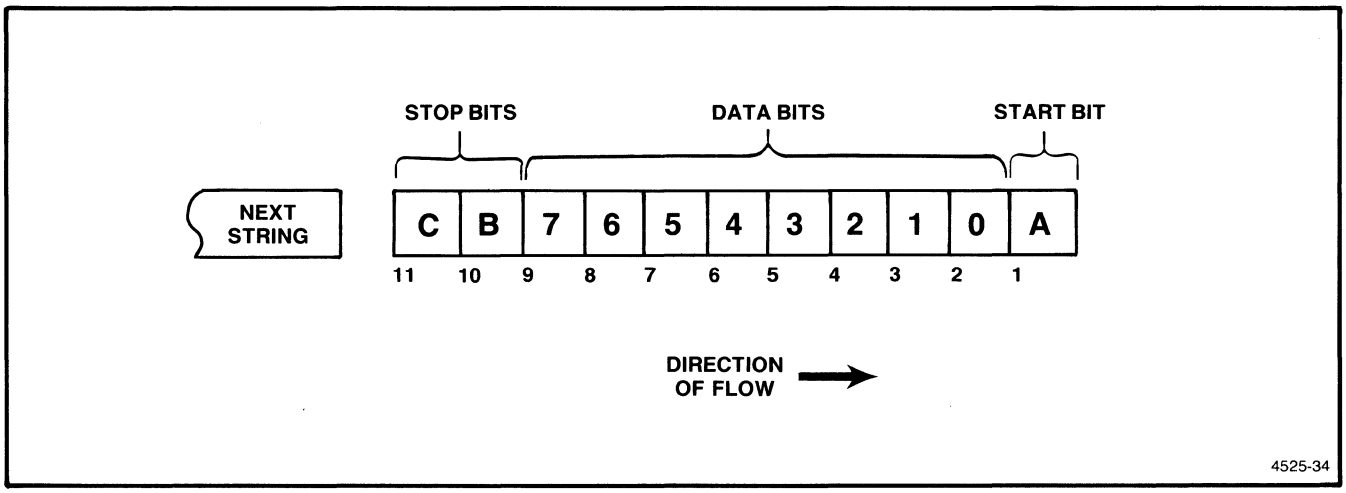


Figure 4-20. Serial Character Format.

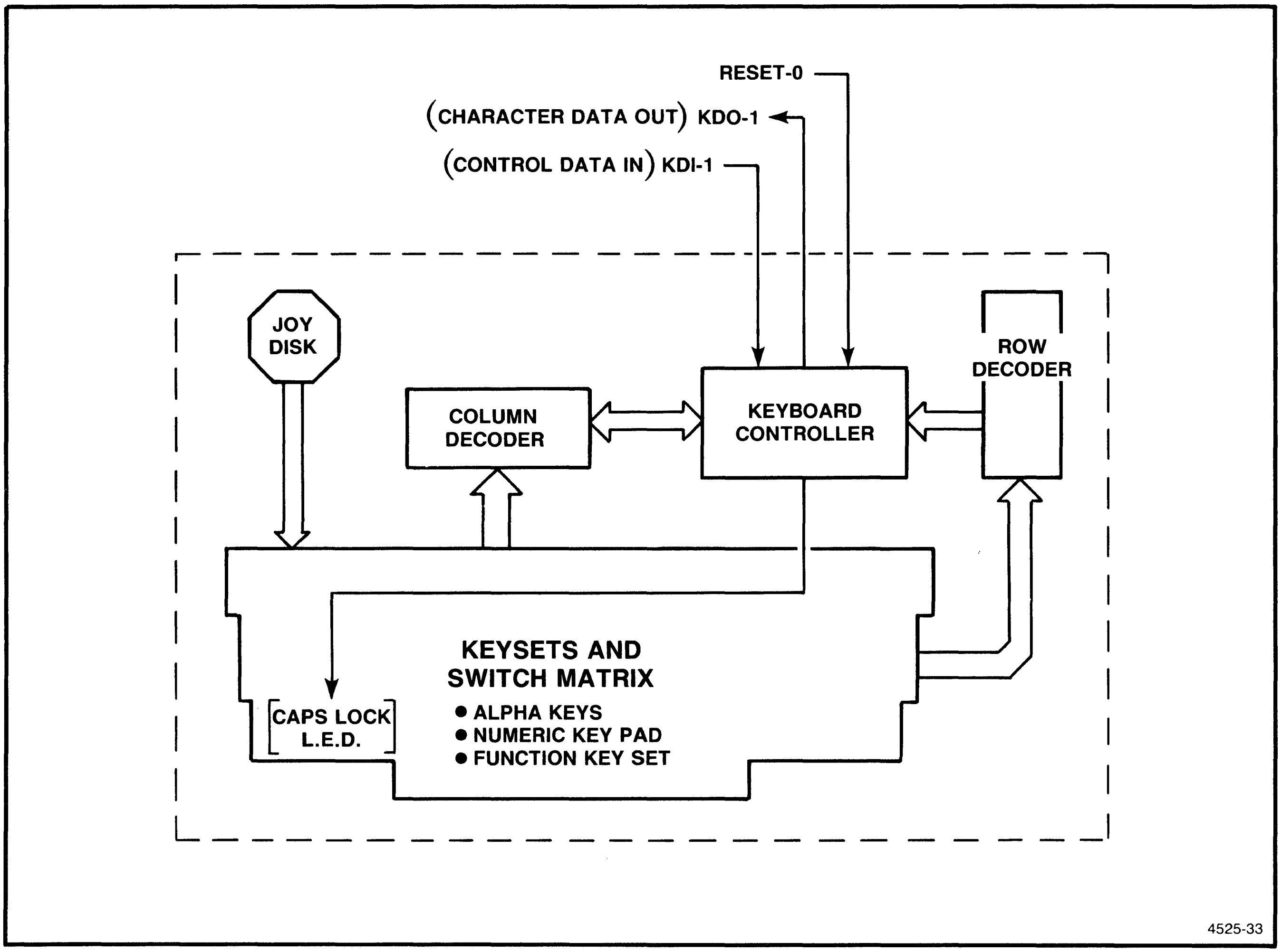


Figure 4-19. Keyboard Module Block Diagram.

KEYBOARD CONTROLLER IC

The keyboard controller is a microprocessor that interfaces between the keyboard and the rest of the terminal. It operates between the Keyboard/Host Comm I/F (on the Terminal Control board), and the key character decoders (on the keyboard module). Figure 4-21 is a functional block diagram of this keyboard controller chip. This controller scans the keys and then debounces the key codes when a key is pressed. The controller places the key characters in an output queue; an 8 byte FIFO. Characters then exit the FIFO over the KDO-1 output line.

The terminal processor manages this controller according to the firmware in the terminal's ROMs. The controller receives control or flagging information (from the processor and Keyboard/Host-Comm I/F) over its KDI-1 and RESET-1 input lines.

The Keyboard Module interface consists of five lines:

- KDI-1 (pin 1) – Keyboard Data In (to the Keyboard Module)
- KDO-1 (pin 2) – Keyboard Data Out (to the main terminal)
- RESET-0 (pin 4) – Reset to the keyboard
- GND (pin 5) – Ground to the keyboard
- +12V (pin 6) – Vcc power to keyboard

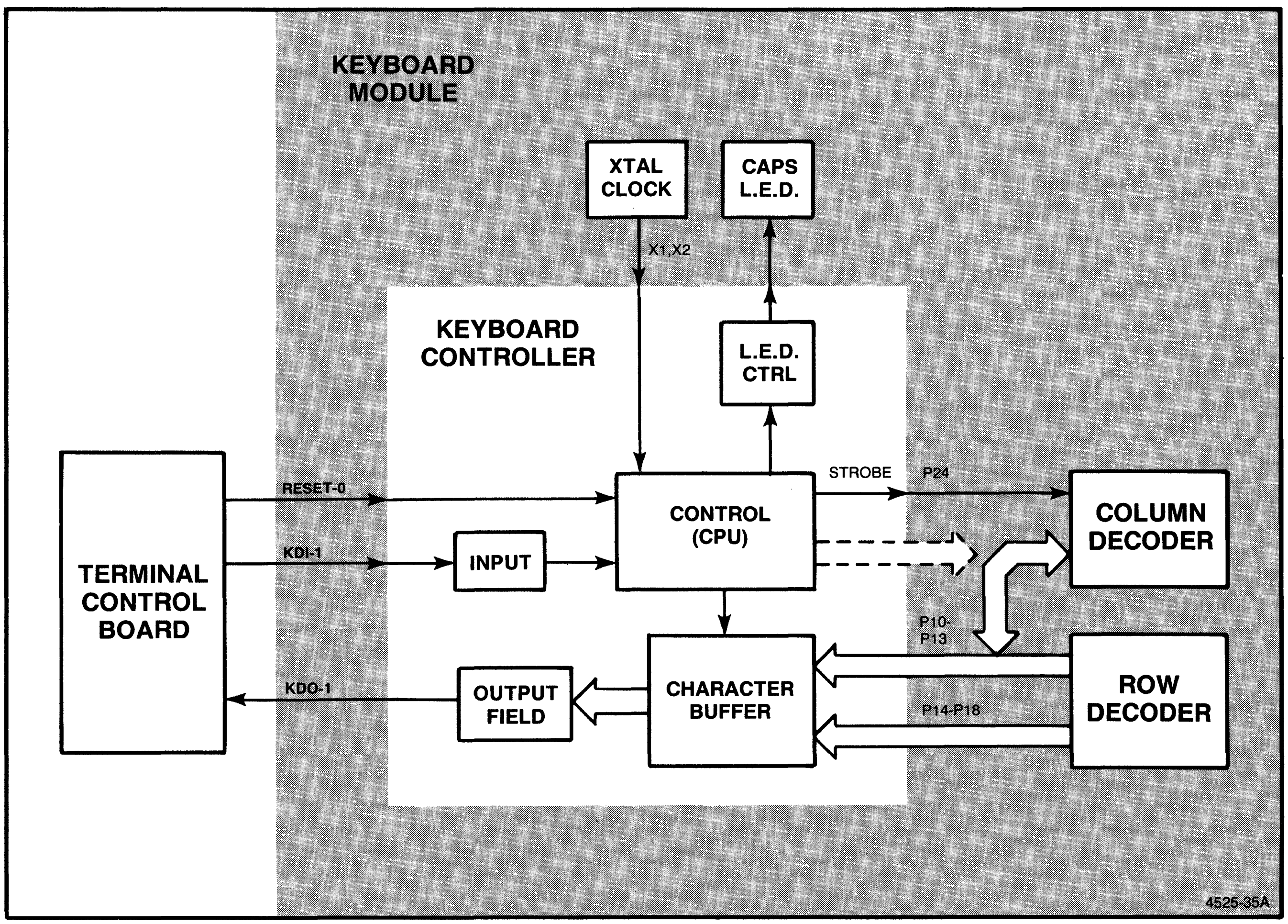


Figure 4-21. Keyboard Controller Block Diagram.

OPERATION OF THE CHARACTER DECODERS AND KEYBOARD

The two keysets (alphanumeric and numeric pad) and the joy disk all consist of key switches that make contact at row-column intersections in a matrix of circuit runs. When a key is pressed, a connection is formed between one row and one column in the matrix. A unique combination of row and column connections specifies each particular key. See Figure 4-22.

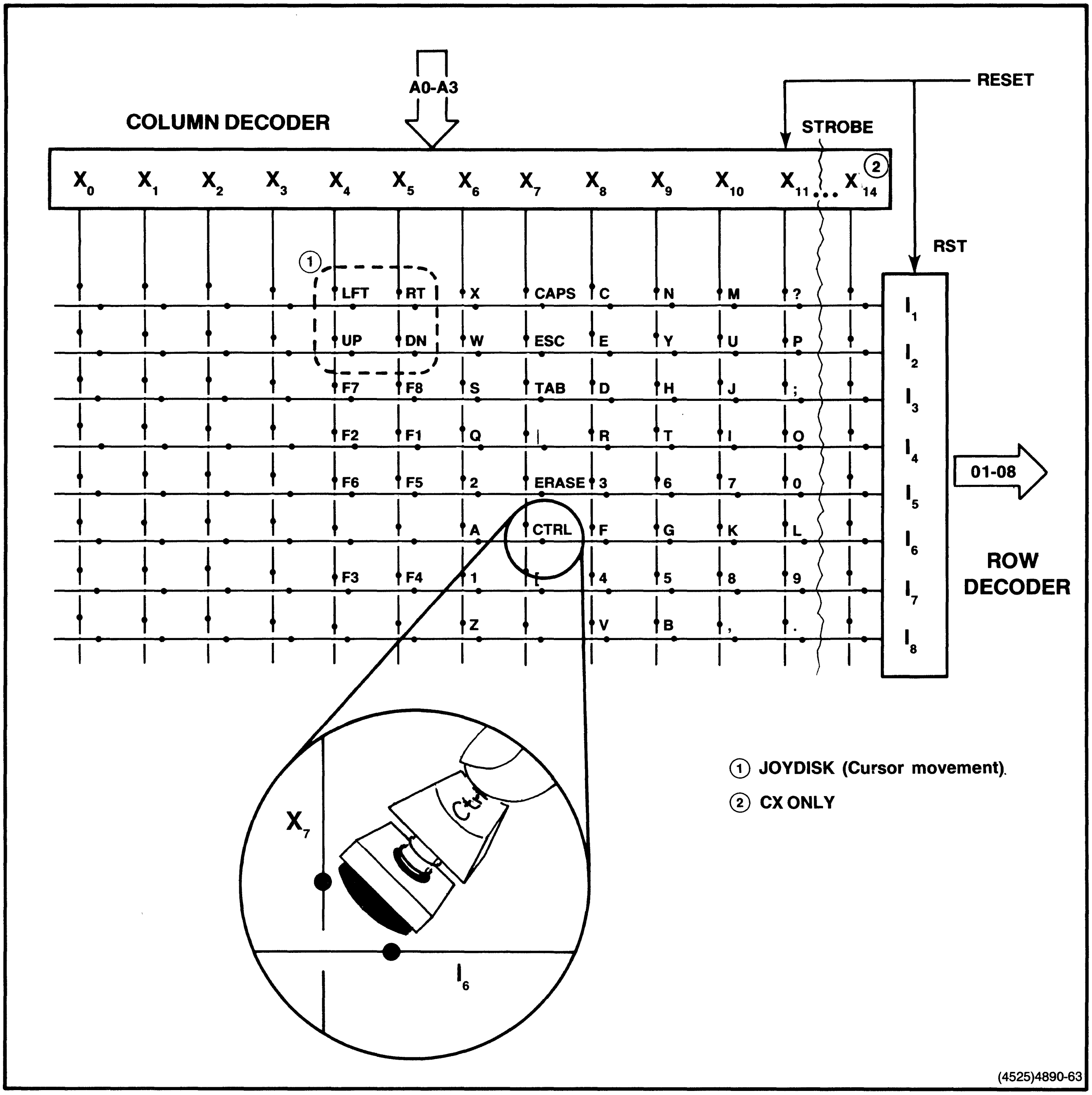


Figure 4-22. Key Matrix and Row/Column Decoders.

CHARACTER GENERATION

Sequence of events for generating a key code:

1. The keyboard controller places a strobe on the column decoder; this disables the outputs of the column decoder, but allows the controller to sequentially read the column line status.

2. The controller then sequentially reads the status of the column lines in the key matrix (via the column decoder chip).

3. When the controller detects a key is pressed, it reads all the row lines (via the Row Decoder) to see which row is also active.

4. From the known active row and active column, the controller generates the appropriate character code. This code is actually two codes: a press code and a release code. The press code falls in the range of X'00' to X'59' (X'00' to X'68' for the CX keyboard). The release codes are formed by adding X'80' to the corresponding key-press codes. These codes are shown on diagrams at the end of Appendix E. (Appendix E also shows the EBCDIC code charts for the CX terminals.)

5. The controller sends a serial character code to the Terminal Control board over the KDO-1 output line. See Figure 4-20, again.

DISPLAY CONTROL BOARD CIRCUIT THEORY

OVERVIEW AND GENERAL DESCRIPTION

The Display Control Board (DCB) generates and stores all of the graphics and dialog (text) data, and it makes control signals for the Display Module. The DCB consists of four major functional units (see Figure 4-23):

- Processor interface (via terminal's system bus).
- Graphics memory and control logic. The graphics memory stores 1024 by 512 pixels, of which 640 horizontal by 480 vertical pixels are displayable. The bit map is four bits deep, allowing sixteen graphics colors to be displayed at once.
- Dialog (alphanumeric) memory and control. This circuitry consists of the dialog memory, its controller chip, and other control logic. The dialog memory is list driven and provides the text on the dialog part of the display screen.
- Pixel Priority Control Logic and Color Map. The pixel priority logic places the cursors, graphics, and dialog text on the proper layers on the display. The Color Map is programmable by the user and allows any dialog/graphics/graphic-cursor values to be reprogrammed to any one of the available colors.
- Timing, syncs, and clocks. This circuitry controls the timing of the display system and synchronizes the various circuit blocks and the display module to itself.

Figure 4-24 is a detailed block diagram of the DCB. The block names correspond to the names on the schematics (Section 11), except where a block is divided into even smaller functional blocks. The Graphics Memory Control block and Graphics Memory (Planes 0, 1, 2, 3) are shown as dotted boxes and are divided into smaller functional units.

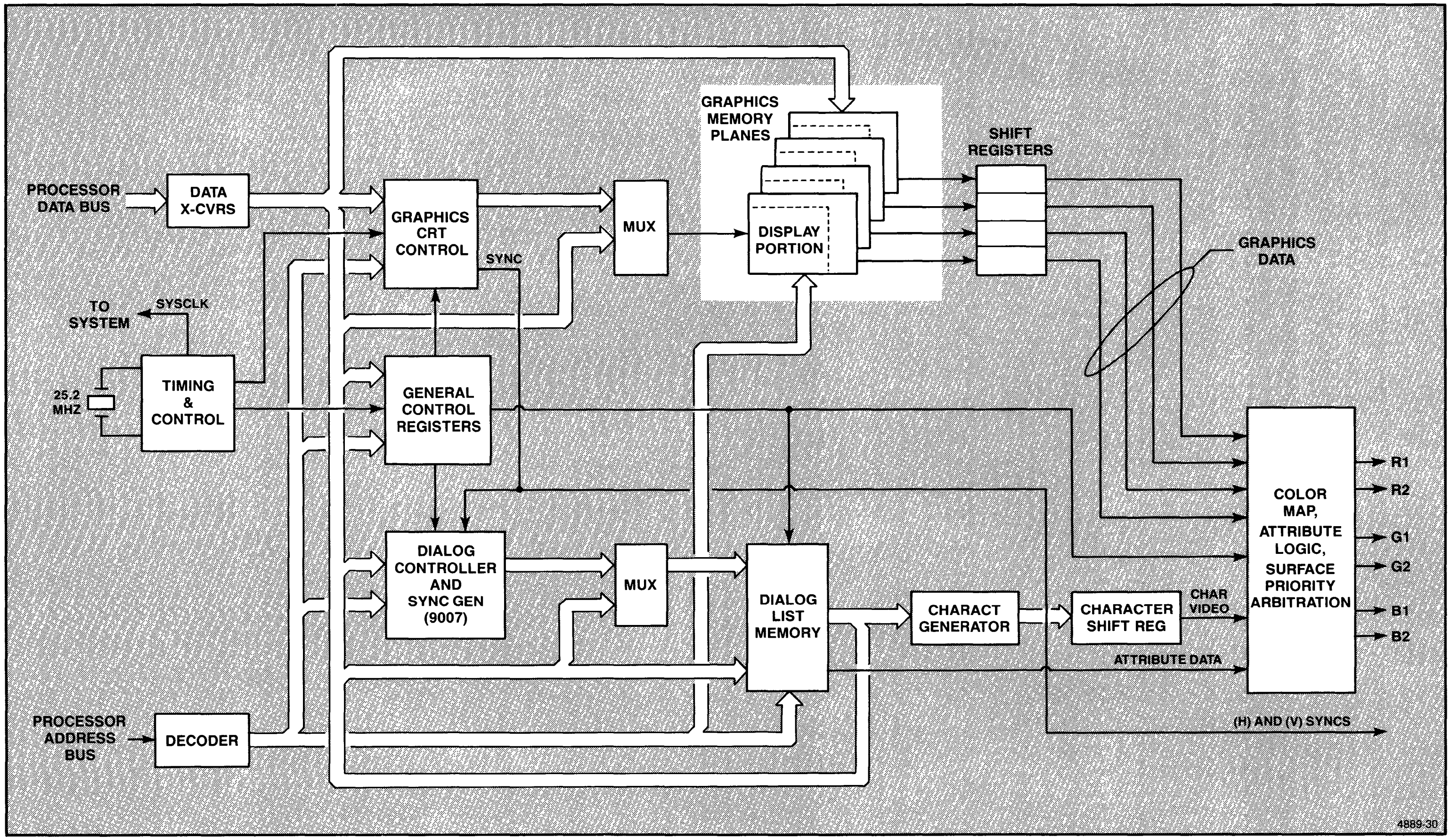


Figure 4-23. Display Control Board Simplified Block Diagram.

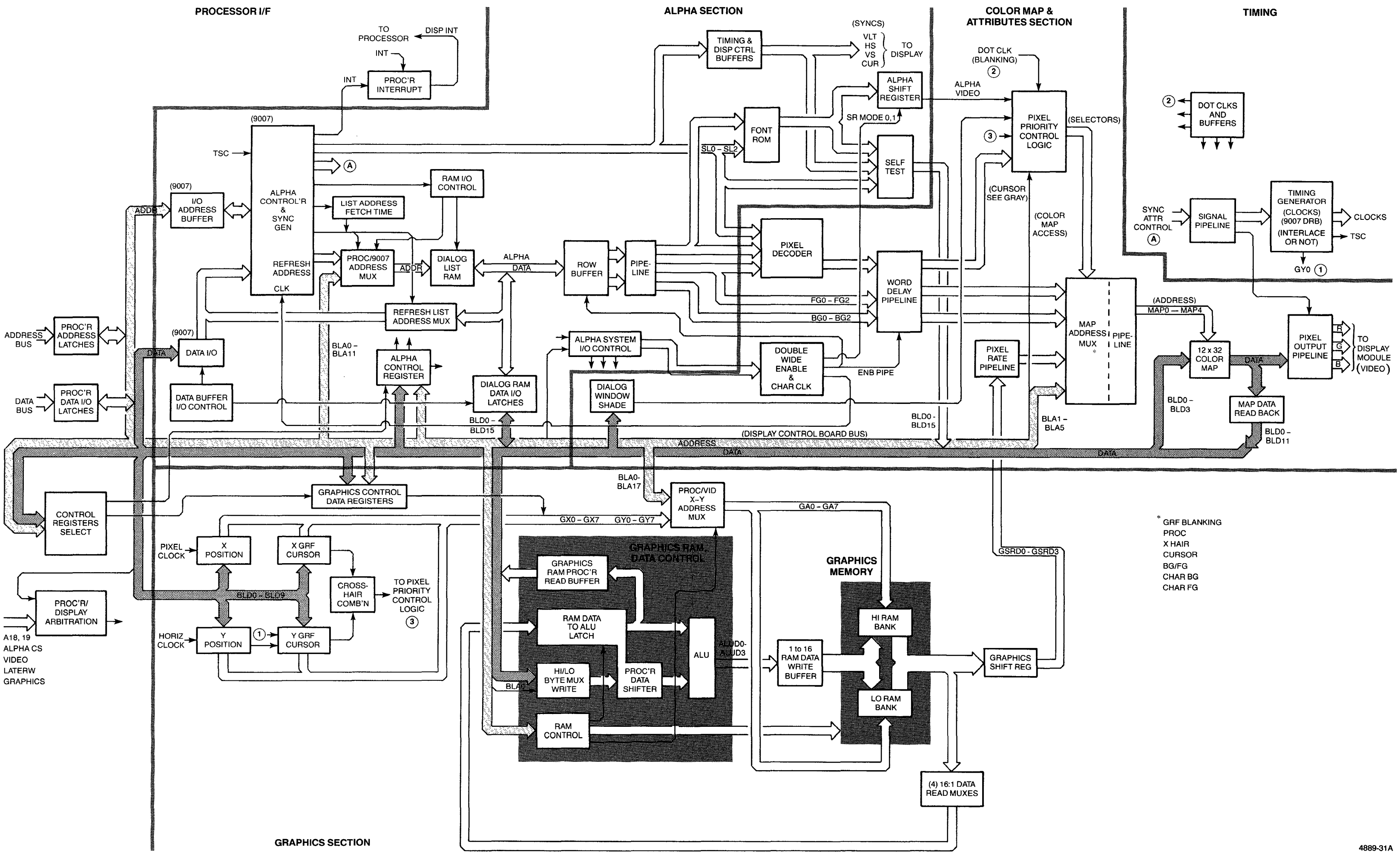


Figure 4-24. Display Control Board Detailed Block Diagram (for enlarged version, see Figure 10-4).

PROCESSOR INTERFACE

The DCB receives data, address, and status information from the processor (on the Terminal Control Board) via a set of latches, collectively called the Processor Interface; the data latches retain data passing to and from the processor.

These blocks interface between the DCB's main bus and the system processor bus (on the Terminal Control board). This portion of the circuitry also includes the control registers for the Alpha and Graphics I/O circuits; this block converts DCB bus addresses and data for the alpha and graphics circuits. See Figure 4-25.

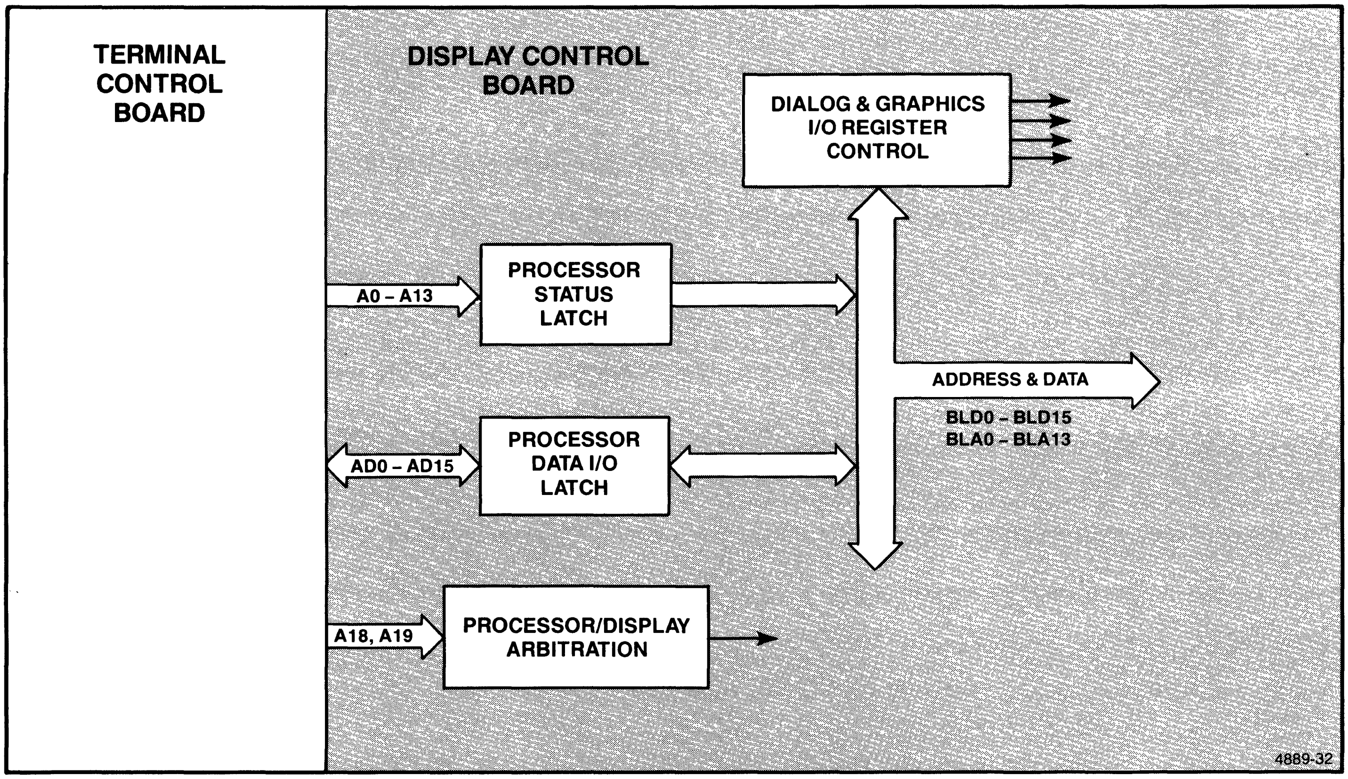


Figure 4-25. Processor Interface to Display Control Board.

Processor Address Latches

This block consists of three latches that capture address and status information from the processor's AD bus. The system address lines, A0-1 through A13-1, are latched and placed on the DCB address bus as BLA0 through BLA17-1 ("big latch" address).

Besides serving as the address interface, this block also accepts status information from the processor. The latches receive the following status lines:

- WRCY-1 Write cycle
- BHE-1 Byte high enable (used with address bit, AO, to determine if the low byte, high byte, or both are to be enabled).

These signals are all transferred onto the DCB bus and are named the same except for the BL in front (i.e. BHE becomes BLBHE, and WRCY becomes BLWRCY).

These latches are clocked by BLCLOCK-0 from the Processor/Display Arbitration circuit.

Processor Data I/O Latches

This block consists of two bi-directional latches that pass data back and forth from the system data bus to the DCB data bus. The system data lines, AD0-1 to AD15-1, become BLD0-1 to BLD15-1. The send versus receive signals come from the Processor/Display Arbitration circuit block; this block also provides the clock for these I/O latches.

These latches pass read data from the DCB to the processor in the usual manner. However, when the processor writes instructions to the DCB (processor-to-display write cycle), these latches operate as follows: The processor writes address, data, and status into the latch upon BLCLOCK-0. Then, the processor is free to execute other operations (bus cycle, etc.) while the DCB is acting on this instruction. If the processor tries to send another instruction to the DCB before it has finished executing the first instruction, the READY line causes the processor to wait until this instruction is executed. This scheme speeds up operations, by permitting the processor to perform other operations while the DCB is busy.

Alpha & Graphics Control Registers

This block consists of three pairs of registers: the alpha and graphics registers selector, the alpha control/status register,and the graphics control/status register. The alpha and graphics registers are bi-directional, allowing a status read as well as control write.

Control Registers Select. This register makes the I/O enable lines for several circuit blocks on the DCB. Each of the two chips receive address inputs via BLA1-1 to BLA6-1. One chip sends word/byte read requests to the addressed blocks; the second chip generates word write strobes for certain blocks. The word read register is enabled by the VIDIO and RENB (Front-End PAL). The word write register is enabled by the HWSTB (hardware strobe) line.

The outputs from the read register are:

- TESTRD-0 — Read enable for Self Test buffer.
- FONTRD-0 — Read enable for alpha Font ROM buffer.
- GCNTLRD-0 — Read enable for the Graphics Control Register.
- ACNTLRD-0 — Read enable for the Alpha Control Register.

The outputs from the write register are:

- XPAN-0 — write strobe for the X-Crosshair Pan register.
- YPAN-0 — write strobe for the Y-Crosshair Pan register.
- XCUR-0 — write strobe for the X-Cursor register.
- YCUR-0 — write strobe for the Y-Cursor register.
- TBWIN-0 — write strobe for the "top/bottom alpha window shade."
- GCNTLWR-0 — write strobe for the Graphics Control Register.
- ACNTLWR-0 — write strobe for the Alpha Control Register.

Alpha Control Register. This register interfaces between the board's data bus and the alpha/dialog control lines. The register accepts control input from the processor and sends this out over its main output lines. The register also allows the processor to read the current status of the same control lines. These control lines are:

- CHARBLINKCLOCK-1 — Character blink clock; accepts alpha character blink command (See NOTE).
- CUBLINKCLK-1 — Cursor blink clock; accepts alpha cursor command (See NOTE).
- BLOCKCUR-1 — Changes alpha cursor from two-line to full-cell cursor.
- XPRNTENB-1 — Blocks out graphics in cells where alpha characters also appear on display. When set, it enables graphics pixels to be seen behind characters that have a background color of 0.
- APAGE0-1 to APAGE2-1 — to Character Font ROM; not used in current applications (smaller ROMs do not require it).
- CLRPIX-0 — "Clear pixel" sets the pixel value to black (no video); used only for testing.
- VRESET-0 — "Video reset" is used to test the video section.
- ATTRTEST-1 — This allows Self Test to check the attribute gate array.
- VIDOFF-1 — Turns off video at the Display Module.
- CAL-1 — not used.
- STOPPIX-1 — This line allows the processor to read the Color Map without causing interference on the display screen; it temporarily disables the clock enable to the video output register.
- ODD-1 — not used.

NOTE

The blink rate for alpha characters and cursor is controlled by firmware (not these hardware registers).

These register chips are clocked in the write direction by ACNTLWR-0 (the enable pins are tied active). The chips are clocked in the status-read direction by RAMRDCLK-0; the read enable comes from ACNTLRD-0.

Graphics Control Data Registers. The terminal uses this register to set up the various graphic circuitry control parameters.

This block consists of two registers which receive control signals from the DCB data bus. These latches decode their data input lines (from the processor) into actual control signals for the various graphics circuit blocks. The processor may also read these latches, to examine the current status of these control lines.

These registers send out the following graphics control lines:

- SHIFT0-1 to SHIFT3-1 — These lines control the shift modes of the data shifter PAL, which controls the shift register's shift/count operations. See Table 4-6 (Data Shifter Modes) for details.
- GPAGE1-1 — This selects "graphics page 1" (versus "page 0") for reading data from graphics memory.
- GWREN0-0 to GWREN3-0 — These are separate write enable lines for the four memory planes in the graphics bit map.
- ALU0-1 to ALU2-1 — These lines select one of eight modes for the ALU (writing data into the graphics memory). See Table 4-5 (ALU Modes) for details.
- WRBOTH-1 — This enable allows simultaneous writing to both halves of the graphics memory; this is used primarily for fast screen erase.

The two chips that make this register, are permanently enabled in the write direction and are clocked by GCNTLWR-0. The same chips are read enabled by GCNTLRD-0; the chips are read-clocked by RAMRDCLK-0.

Processor Interrupt

This block provides interrupt feedback to the processor. The alpha controller chip generates an interrupt signal called INT-1. This signal is ORed with the system interrupt signal (INT-0), from the additional 96-pin connector. The resulting signal, DISPINT-1, is placed back on the system bus to the processor. This signal tells the processor that the DCB is generating an interrupt and wants service.

Processor/Display Arbitration

This block is a programmable array logic chip that could be called the "front end PAL" (since it drives the control PALs for the alpha and graphics systems). The main function of this chip is arbitration between the processor and the DCB for controlling the alpha and graphics sections. The chip functions as a two-bit state machine (four states) that tells the processor if the DCB is busy or not. The four states and jump conditions are shown in Figure 4-26. The chip accepts numerous inputs that indicate the busy condition of the DCB. When the board conditions are right and the right PAL states are up, the processor can access the DCB.

The inputs for this chip are certain control lines on the DCB bus and certain control and I/O lines from the system bus. These inputs are combined by the internal logic array to make the required output signals. The outputs control the Processor I/O Data Latch and the Graphics and Alpha Control Registers. These input lines and conditions are:

- GBUSY-0 — Graphics system busy report.
- ABUSY-0 — Alpha system busy report.
- LS2-0 — Not I/O space. "Latched status 2"; a processor status bit that indicates whether the current bus cycle is a memory access or an I/O access.
- A18-1 — Upper Address bits.
- A19-1 — Upper Address bits.
- ALPHACS-0 — Alpha system chip select from processor.
- VIDIO-0 — Processor access to certain parts of the DCB not accessed by ALPHACS-0.
- LATERW-0 — Late read or write, from Terminal Control board. (This is BRW-1 delayed by one processor clock cycle.)
- SMRESET-0 — same as SYSRES (system reset) from processor.
- BLWRCY-1 — Latched version of write cycle from processor.
- WRCY-1 — Write Cycle from processor
- APAGE1-1 — This distinguishes between Page 0 and Page 1 of memory. Used during write operations to graphics memory, this provides latched information selecting either Page 0 or Page 1 of graphics memory for a write cycle operation.

The processor sends a request via A18, A19, alpha chip select, and video I/O. This is translated into an alpha request (ALPREQ-1) or graphics request (GRFREQ-1), which go to the alpha or graphics state machines. These state machines respond by executing the request and placing ABUSY or GBUSY on the inputs of this chip. The "page 0" signal tells which half of the graphics bit map RAMs are being accessed. The "ready" output becomes DISPRDY-1, which allows the processor to complete the current bus cycle and start the next. The WENB (write enable) output enables the input data latch so the processor can write data to the DCB. The RENB-0 line enables the contents of the DCB's read data latch onto the processor data bus during read operations.

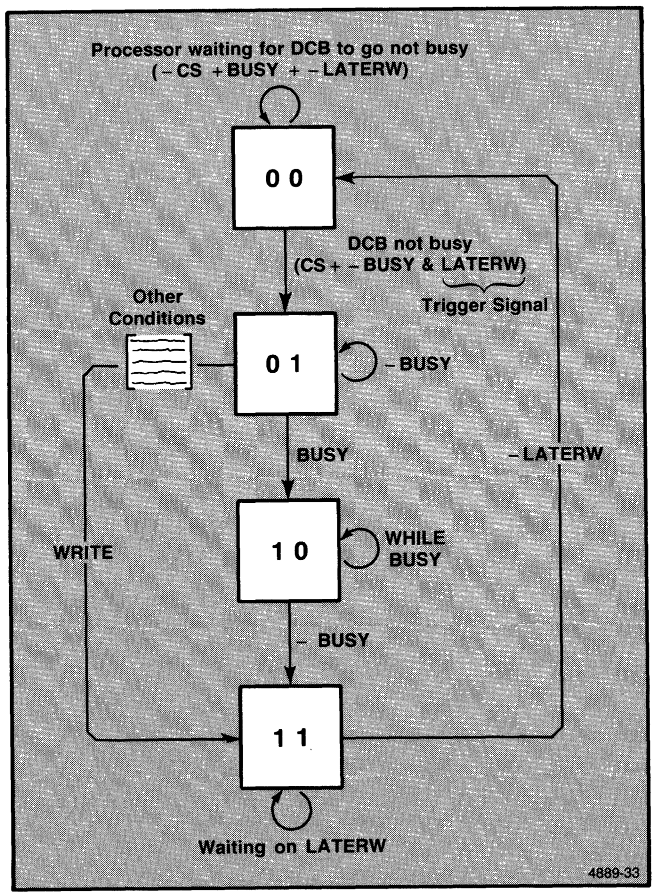


Figure 4-26. Front-End PAL States.

DIALOG (ALPHA) SECTIONS

This part of the DCB theory describes the circuitry that creates, stores and writes alphanumeric data on the display screen. The most common use for alpha data in this terminal is in terminal-to-host communication (and echo on the screen); hence the term "dialog area." The dialog circuitry contains its own memory, controller chip, character font generator, and I/O circuitry to the board bus and to the Color Map.

Alpha Controller

The alpha controller consists of a type-9007 crt controller chip and various blocks of supporting circuitry.

9007 I/O Address Buffer. This circuit buffers the DCB address bus lines, BLA1-1 to BLA5-1, and places them on the alpha controller's address inputs, VA0 through VA5, during a 9007 I/O cycle.

9007 Data I/O. This bi-directional latch passes data between the DCB data bus and the alpha controller's data inputs. Viewed from the board side of the bus, the inputs to this latch are, BLD0-1 through BLD7-1. The latch's outputs feed the controller's data I/O lines, VD0 through VD7. The Data Buffer I/O Control block determines the direction of data flow through this latch.

Alpha Controller & Sync Generator (9007). This controller chip manages the dialog/alpha portion of the display. As such, it acts independently of the main processor and controls the activity of the Dialog RAM and Character Generator blocks.

The 9007 controller addresses the Dialog List RAMs and controls the other dialog circuits. The controller contains a series of internal registers that increment according to firmware, to remember which character row is currently addressed. The Dialog CRT Controller also controls the character row buffers and makes the timing and sync (vertical and horizontal) signals for other Display Control board logic and for the Display Module. Figure 4-27 is a functional block diagram of the Dialog CRT Controller chip.

Processor I/O Address Bus lines A1 through A5, plus WRCY (write cycle) pass through an input buffer and drive VA0 to VA5. These lines connect to the 9007's input address pins of the same names.

VA0 to VA5 serve as both input and output lines for addresses. When serving as inputs (driven by the processor) VA0 – VA4 address an internal register (VA5 selects read or write: 1 = read, 0 = write). During output, all thirteen lines pass addresses for screen dialog refresh. Such addresses go to the Dialog Memory RAM. Video data cannot be displayed while the processor is writing the 9007; this is because six address bits are taken up during such a write. The dialog control state machine prevents interference during such a write.

The eight-bit data port (VD0 – VD7) handles both incoming and output data. Input data comes from either: the processor I/O (DAT0 – DAT7) via the DC board data bus, or the refresh video list address. The refresh dialog list address comes from the output of the Dialog RAMs through a multiplexor that selects between alternate bytes in the 16 bit List RAM word. Data to and from the DC board data bus passes through a bi-directional latch, U477. The B port of this latch accepts incoming bus data, while the A port accepts incoming data from the controller chip (going out to the bus and to the Processor).

At the beginning of each display screen character row, the 9007 reads a row table to see where the data for this row of characters begins. The 9007 then fetches data from the Dialog List (without intervention from the processor), causing their display on the crt.

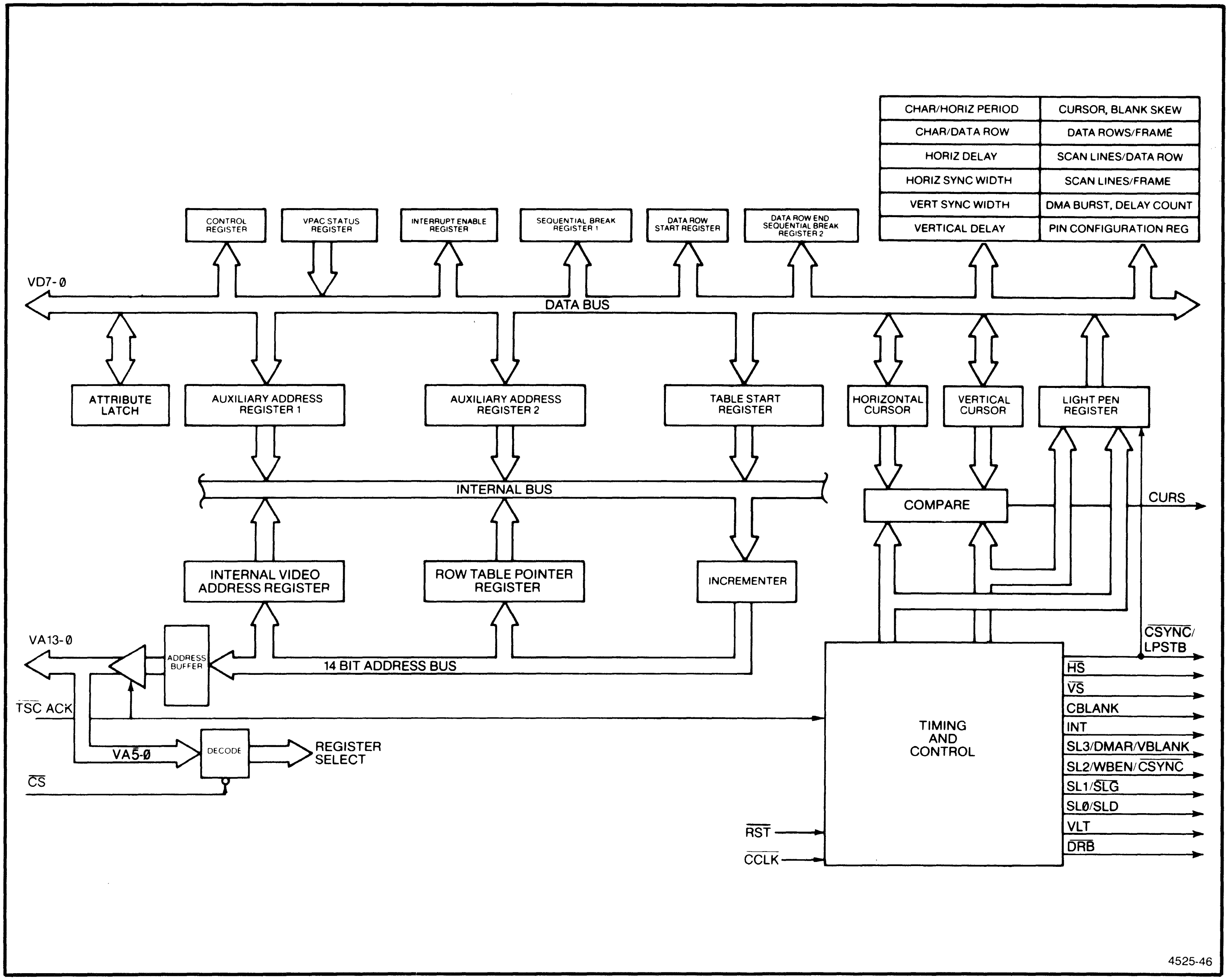


Figure 4-27. Dialog CRT Controller Chip (9007).

Figure 4-28 shows timing relationships for several 9007 signals.

The address in/out direction is controlled by:

- TSC [pin 33] – Tri-State Control input. When this control line is active low, the address port is in the input mode (processor I/O); when it is high, the address port outputs the CRT Controller addresses.

The remaining input/control lines serve the following functions:

- CCLK [pin 14] – Character Clock input accepts CCLK-0 (Character Clock) signal, from the Timing Generator PAL.
- RST [pin 26] – Reset input, accepts the VRESET-0 (Video System Reset) signal. This is a hardware reset to the 9007.
- CS [pin 25] – Chip Select input accepts the signal, 9007CS-0 (Dialog Controller Chip Select) which comes from the alpha control state machine. This signal selects the 9007 for processor I/O through its data port (VD0 – VD7).

The following output/control lines serve these functions:

- CBLANK [pin 35] – Composite Blanking output signal passes through the Character Pipeline on its way to the attribute logic.
- CURS [pin 34] – Alpha Cursor output (CURS-1) feeds the attribute logic and the double-high & double-wide circuit. This signal is true during the row and column where the alpha cursor is positioned, and at the beginning of a double-wide character row.
- INT [pin 27] – output signal, DISPINT-1 (Display Interrupt), exits the board on the Display Module connector. It generates the vertical rate interrupt.
- VLT [pin 11] – Visible Line Time tells the display circuitry which part of the horizontal scan is available for data display.
- DRB [pin 15] – Data Row Boundary identifies (to the display) each new character row. It occurs on every fifteenth scan line and is active for the whole scan line (including most of the blanking interval).
- HS [pin 13] – Horizontal Sync, is used for Display Module sync.
- VS [pin 12] – Vertical Sync for the Display Module.

A set of four address outputs select one of the fifteen scan lines per character cell. These outputs are: SL0 thru SL3 [pins 28 – 31] – Scan Lines 1 to 15 select (binary decoded).

The 9007's TSC input is driven active (low) by the Timing Generator circuit block.

RAM I/O Control. This circuit simply gates the read enable signal with TSC-0 to make the output enable signal for the dialog RAMs. The high and low chip select lines, that enable the dialog RAMs, are shown with this block.

List Address Fetch Time. This block combines some 9007 timing signals and uses this to set the proper time for the list address to be placed on the 9007 data bus. This AND gate and driver accepts the horizontal sync output from the 9007 and combines it with the tri-state control signal.

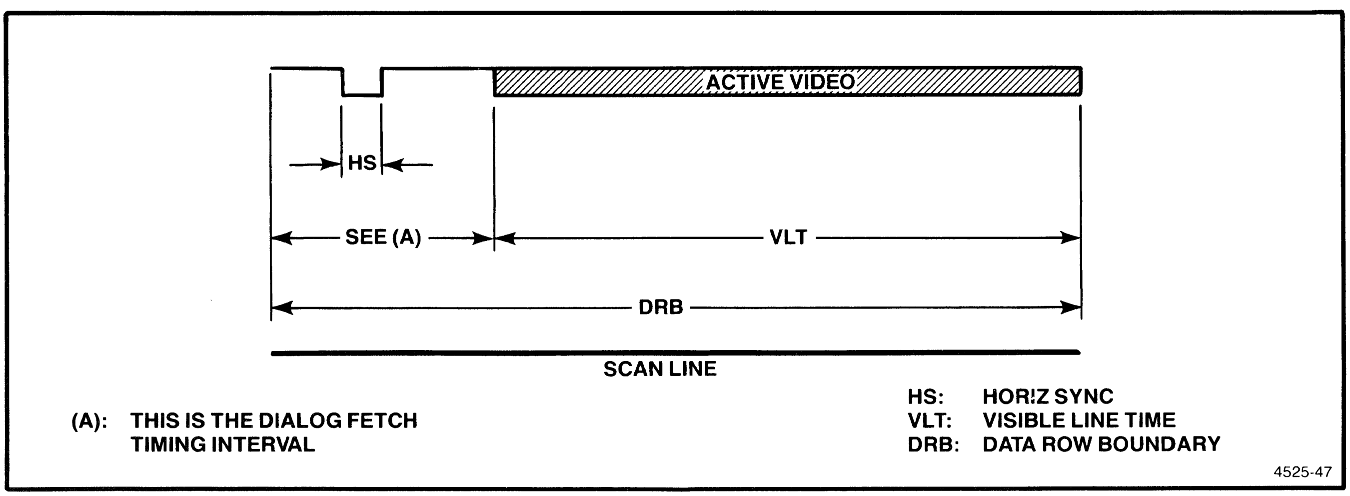


Figure 4-28. Dialog Fetch Timing Diagram.

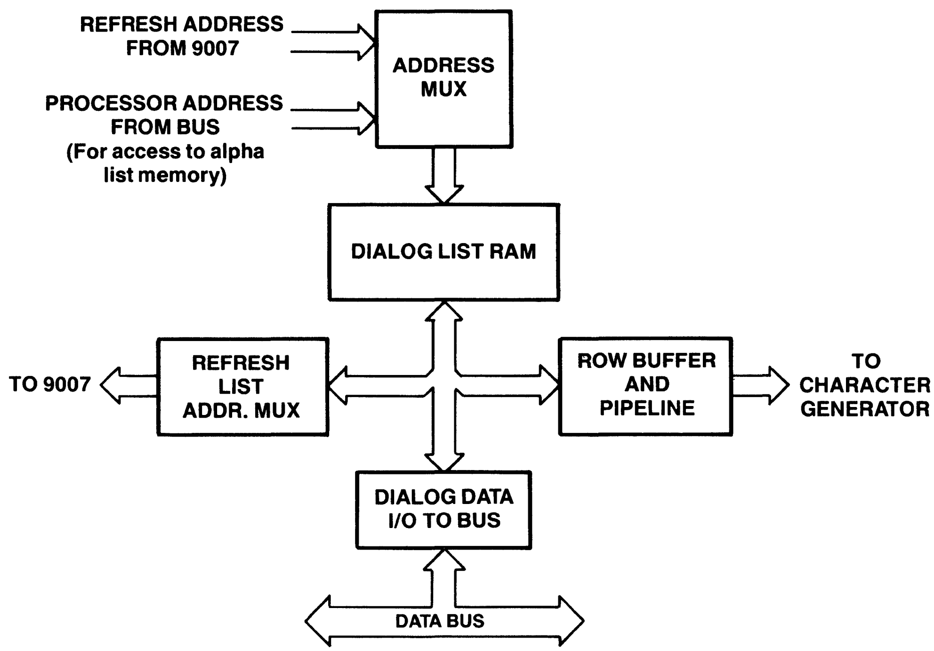
Data Buffer I/O Control. This circuit determines the direction of data flow through the 9007 Data I/O Latch and through the Dialog Memory Data I/O Latch. The circuit consists of several groupings of AND gates. They logically combine the input signals to make outputs that enable these data transfers:

- Processor to 9007
- 9007 to processor
- Processor to RAM
- RAM to processor

Dialog Memory and I/O

The Dialog List Memory consists of several smaller functional groups, as indicated in the upper part of Figure 4-29. These sub-blocks are:

- Dialog Memory Address MUX
- Dialog List RAM
- Refresh List Address MUX
- Row Buffer and Pipeline



	LOW BANK	HIGH BANK
UPPER BYTE	U675	U681
LOWER BYTE	U875	U881

4889-34

Figure 4-29. Dialog List Memory Diagram.

The dialog memory provides storage for: a row link-list table, and the lists of character codes/attributes for each row of displayed characters. The RAMs are either addressed directly by the processor (when building lists) or by the 9007 controller (in refresh mode). The address MUX selects one of these address sources. The RAM I/O Control circuitry selectively enables different physical RAMs, depending on the address selected. Data is then written into, or read from, the RAMs via a set of data latches that interface with the DCB data bus. This allows the processor to write to or read from this dialog memory list. A second output latch sends character data to the character generator. The third output latch passes dialog data back to the 9007's data input (for refresh only). The refresh data is essentially MUXed with the processor data going into the 9007. This is shown in Figure 4-29.

Processor/9007 Address MUX. The address MUX switches between the address lines from the processor (BLA1 to BLA12), and the address lines from the 9007 controller (VA0 to VA11). This sub-block consists of three MUX chips that switch between these two sets of address lines. The control input for these MUXes is the TSC-0 clock signal from the Timing Generator circuitry.

Dialog List RAM. The Dialog List RAM provides 8K bytes of memory for dialog text storage. The standard terminal contains four chips, divided into two banks, each with upper and lower bytes. See the lower part of Figure 4-29.

Dialog RAM Data I/O Latches. This pair of latches is the data I/O port for the dialog list RAMs. These latches store lines BLD0 through BLD15 going into memory, and D0 through D15 coming out of memory. RAMRDCLK-0 clocks these latches to write processor data into the RAMs. The enable for reading RAM data onto the DCB bus comes from the Data Buffer I/O Control block.

Refresh List Address MUX. This block is a 16-to-8 MUX chip. The Refresh List Address MUX accepts output data from the Dialog List RAMs and sends it back into the 9007 during list address fetch time. The 9007 then sets the RAMs' address lines and control inputs for the fetch. The inputs to the MUX are the sixteen data lines (D0 through D15). The MUX switches between the low and high data bytes, and places its output on VD0 through VD7 (going into the 9007).

Row Buffer. The Row Buffer passes dialog list output data to the character generator circuits. This block consists of two byte-wide, 80 character buffers. Each buffer has enable and clock controls. These buffers store a single row of characters of the first scan line (DRB time). The row buffers then provide the character data for the remaining scan lines of the character row, freeing memory for processor accesses. (This eliminates 14 rows of access to the RAMs, which is RAM access time that the processor can use.)

Pipeline. The pipeline acts with the Row Buffers to pass dialog data to the character generator. These two pipeline latches provide the timing necessary to compensate for propagation delay through the parts.

The sixteen data lines are labeled according to functions at the Pipeline outputs. These following data lines are collectively known as "character attributes":

- D0 to D7 — C0 to C7 (Character code)
- D8 to D10 — FG0 to FG2 (Foreground code)
- D11 to D13 — BG0 to BG3 (Background code)
- D14 — BLINKENB (Blink enable)
- D15 — UNDERLINE (Underline enable)

Character Generator Operation

The alpha character generator circuit consists of a character ROM, an output data latch, alpha shift registers, and some discrete logic used to create double-wide characters. This circuit block functions with the Character Attribute Pipeline and the Character Attribute and Control Logic to actually make alpha screen characters.

How Alpha Characters are Produced. This is an overview explanation of how alpha/dialog characters are generated. Refer to Figure 4-30 while reading this explanation.

The Character ROM receives an eight-bit address from the Dialog RAM output latch. These ROM address lines, C0 through C7, specify a particular character stored in the ROM. The ROM's SL0 to SL3 inputs determine the character-matrix-row location along the current scan line. The accessed character-matrix-row exits the ROM as an 8-bit parallel character code. Each 8-bit code is loaded into a shift register and converted to a serial stream. This serial stream then enters the pixel-priority circuit, along with other attribute data (such as underline, blink, etc.). This logic is a combinatorial array of logic gates arranged to select the desired pixel outputs for any one of many input conditions. The serial data from the character ROM, along with the other input signals, allow the pixel-priority logic to decide which pixel source should generate the next pixel on the crt. Several of these signals have been pre-processed to allow the attribute logic to perform its task. There are also several signals that are pipelined to align all of the pixels.

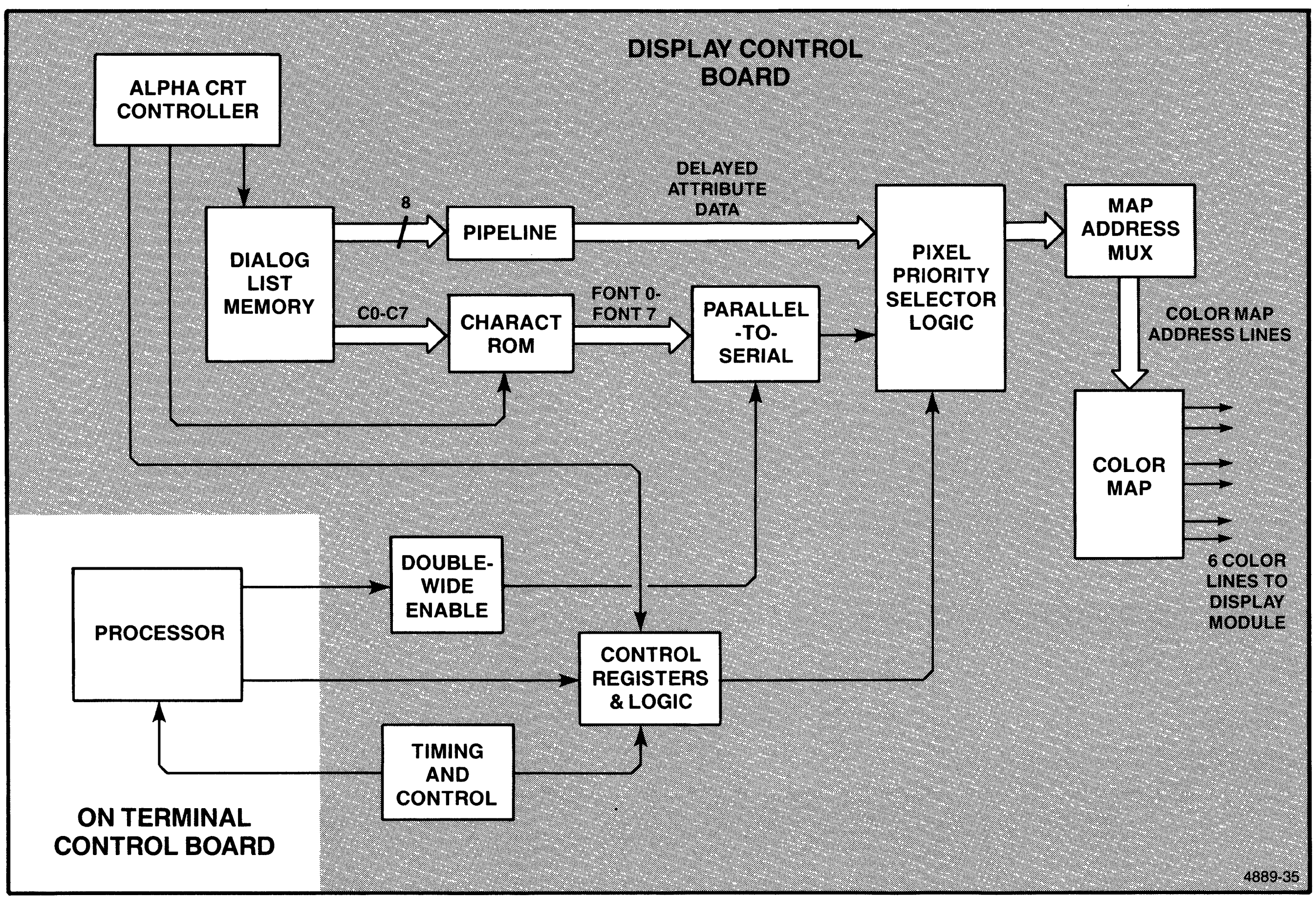


Figure 4-30. How Alpha Characters are Produced.

This selection information exits on one of the eight outputs of the custom logic circuit, which act as a selector for the address needed to generate the desired pixel:

0 Processor access to color map

1 Blanking of the screen

2 Crosshair cursor

3 Alpha cursor

4 Graphics pixels

5 Character foreground

6 Character background

7 (not used)

After the pixel-priority logic selects the desired pixel source, this data is translated into color codes by the Color Map. The Color Map is programmed by the processor. The Color Map's outputs are latched and sent to the Display Module as two bits each of RV (red video), GV (green video), and BV (blue video).

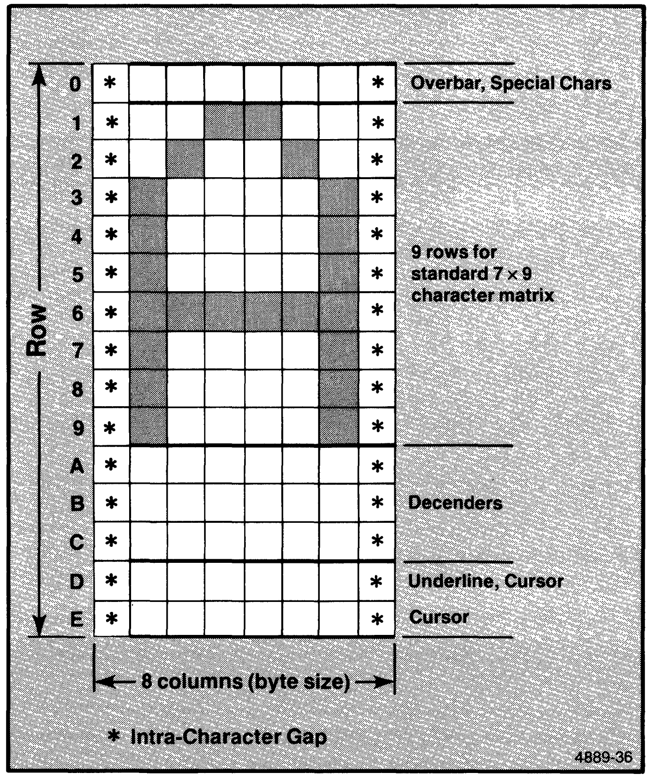


Figure 4-31. Alpha Character Cell.

Font ROM. The Font ROM contains the pixel patterns for the dot-matrix alpha-character fonts that are included in the standard terminal. The first four address line inputs are programmed to select one of fifteen rows within a character matrix. The remaining eight inputs access a particular character code. (The character occupies a 7 by 9 area in an 8 by 15 cell; see Figure 4-31). The ROM stores pixel patterns for 255 different characters.

The character data exits on outputs O0 to O7. These data bits are presented to the alpha shift register.

Alpha Shift Register. This sub-block is a pair of 4-bit shift registers connected in series. This circuitry converts the 8-bit parallel output of the Character ROM into a serial pixel stream. The Q3 output of the first register connects to the DSR (data shift right) input of the second register. The Q3 output of the second register passes the serial character stream to the Alpha Video input of the pixel-priority logic. The Double-Wide Enable block controls the shift and load functions of this block. The two shift/load inputs (SRMODE0 and SRMODE1) are decoded according to Table 4-4.

Table 4-4

SHIFT REGISTER MODES

SRMODE0	SRMODE1	Function
0	0	Hold
0	1	Shift right
1	0	Shift left
1	1	Load next character

Self Test Buffer for Font ROM Data

This buffer enables the output of the Font ROM, FONT0 to FONT7, onto the DCB data bus, BLD0 through BLD7. During Self Test, the processor uses this buffer to read the contents of the Font ROM. This data is compared to the character font table in the system EPROMs; the processor thus verifies that the Font ROM is correct and is working properly.

Alpha System I/O Control

This block consists of two custom array logic chips (NOTE), the "alpha controller" and "alpha I/O logic." These combinational logic chips accepts address and control signals from the processor, from system and board clocks, and from other control sources; and they make the signals that control the entire dialog/alpha system.

NOTE

Also called "PAL" (Programmable Array Logic).

The first chip is a state machine that accepts: (a) request lines from the processor/display arbitration block, and (b) status lines from the alpha circuits. It sends state information to the second chip via pins 15 through 20. This controller chip also makes the ABUSY-0 status signal, and the MAPIO-0 status signal. Figure 4-32 shows the control states of this chip.

The second chip makes the appropriate control signals for the dialog memories and related blocks based on information from the controller state machine. It chip selects the 9007, makes the high and low RAM-write control lines, and a strobe and clock:

- ADREN-0 — Address enable
- HWSTROBE-0 — Hardware strobe
- ARAMWR-0 — Enables a write to the alpha RAMs.
- 9007CS-0 — Chip select for the 9007 controller chip.
- AHIWR-0 — Write strobe to high bank of dialog RAM.
- ALOWR-0 — Write strobe to low bank of dialog RAM.
- RAMRDCLK-0 — During write cycles, it clocks data into the RAM data input registers; during read cycles, it clocks RAM data into the registers so the processor can read it.
- MAPWR-0 — selects a write to the Color Map.

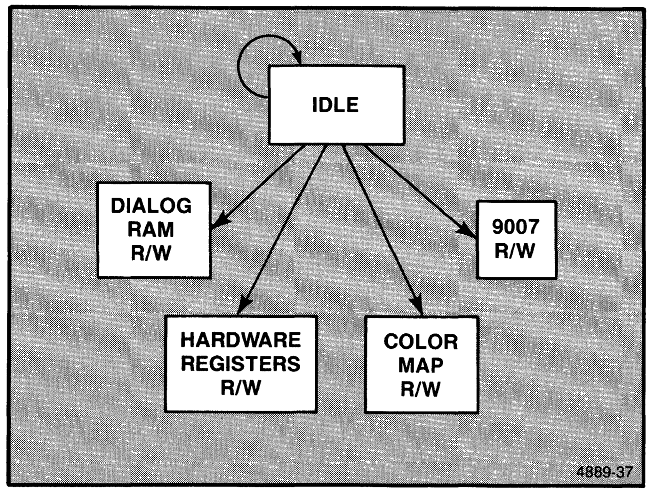


Figure 4-32. Alpha System I/O States.

GRAPHICS SECTION

Graphics data on the screen comes from the four-plane graphics bit map. This graphics memory is a RAM array, organized to store 1024 by 512 pixels (with four bits per pixel). The dimensions of the memory corresponds to the 640 by 480 display area on the screen, and the four bits-per-pixel provides the pixels' color information. Figure 4-33 shows this memory organization as it relates to the display screen. The graphics control circuitry provides refresh addresses for the graphics memories during display cycles.

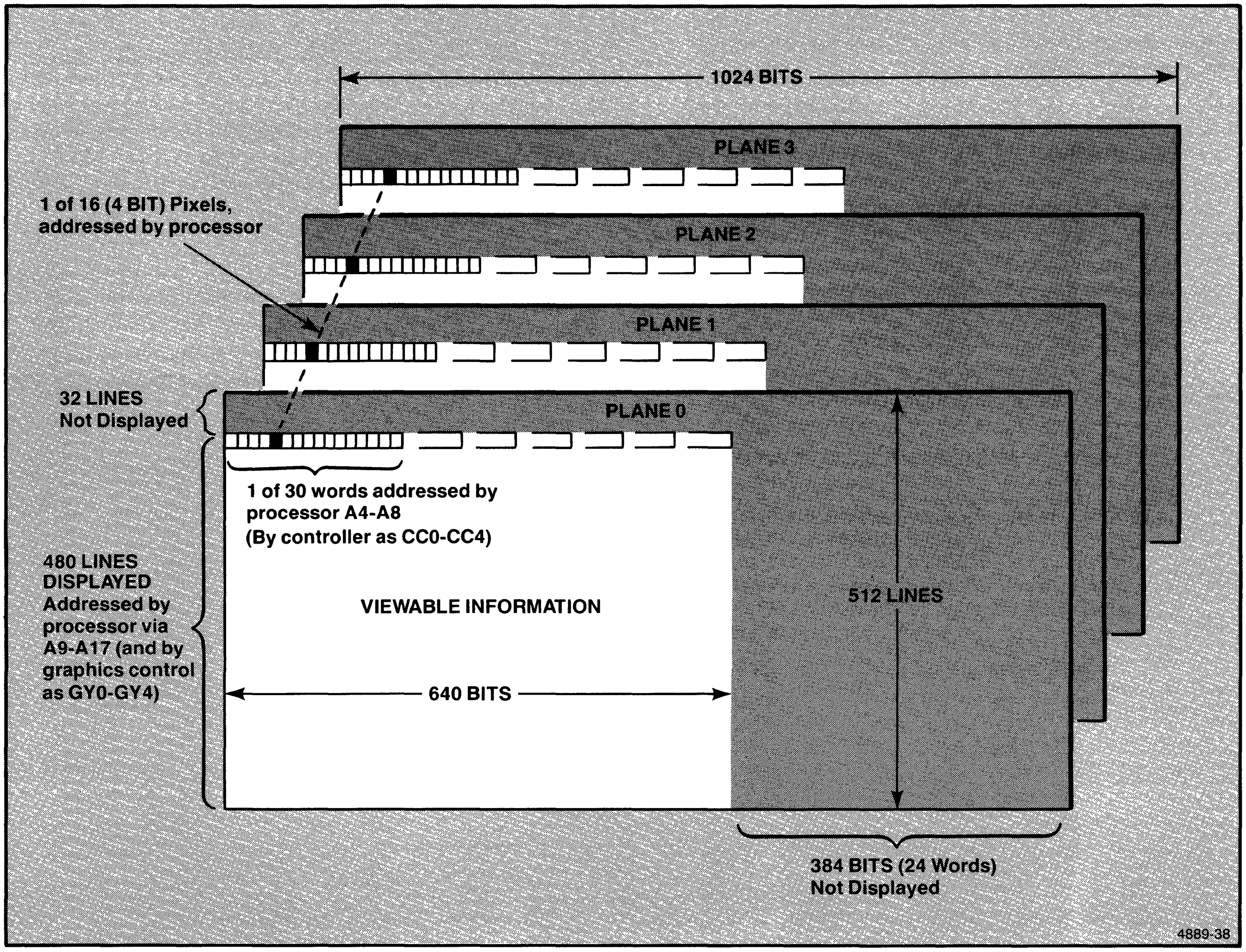


Figure 4-33. Graphics Memory Organization.

The graphics memory circuitry consists of these super-blocks:

- The RAM and associated I/O circuits (1)
- RAM addressing and cursor circuits (2)
- Memory control and data input (3)

These functional parts (as numbered) are depicted in Figure 4-34. Since the crosshair circuit is closely related to the addressing circuits, the crosshair circuitry is described with the graphics memory.

Crosshair Cursor

The terminal displays two kinds of cursors: an underline dialog cursor, and a crosshair graphics cursor. The graphics cursor may be used to locate a point on a graphic screen presentation and then send that point to the applications program. Under program control, the joydisk may be used to move the crosshair up or down, and left or right. Next, are the descriptions of the circuit blocks that create the horizontal and vertical line components of this crosshair cursor.

Figure 4-35 shows the arrangement of the blocks that make the cursor. This diagram also shows the graphics address counters, which are related to the cursor blocks.

X Graphics Cursor. This block makes the vertical line part of the crosshair cursor. Since the location of this line is specified by an X ordinate value along the horizontal axis, the circuit is called the X Graphics Cursor block. The position latch/register in this block accepts data from the processor via BLD0 through BLD9. This latch is loaded by XCUR-0. The data in this latch is then placed on one set of inputs of a 10-bit comparator. The comparator compares the data from the position latch with the data from the X address counter, GX0 through GX9. When the requested line (from processor) matches the addressed line (from the X address counter) the comparator outputs the vertical crosshair signal.

Because the X component of the cursor may be greater than 640 pixels, the comparator needs to be more than 8-bits wide. Therefore, the comparator consists of an 8-bit comparator chip and two XOR gates (which add bits 9 and 10).

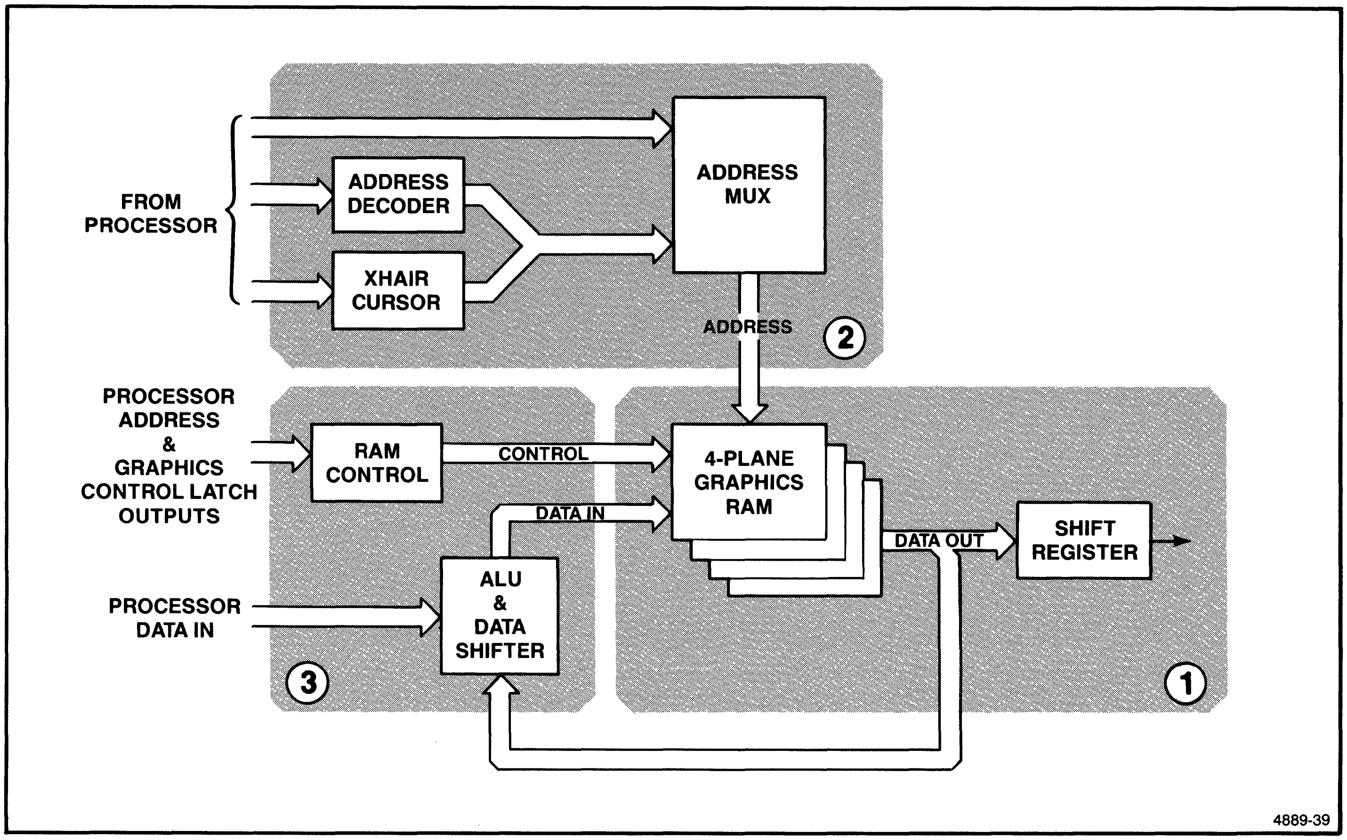


Figure 4-34. Graphics Memory Super-Block Diagram.

Y Graphics Cursor. This block makes the horizontal line part of the crosshair cursor. Because the location of this line is specified by a Y ordinate value along the vertical line, the circuit is called the Y Graphics Cursor block. The position register/latch in this block accepts data from the processor via BLD0 through BLD8. This latch is loaded by YCUR-0. The data in this latch is placed on one set of inputs of a 9-bit comparator. The comparator compares the data from the position latch with the data from the Y address counter, GY0 through GY8. When the requested line (from the processor) matches the addressed line (from the Y address counter) the comparator outputs the horizontal crosshair signal.

The XOR gate, connected to GY0, and the 8-bit chip combine to make a 9-bit comparator.

Crosshair Combination. The Crosshair Combination block combines the X and Y cursor signals and makes two other signals: XHAIR-1 and INTERSECT-0. XHAIR-1 makes the hole at the center of the intersect point. (This allows you to see the pixel beneath the crosshair intersection.) An XOR gate combines the two inputs to make this signal.

The INTERSECT-0 signal is not used by the terminal; it is only used during factory testing of this board.

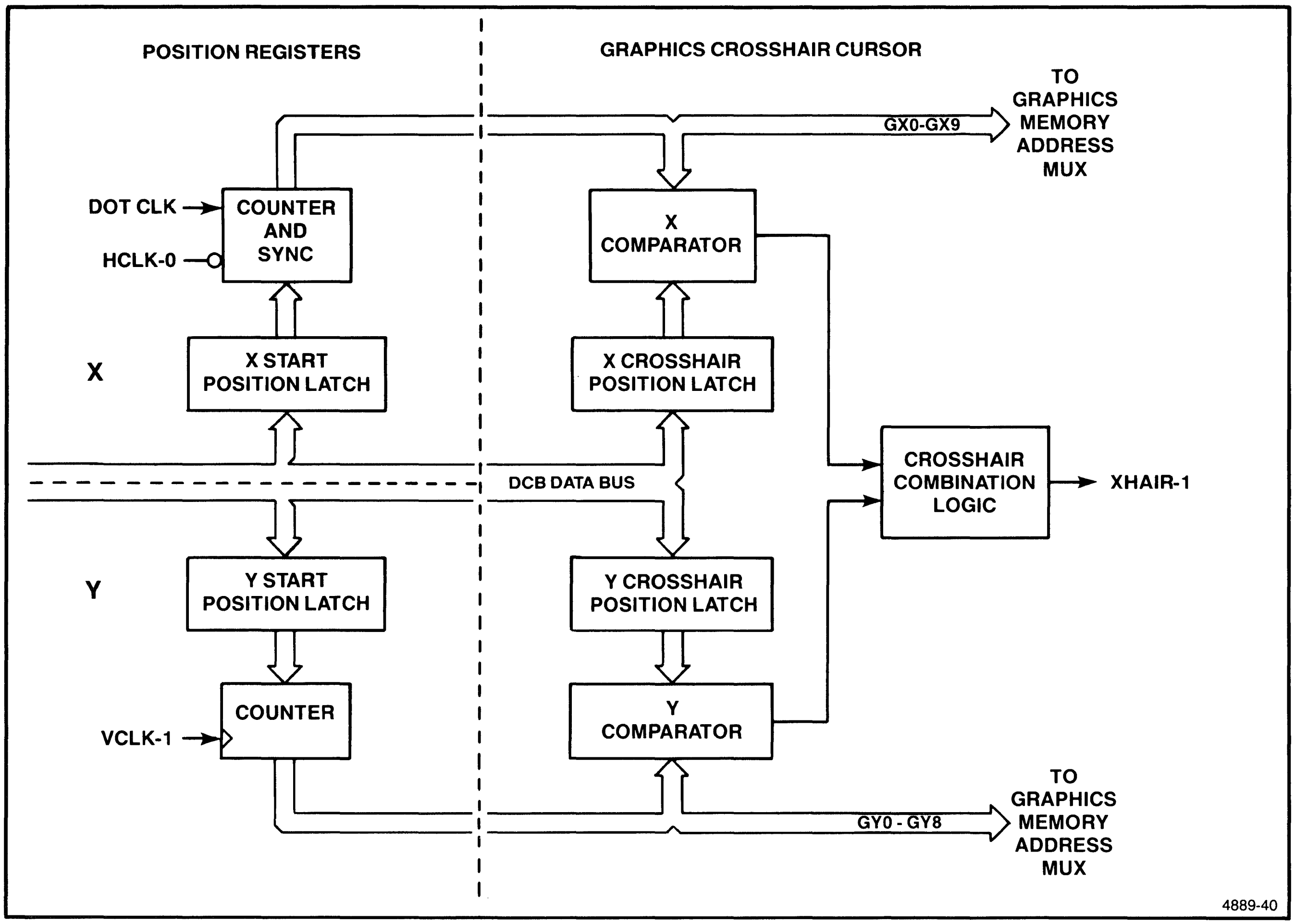


Figure 4-35. Graphics Cursor and Position Register Blocks.

RAM Addressing Blocks

The graphics RAMs are either addressed directly by the processor or by the X and Y Graphics Address blocks (during screen refresh cycles). The X and Y address counters provide the screen address during refresh memory cycles. The register in the X Addressing block selects the starting horizontal screen position for graphics (panning is accomplished by firmware). The address MUXes in these blocks select an address from either the processor or the address counters. See Figures 4-34 and 35 again.

X Position Block. This block outputs the proper X address to the Graphics RAMs to correspond with the writing beam horizontal position on the display screen.

The block consists of a loading latch and a 10-bit counter. The latch provides the initial X address for the X counter, which is loaded by HCLK-0 during the horizontal retrace time. The counter counts at the horizontal pixel rate of 25 MHz and sequentially sends addresses to the RAMs for each word along the scan line. The counter is made up of four 4-bit binary counter chips. One chip keeps the graphics and dialog displays synchronized. The other three counter chips act in parallel and send addresses, GX0 through GX9, to the RAMs (via the MUX) and to the crosshair circuit.

Y Position Block. This block contains a loading latch (register) and a 9-bit counter. The latch provides the initial value for the Y-axis counter, which is loaded by VCLK-0 during vertical retrace time. The counter counts at the vertical scan rate of 60 KHz and sequentially sends addresses to the RAMs for each scan line on the display screen; HCLK-0 clocks this counter on each horizontal retrace time. The counter is a 10-bit counter chip. The counter's outputs, GY0 through GY8, go to the Graphics Address MUX and the Y-crosshair circuit. Input pin 13 is the tri-state output enable for the PAL. The pin is connected to a "pull-down" resistor, to the Window Shade PAL, and to the Graphics Control Register; this allows a board tester to tri-state the outputs of these devices during testing.

Graphics Memory Address MUX. This MUX sends addresses to the Graphics RAMS; it selects an address from either the processor or from the X and Y graphics position registers. The graphics address MUX is a 2-stage multiplexer. The first stage uses the state of PROCESSOR-0 (signal) to select either: 1) the XY position register output, or 2) the processor address bus, as the source for the next memory address. The second stage is a clocked MUX that provides the row/column address MUXing for the RAM; see Figure 4-36.

The RASn-0 outputs of the RAS/CAS PAL are ORed together by U217A; this provides the row/column address select signal for the second stage of the Graphics Memory Address MUX.

Graphics RAM Control and Data Input

The graphics memory array is controlled by signals from a custom ALU. The ALU selects and modifies the data going into the RAM. The following functional and block descriptions provide detail about this part of the graphics memory.

Two types of memory cycles are used, depending on the type of ALU operation being performed. When the ALU is set for "replace mode," and no write-protect bits are asserted, the graphics controller performs a write-only cycle. If any write-protect bits are asserted, or if the selected ALU mode is a "bit modification mode" (AND, OR, XOR), a read-modify-write cycle is performed. During such time, the current contents of the selected pixel location are read, operated on by the ALU, and then written back into the pixel locations in memory. See Figure 4-37.

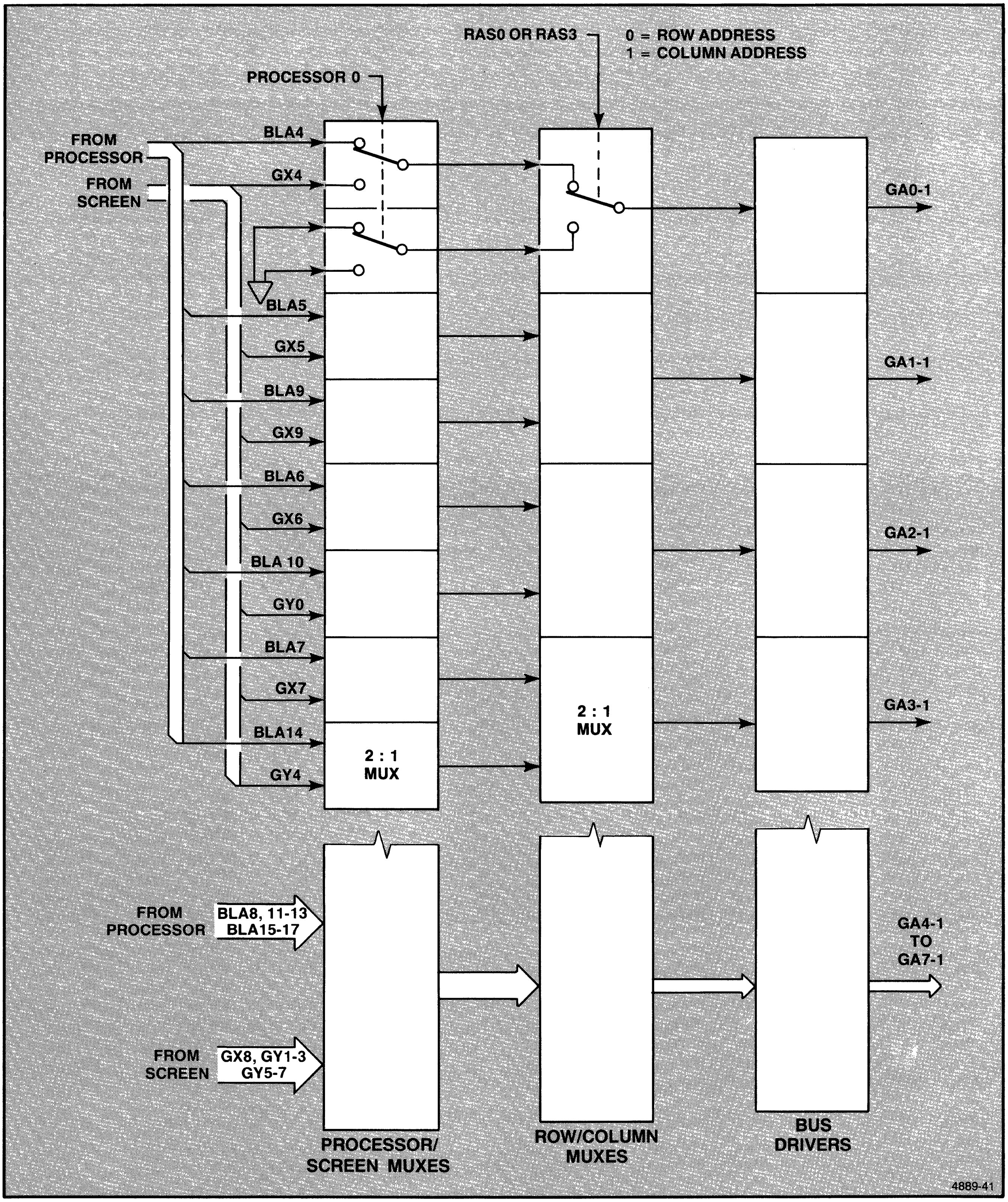


Figure 4-36. Graphics Memory Address MUX.

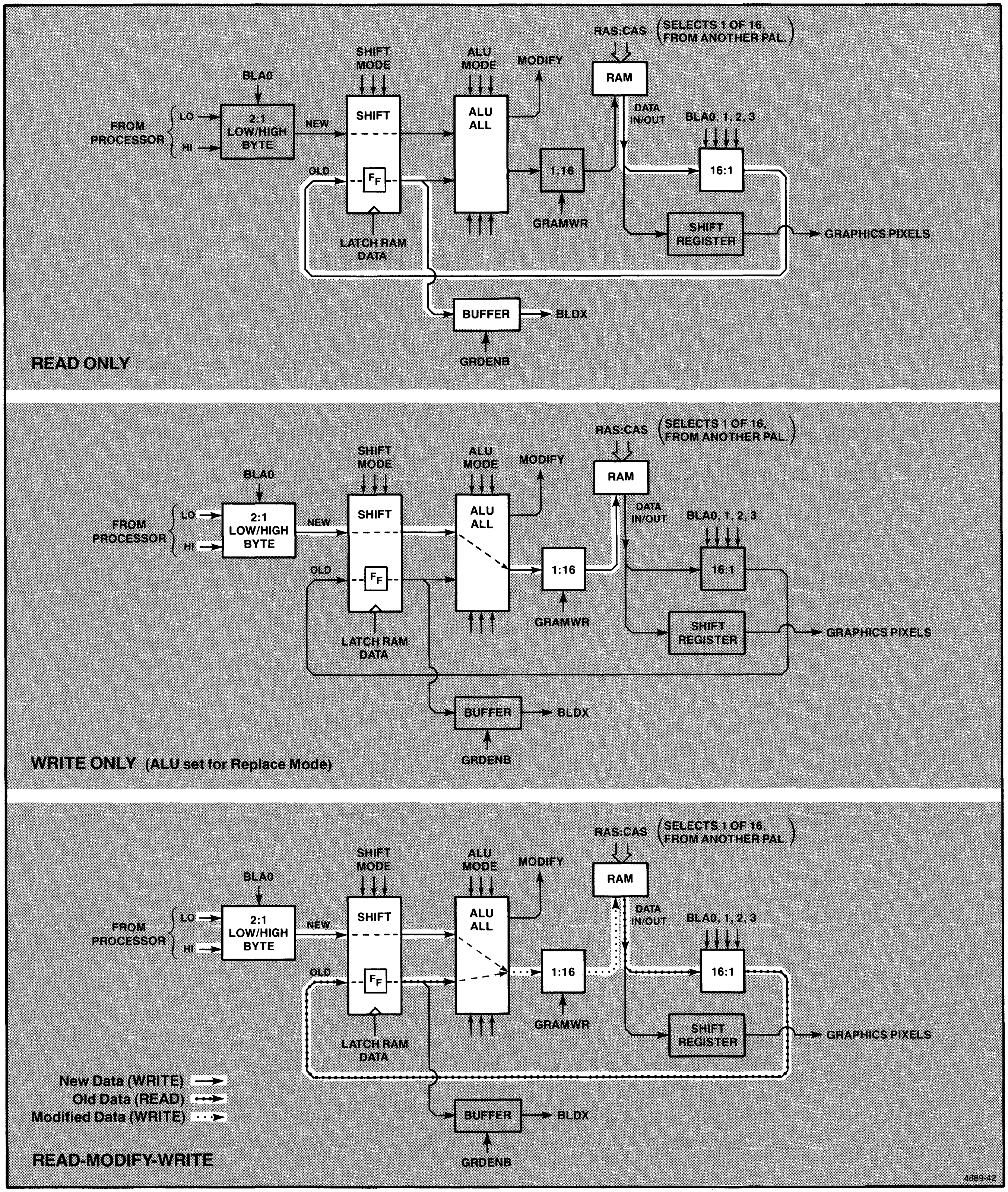


Figure 4-37. Graphics Memory Cycles.

ALU. The ALU (arithmetic logic unit) modifies pixel data as requested by the processor via the ALU mode-select inputs. The ALU is a custom array logic chip that modifies data going into the RAMs according to one of 8 different ALU function modes. The ALU does not alter a pixel if its associated write-protect bit has been set; the WRDIS0-1 to WRDS3-1 (write disable) lines prevent the ALU from modifying or over-writing data for the corresponding ALU modes. A 3-bit input, ALU0 to ALU2 (from the Graphics Control Register), selects the ALU mode; the selection decision is made by the processor. Figure 4-38 is a functional diagram of the ALU.

The 16 operating modes of the ALU are listed in Table 4-5.

Table 4-5

ALU MODES AND FUNCTIONS

ALU0	ALU1	ALU2	Explanation of Operation Performed
0	0	0	Replace current pixel contents with processor data.
0	0	1	"XOR" current pixel contents with processor data.
0	1	0	"OR" current pixel contents with processor data.
0	1	1	"AND" current pixel contents with processor data.
1	0	0	Replace current pixel data with 0's.
1	0	1	Replace current pixel data with 5's.
1	1	0	Replace current pixel data with A's.
1	1	1	Replace current pixel data with 1's.

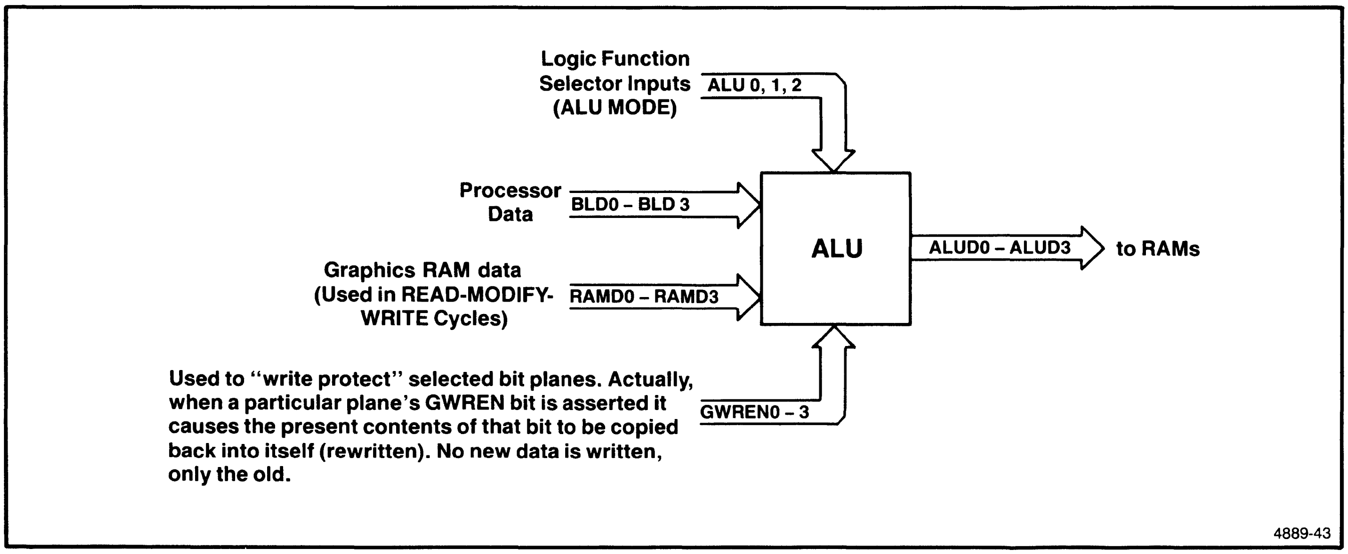


Figure 4-38. ALU Functional Block Diagram.

RAM Data-to-ALU Latch. Data enters the ALU from two sources: data read from the RAMs (during the read portion of a read-modify-write cycle), and data coming from the processor. Data from the RAMs passes through the RAM data latch on its way to the ALU; from the ALU it passes back into the RAMs (during a write cycle). This latch is actually part of a 20R4A custom array logic chip. (The other part of this chip is the Data Shifter in the processor-to-ALU data path.) This RAM data latch accepts RAM data, RAMD0 through RAMD3, from the 16-to-1 RAM Output Data MUX. During a read cycle, graphics RAM data is clocked into this latch by a clock signal from U215 (the Graphics Output Enable Write PAL). The SHIFT0 to SHIFT3 inputs control the data shifter modes: the number of bit positions, and the direction (left or right) that incoming processor data is shifted before being sent to the ALU. The four output lines, from this part of the chip, go to the ALU and to the Graphics RAM Processor Read Buffers.

Graphics RAM Processor Read Buffers. A pair of Graphics RAM Data Buffers direct the graphics memory read data to the proper bits of the DCB data bus during a processor read cycle. One of the buffers presents data on the lower four bits of both bytes (high and low) of the DCB data bus. This is done to ensure that the processor receives data on the proper half of the bus for both even and odd addresses. The other buffer forces zeroes on the remaining four bits of the high and low bytes of the DCB data bus, during a read of the graphics memory. Because the graphics memory is only four bits deep, these bits complete the data byte being read. Otherwise, these bits would have to be masked by an additional operation after being read by the processor.

Hi/Lo Byte Write MUX. During write cycles, data is transferred from the processor data bus to the inputs of the Data Shifter PAL by this high/low byte multiplexer. The write multiplexer selects between the low and high processor data bytes for writes to even and odd bytes, sending the correct data to the RAMs during write cycles.

Processor Data Shifter. The Data Shifter parallel shifts the bit positions of the new data coming from the processor and the old data coming from the RAMs (going to the ALU). The data shifter is contained in the second half of the Graphics RAM Data Latch PAL. This circuit shifts the incoming processor data by a specified number of bit positions, either to the left or the right. The circuit also contains test modes, used by the terminal's Self Test firmware to verify data path integrity in this section of the DCB.

The Data Shifter is part of a custom logic array (or PAL). Its control inputs are bits 12 through 15, and these combine to shift the data in one of 16 different modes; see Table 4-6.

Table 4-6

DATA SHIFTER MODES

Control Bits				Functions
15[c]	14	13	12	
0	0	0	0	Shifts new processor data no spaces; moves old data from RAMs[a].
0	0	0	1	Shifts new processor data left 1 space; reads old data from RAMs[a].
0	0	1	0	Shifts new proc'r data left 2 spaces[a].
0	0	1	1	Shifts new proc'r data left 3 spaces[a].
0	1	0	0	Shifts new proc'r data right no spaces[a].
0	1	0	1	Shifts new proc'r data right 1 space[a].
0	1	1	0	Shifts new proc'r data right 2 spaces[a].
0	1	1	1	Shifts new proc'r data right 3 spaces[a].
1	0	0	0	Write new data as 0's (bin) [a].
1	0	0	1	Write new data as 0's (bin); Read old data as 1's (bin).
1	0	1	0	Write new data as 1's (bin)[b]; Read old data same as in RAMs.
1	0	1	1	Read old RAM data as 0's (bin)[b].
1	1	0	0	Read old RAM data as A's (hex)[b].
1	1	0	1	Read old RAM data as 5's (hex)[b].
1	1	1	0	Read old RAM data as C's (hex)[b].
1	1	1	1	Read old RAM data as 3's (hex)[b].

[a] Reads old RAM data the same as it is currently stored in the RAMs.
[b] Writes new data into RAMs as 1's (binary).
[c] A "1" on Bit 15 signifies Test Mode; a "0" means normal operation.

RAM Control. The graphics RAM Control circuit generates the row and column address strobes (RAS and CAS) for the RAMs, and it controls data output from the RAMs. The block consists of three custom array logic chips; see Figure 4-39. The first chip accepts control lines from the DCB bus and controls the other two chips. The second chip is the RAS and CAS generator; and the third chip is the write enable and output enable control logic for the RAMs. The third chip also provides the clock signal for the RAM Data-to-ALU Latch.

The RAS/CAS generator performs a two-fold function. During a screen refresh cycle, all RAS and CAS control lines are asserted, enabling 16 RAMs (one graphic word) simultaneously. (16-pixel words are read and loaded into the Graphics Shift Register during screen cycles). During a processor byte read or write operation, a certain combination of the RAS/CAS lines are used to select one of the 16 RAMs. However, a word write operation by the processor, causes all of the RAS and CAS lines to be asserted, thus performing a 16-pixel-at-a-time write.

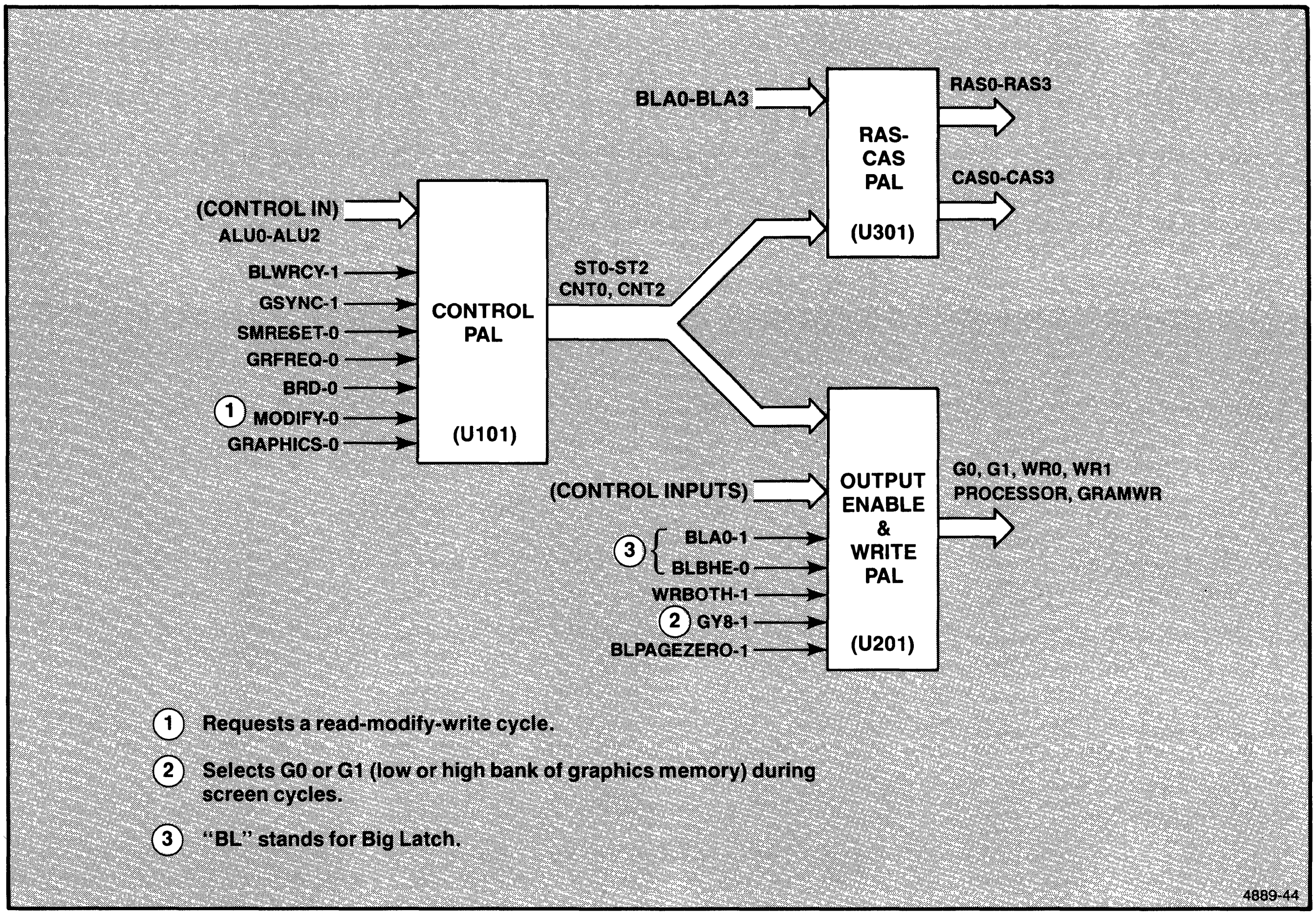


Figure 4-39. RAM Control Circuit.

Graphics Memory and Data Output

See Figure 4-40.

The 512K bytes of graphics memory is divided into four bit planes. Each of these memory planes contain these functional sub-blocks:

- 1-to-16 data input buffer
- RAM array (two 16K sections, divided into four bit-planes)
- Output data shift register
- 16-to-1 data output MUX

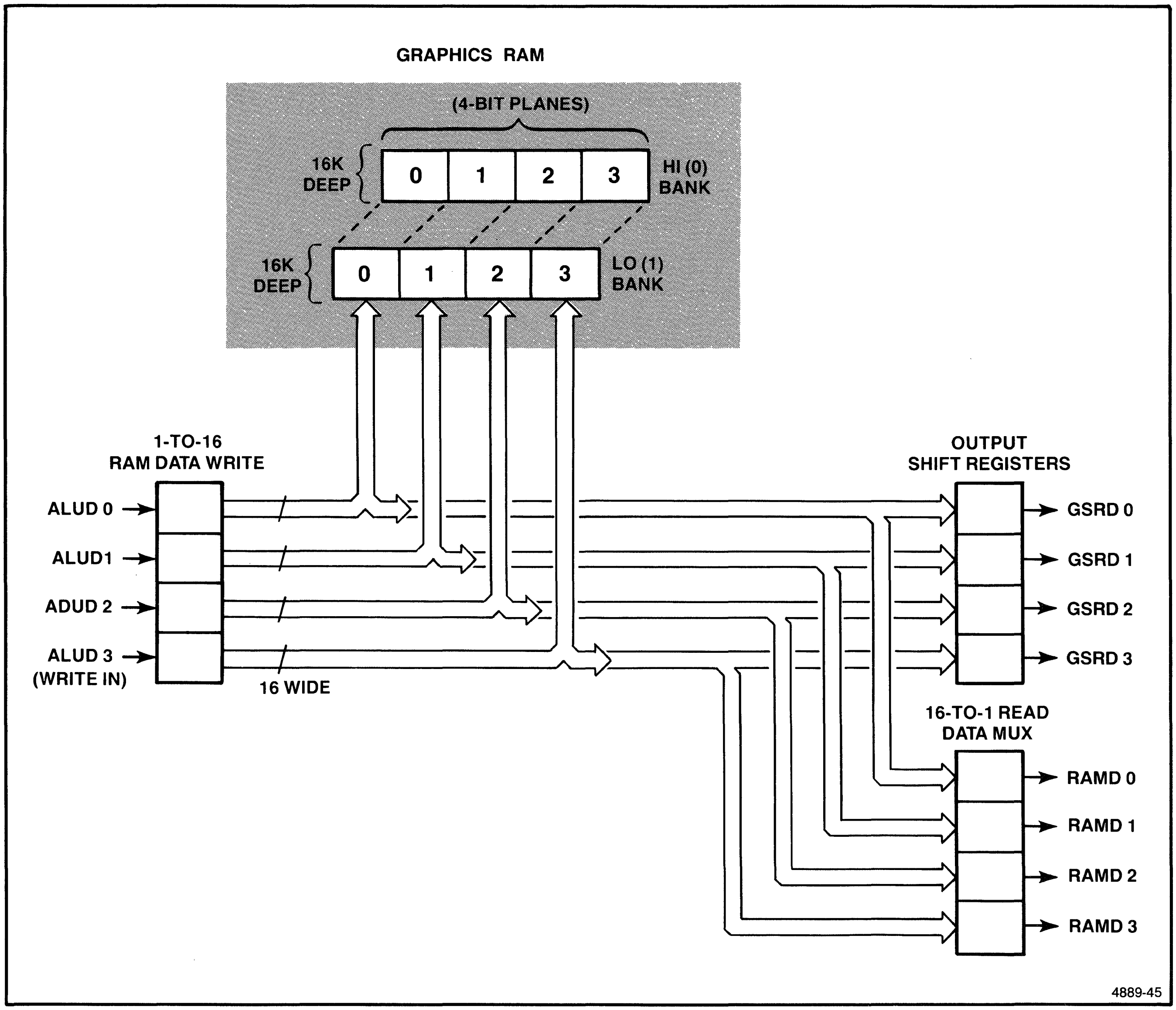


Figure 4-40. Graphics Memory Planes Block Diagram.

The graphics memory is organized as a "two-page" system; the read addresses are repeated in each page. This system is required because the upper half of the graphics RAM shares its address space with the system ROMs (firmware). When writing to the RAMs, you can use the entire address space because the ROMs are not enabled for writes. However, when reading these RAMs, the processor and display would have to distinguish between RAM and ROM in the upper (common) address space. Therefore, the lower RAM address space is duplicated and called page 0 and page 1. This region is 40000 to 7FFFF. The entire RAM write region is 40000 to BFFFF. The "page control" bit, in the Graphics Control Register, selects Page 0 or Page 1 for read operations. This 2-page addressing scheme is depicted in Figure 4-41.

A graphics word contains 16 pixels. Each pixel is individually addressable by the processor and consists of a 4-bit data byte. Thus, each RAM chip stores one of the 16 pixels in a graphics word. Also, each bit of a RAM is an element of a bit plane. The low order bits (00 to 0F) are Plane 0, up through the high order bits (30 to 3F) which are Plane 3.

The RAM address comes from the Graphics Memory Address MUX, described earlier in this section. The 4-bit outputs of the RAMs go to an output shift register (then, to the color map address MUX) as GSRD0 to GSRD3. RAM data is also read back to the ALU and processor (via the 16-to-1 MUX and a read data latch) during memory read operations.

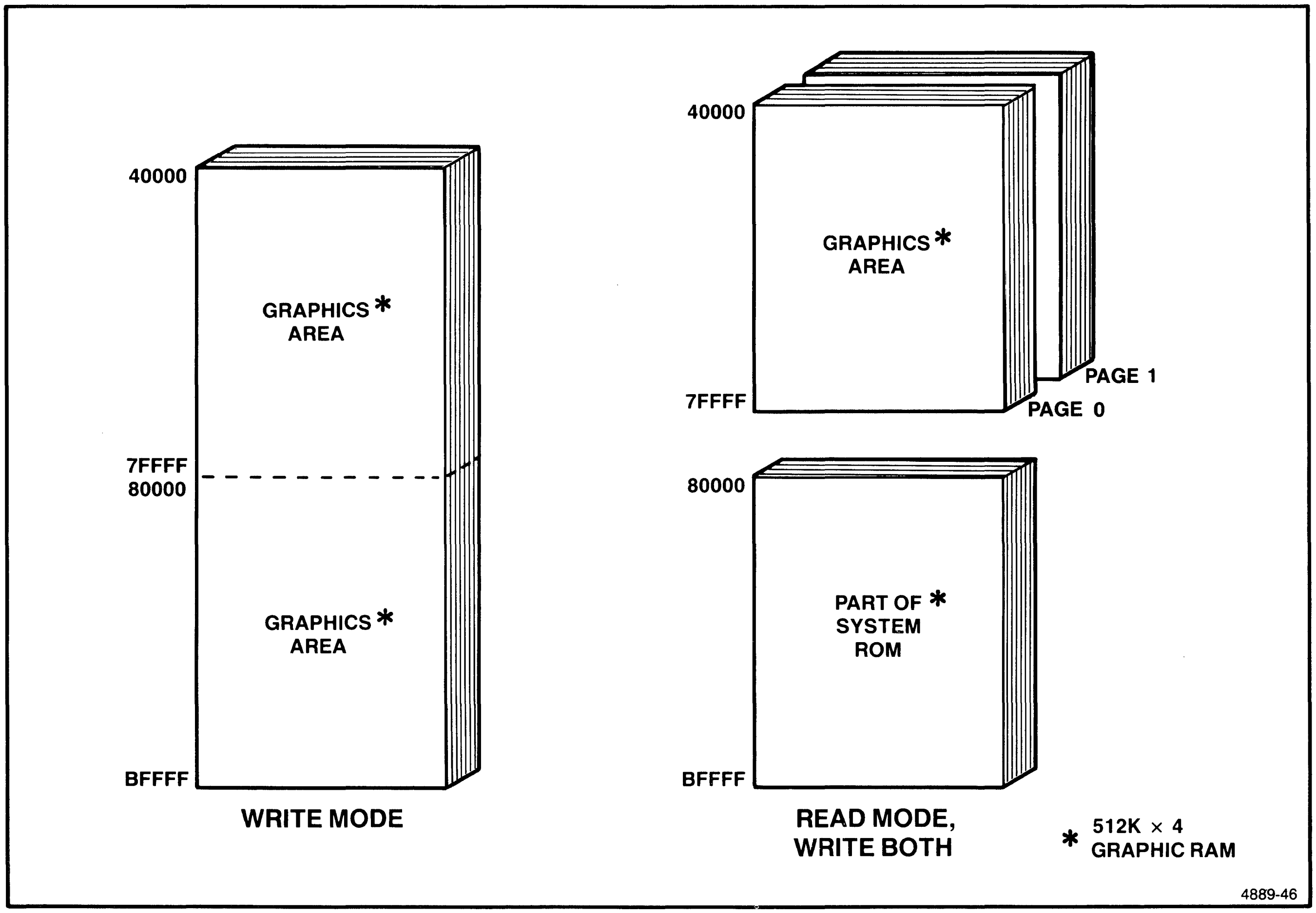


Figure 4-41. Two-page Memory System.

1-to-16 RAM Data Write Buffers. RAM input data passes through a set of four 1-to-16 buffer sets. (Two 8-bit buffers, per set, provide the 1-to-16 bit extensions.) Only four data lines come from the ALU, but each RAM bank has 64 data ports. For this reason, each buffer takes an ALU output line and makes it into 16 separate RAM inputs. Consequently, the first buffer accepts the first output from the ALU, ALU0, and extends it into RAM data inputs 00 to 0F. Likewise, the second buffer extends ALU1 into inputs 10 to 1F, ALU2 supplies 20 to 2F, and ALU3 supplies 30 to 3F.

While a buffer is placing identical pixel data on all 16 inputs, the RAM RAS/CAS generator is selecting only one of these 16 RAMs for data input.

Low and High RAM Banks. The graphics memory is a 512K RAM array. Functionally, it is divided into four bit-planes, with each plane storing one bit per pixel. Looking at the schematic, this is not obvious. Each RAM chip in the array contains four bits per memory location; hence the four planes of graphics memory.

A more obvious feature of the RAM array is the two-page addressing system (already described). The schematic shows that the RAMs are split into two groups (the low and high banks) which corresponds to the two pages in memory address space. See Figure 4-41, again.

The RAM enables come from the Graphics System Control block.

Graphics Shift Register. The RAM output data must pass to the display in a serial stream. So this block converts the graphics output data from parallel to serial. The four 16-bit shift registers in this block convert the 16-bit words, from each of the four bit planes, to a serial data path. The four data streams are labeled GSRD0 to GSRD3. These data streams go through a pixel delay pipeline and on to the Color Map address MUX.

16-to-1 Data Read MUXes. One of the RAM output data paths is back to the ALU and processor read latch. The ALU and latch accept only four data lines, while the RAMs have 64 data ports. The 16-to-1 Data MUXes provide the function of merging these 64 data lines into the four ALU inputs. The MUX's switch positions are controlled by the BLD0 through BLD3 lines from the processor. The first MUX accepts RAM data lines 00 to 0F and makes RAMD0. The next MUX accepts data lines 10 to 1F and makes RAMD1. The other two MUXes operate the sames; converting 20 to 2F into RAMD2, and converting 30 to 3F into RAMD3.

Graphics System Control Registers. See description under Alpha and Graphics Control Registers (Processor Interface), earlier in this section.

PIXEL PRIORITY CONTROL AND COLOR MAP SECTIONS

The Color Map and the Pixel Priority Control logic are grouped here into one superblock description.

The alpha and graphics data appear on different layers on the display screen. Depending on their pixel priorities, some images are in front of (and cover) others. The Pixel Priority Logic accepts operator input (via the processor and firmware) and display pixels of five different types, and it accordingly places these images on different layers on the screen. The priority and placement of these attributes are set by a pair of state machines in two programmed array logic (PAL) chips. The priority codes from the main attribute PAL, along with the alpha and graphics data, are MUXed together and sent to the Color Map. The Color Map then converts the combined pixel priority, graphics, and dialog information into standard RBG-encoded color signals for the Display
Module.

This part of the DCB also contains some pipeline latches, that keep the alpha, graphics, and attribute data synchronized along their parallel paths to the Color Map.

Pixel Priority Control

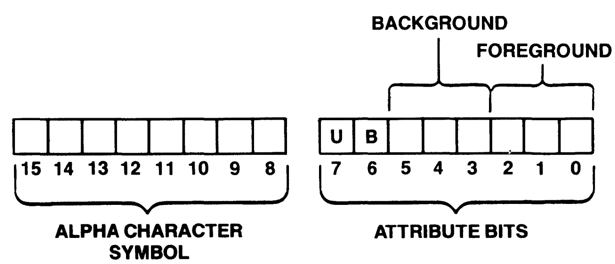
Each dialog/alpha character in the display list is allocated two bytes of information. The first 8-bit byte addresses the character symbol in the Font ROM. The second 8-bits sets the attributes of the displayed character. Figure 4-42 shows this scheme. When the two most significant bits are a zero, the character appears opague and on the front surface. The background and foreground each have 3-bit fields that contain an index value for selecting one of eight dialog colors. These indices are sent to the Color Map where the actual color selections occur. The combinations of attributes are logically arranged according to the two programmed array logic chips mentioned earlier.

The graphics images: crosshair cursor, and other stored patterns, also have certain display characteristics. The Pixel Decoder and Pixel Priority Control Logic PALs prioritize and merge the dialog and graphics images (with attributes), causing them to appear to be on different layers on the display screen.

Pixel Decoder. This 20L8A logic array accepts pixel priority requests from the alpha and graphics control registers (and 9007); it also accepts the identification code of the current character. The chip decodes and merges these request signals and sends its outputs to the Pixel Priority Control Logic PAL.

The inputs to this Pixel Decoder are:

- C0-1 through C7-1 — Character code; used to generate EOLLOCK-1 signal when an end-of-line character is encountered.
- CURS-1 — Cursor request signal; asserted by 9007 when the current character position coincides with the contents of the 9007's cursor position register.
- BLOCKCUR-1 — Cursor mode select; when 0, selects underline cursor; when 1, selects full-cell cursor (not supported by firmware in this product).
- XPRNTENB-1 — Transparent enable: when bit = 0, lets graphics be viewed behind dialog characters whose background index is 0. When bit = 1, the background of characters (with index = 0) becomes opaque, covering the graphics.
- SL0-1 through SL3-1 — Scan line counter output from 9007; used to decide which lines to use for cursor underline and for underlined characters.
- UNDERLINE-1 — Character attribute bit from character pipeline; when bit = 1, the current character is underlined.
- BG0-1 through BG2-1 — Indicates the background color index attribute for current character. Used to generate SEEGRAPHICS-1 signal when XPRNTENB = 0 and the current character's background index is 0.



U-1 When this bit is "1", the associated character is underlined in the selected foreground color.

B-1 When this bit is a "1", the character foreground color blinks to the background color at a rate set by the Character Blink Clock.

4889-47

Figure 4-42. Byte Format.

The outputs of this logic chip are:

- EOLLOCK 1 — When an end-of-line character is encountered (character codes 80 and 90 Hex), this signal is generated, disabling the clock enable of the character pipeline stage (that follows the row buffers).
- CURSOR-1 — Enables the alpha cursor.
- SEEGRAPHICS-1 — Makes the dialog background transparent (index = 0), showing graphics.
- DOUNDERLINE-1 — Enables the underline (part of alpha character cell).

Pixel Priority Control Logic. This block consists of a 20R8A programmed array logic chip. This state machine accepts pixels from five different sources and selects the correct source for the pixel being displayed. The priorites for pixels sources is:

1. Graphics crosshair cursor
2. Alpha cursor
3. Alpha foreground
4. Alpha background
5. Graphics

The PAL assesses the state of the current incoming pixel sources, selects one source according to the priority list, and enables the selected source to address its entry in the Color Map.

The pixel source selections are overridden by either: a processor access to the Color Map, or by display screen blanking intervals. (The processor has highest priority).

This PAL then selects one of eight 4-line inputs to the Color Map. These Color Map inputs come from:

- Processor (color map I/O)
- Crosshair cursor
- Alpha cursor background vs. foreground
- Retrace blanking
- Graphics data out
- Alpha character background vs. foreground
- (One is not used except for testing)

Each of the above items corresponds to one of this PAL's output control lines. These control lines switch/control the Map Address MUX.

The inputs to the PAL are:

- COLORMAPACCESS-0 — Same as MAP I/O request from processor.
- ALPHAVIDEO-1 — This is the serial alpha character stream coming from the Alpha Shift Register.
- PIPECBLANK-1 — This shuts off video (makes a black screen). Pipelined version of the composite blanking signal from the 9007. Active during H Sync and V Sync intervals.
- ATTRTEST-1 — Self Test control line for testing this PAL.
- XHAIR-1 — This requests the crosshair cursor.
- DIALOGENB-0 — This puts the window shade up, making dialog area visible. See NOTE, following this list.
- BLOCKCUR-1 — This requests a full-cell block cursor, instead of the 2-line underline cursor. (Not used in this product.)
- CURBLNKCLK-1 — This sets the blink rate for blinking cursor.
- CURSOR-1 — Alpha cursor request signal.
- SEEGRAPHICS-1 — This makes the dialog area transparent for alpha characters whose background index is 0.
- DOUNDERLINE-1 — Requests underline-mode with alpha characters.
- BLNKCHAR-1 — Enables character/cursor blink-mode.

This PAL is clocked by DOTCLK5.

NOTE

The dialog area scrolls up from the BOTTOM of the screen; when the shade is up, the dialog area covers the screen.

Delay Pipeline. This block adds the necessary pipeline delay to these signals:

- the attribute signals coming from the Dialog List
- the graphics pixels coming from the Graphics Memory (before they reach the color map's address MUX).

This circuit consists of two latch chips and part of a third one. The background and foreground signal groups pass through one alpha character delay and one pixel delay pipeline stage, while the graphics data passes through only one pixel rate stage. The CURSOR, SEEGRAPHICS, DOUNDERLINE, and BLINKCHAR signals also are pipelined just once. These pipeline latches are clocked by DOTCLK5 (from the Dot Clocks circuit). The latches' outputs are permenantly enabled. U657 operates at the character clock rate, while U655 operates at the pixel clock rate.

Dialog Window Shade. The Window Shade block determines the starting character row and the number of character lines for the dialog window shade as it appears on the display screen. This circuit consists of a control latch/register and a state-machine (programmed array logic) chip.

The latch receives two 5-bit words of control data (BLD0 through BLD4, and BLD8 through BLD12). The first five bits designates the screen location of the first visible character row. This is the top or starting point of the dialog window shade. The second five bits designates the number of visible character lines after the first line.

The two control words enter the data inputs (pins 2 to 11) of the custom state-machine. The WINCLK-1 signal (from the Timing Generator) clocks this chip. This clock pulse occurs when DRB and HSYNC coincide, outside the vertical retrace time; this phases the chip with the character rows until it reaches the last visible line. Then, during vertical retrace time WINCLK clocks rapidly; this resets the chip to its last state so it is ready for the next display frame. The chip outputs this information on its pin 16 (DIALOGENB-0). This signal is high until it reaches the first visible dialog line (top of window shade). Then it goes low until it reaches the last visible dialog line (bottom of window shade), after which it goes high again. This signal goes to the Attribute Control block.

VRESET initializes this chip to its first state.

Color Map Section

The Color Map works closely with several other blocks to translate dialog and graphics pixels into color encoded pixels for the color Display Module. The processor writes to the map and sets the color index values. The map then sends the translated pixel data to the display. The following blocks are part of the Color Map section and pass addresses and data to and from the map:

- Map Address MUX
- Pipeline
- Pixel Output Pipeline
- Map Data Read Back

Map Address MUX. Not counting the processor, there are six sources of addresses for the Color Map:

- Graphics cursor (crosshair)
- Blanking address (during CBLANK time)
- Alpha character foreground
- Alpha character background
- Graphics pixel data

This MUX circuit selects one of these address inputs for the Color Map. The outputs of the Pixel Priority Control PAL control the output enable inputs of a set of 74F240 buffers. These buffers are combined to form a 24-to-4 line MUX-equivalent; only one buffer is enabled at a time, according to the next pixel source to be selected. The outputs of these buffers provide the Color Map address for the corresponding pixel source.

Pipeline. This pipeline is a buffer that compensates for propagation delays in the address path to the Color Map. It is located between the Map Address MUX and the map.

Color Map. The Color Map is a memory array that stores 32 words of 16-bit color-index information. Only the lower 12 bits of each word are used to store actual color codes. These 12 bits are divided into three 4-bit groups, as indicated in Figure 4-43. This illustration also shows how the map memory is divided into color index regions for: graphics, dialog background and foreground, cursor background and foreground, crosshair background and foreground, and blanking.

Figure 4-43 also shows that four bits are used to control each color gun level. Each 4-bit group decodes into a 16-level index; each index sets the output level of one of the three color guns in the Display Module. Table 4-7 defines this scheme.

Combining the 16 levels on each of the three colors creates a total pallet of 4096 colors (of which 16 may be displayed at one time).

The Color Map hardware consists of an array of six 24 by 4-bit RAM chips. The processor writes index data to the RAMs via BLD0 to BLD11. The processor can also read map data over these lines. The RAMs are addressed via MAP0 to MAP3. MAP4-1 enables a read from the upper half of the map; MAP4-0 enables a read from the lower half of the map. MAPWR-0 is the write enable for the entire Color Map. The firmware uses bit-13 to prevent interference with the display image while map accesses are taking place.

Pixel Output Pipeline. Color Map output data passes through this pipeline before exiting on the output connector to the Display Module. This pipeline compensates for propagation delays, so the output pixel data and the sync signals both reach the display at the same time.

This block also provides the signal currents needed to drive the monitor interface circuitry in the Display Module.

Map Data Read Back. The processor reads Color Map data from the RAMs by looking at the contents of the Map Data Read Back latches. This pair of latch chips place Color Map data on bus lines BLD0 through BLD11. When the processor wants to read the Color Map, it sends an address to the graphics decoder. The decoder then sends a MAPIO and a BLWRCY signal; these signals are ANDed together to enable these output data latches.

An additional input to these buffers, YEP3-0, indicates the presence of the RAM3 board.

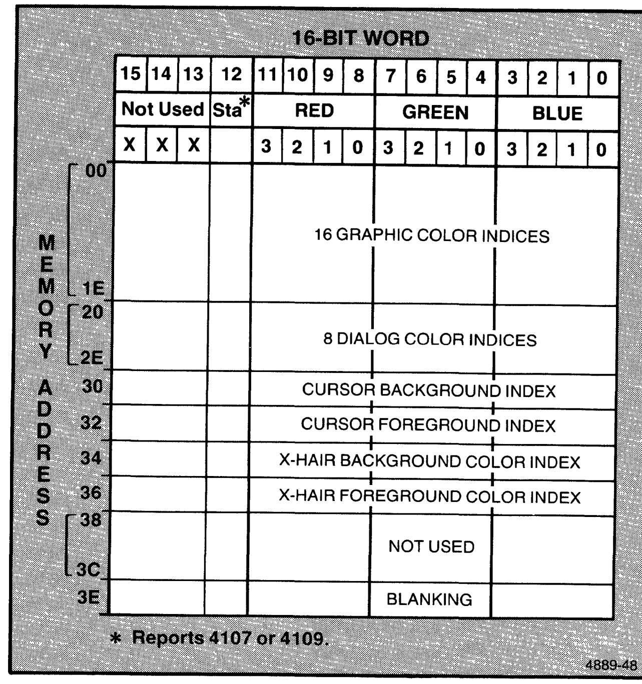


Figure 4-43. Color Map Organization.

Table 4-7

COLOR INDEXES

Index	Field Value	Gun Level
0	0000	0%
1	0001	6.67%
2	0010	13.33%
3	0011	20.0%
4	0100	26.67%
5	0101	33.33%
6	0110	40.0%
7	0111	46.67%
8	1000	53.33%
9	1001	60.0%
10	1010	66.67%
11	1011	73.33%
12	1100	80.0%
13	1101	86.67%
14	1110	93.33%
15	1111	100%

TIMING, SYNC, AND CLOCKS

This heading covers an assortment of blocks that make the timing signals for the many parts of the DCB.

Double-Wide Enable and Character Clock

This block generates the signals that tells the alpha shift-register to make double-wide (and double-high) alphanumeric characters. These DHDW control signals are SRMODE0 and SRMODE1. The block consists of a programmed array logic chip that combines several input conditions to make the two shift-register mode signals. (See Alpha Shift Register block description for details.) If the 9007's cursor signal occurs during HSYNC (horizontal sync time) then the array makes the proper combination of SRMODE0 and SRMODE1 to produce double-wide characters for the current character row.

This block also makes the character clock signal (CCLK-0), and the Word Delay Pipeline enable signal (ENBPIPE). CCLK is the alpha character clock that runs the 9007 and the character pipeline register. The ENBPIPE signal also clocks the 9006; it occurs once for every eight dot clocks, at the end of each character cell.

Timing Generator (and Signal Pipeline)

The Timing Generator is a programmed logic array that combines several time- and state-dependant signals to make more timing signals for other DCB circuit blocks. This block can be divided into three functional groups:

- The first part makes the HCLK and the VCLK signals. These clock the X and Y Address Counters (respectively). This part also makes the WINCLK signal, that clocks the Alpha Window Shade counter.
- The second part makes the TSC (Tri-State Control) signal that goes to the 9007.
- The third part of the chip makes the GY0 interlace-or-not signal that addresses the graphics memories. A divide-by-two flip-flop makes a signal that indicates (for interlaced mode) whether the display is showing the odd or even field. The flip-flop's inputs are PIPEVS-0 and HS-0. If HS-0 occurs at the beginning of PIPEVS, then an even field is displayed.

The gate array's GY0 tracks this input signal for 30 Hz interlaced mode. However, for non-interlaced mode, GY0 tracks the YDCGY0 signal (which is the least significant bit from the Y Position down-counter).

Signal Pipeline

This block is simply a pipeline latch for the input signals that go to the Timing Generator. The block performs a character delay on these signals: HS-0, VS-0, CBLANK-1, and CSYNC-0. The CBLANK signal exits on pin 19 and splits, where part of it is run through the latch to give it two delays. This twice-delayed CBLANK is AND gated with the original (undelayed) CBLANK to make the Composite Blanking signal for the Display Module.

Before entering the Pipeline, the VS-0 and HS-0 signals exit the 9007 and each passes through an AND gate that acts as a buffer/driver.

Dot Clocks and Buffers

This block generates the dot clock, that sets the rate of pixel data going through the DCB toward the display. This clock signal is used to clock and synchronize several other circuit blocks. A 25.2 MHz oscillator drives the circuit. The oscillator output enters a divide-by-two flip-flop. The resulting 12.6 MHz clock and the 25.2 MHz clock then enter a MUX that selects one or the other (depending on whether the DCB is in interlaced or non-interlaced mode). The INTERLACE-1 signal from the Alpha Control Register switches this MUX (actually three NAND gates and one inverter). The output of the MUX fans out into six identical signals called DOTCLK1 through DOTCLK6. These clocks are individually buffered and sent to different circuit blocks. Splitting the dot clock into separate lines, eliminates the following undesirable effects: line overloading, propagation delays, and line reflections.

RAM3 BOARD THEORY OF OPERATION

The RAM3 board provides 256K bytes of memory for storage of picture segment and display list information. This board is located between the Terminal Control board and the DCB, connected to each by 96-pin DIN connectors.

The address location of the RAM3 memory is split into two banks. The address of the lower 128K bytes is from 20000 to 3FFFF and the address of the upper 128K bytes is from C0000 to DFFFF. These two banks make up the 256K bytes of auxiliary processor memory. Figure 4-44 shows the six blocks that make up the RAM3 board; these are:

- Ready and Write Select (and address decoder)
- Data Output Buffer
- Input Data Latch
- RAM Controller
- Dynamic RAM
- Clock (oscillator)

The RAM3 board's circuit blocks are described next.

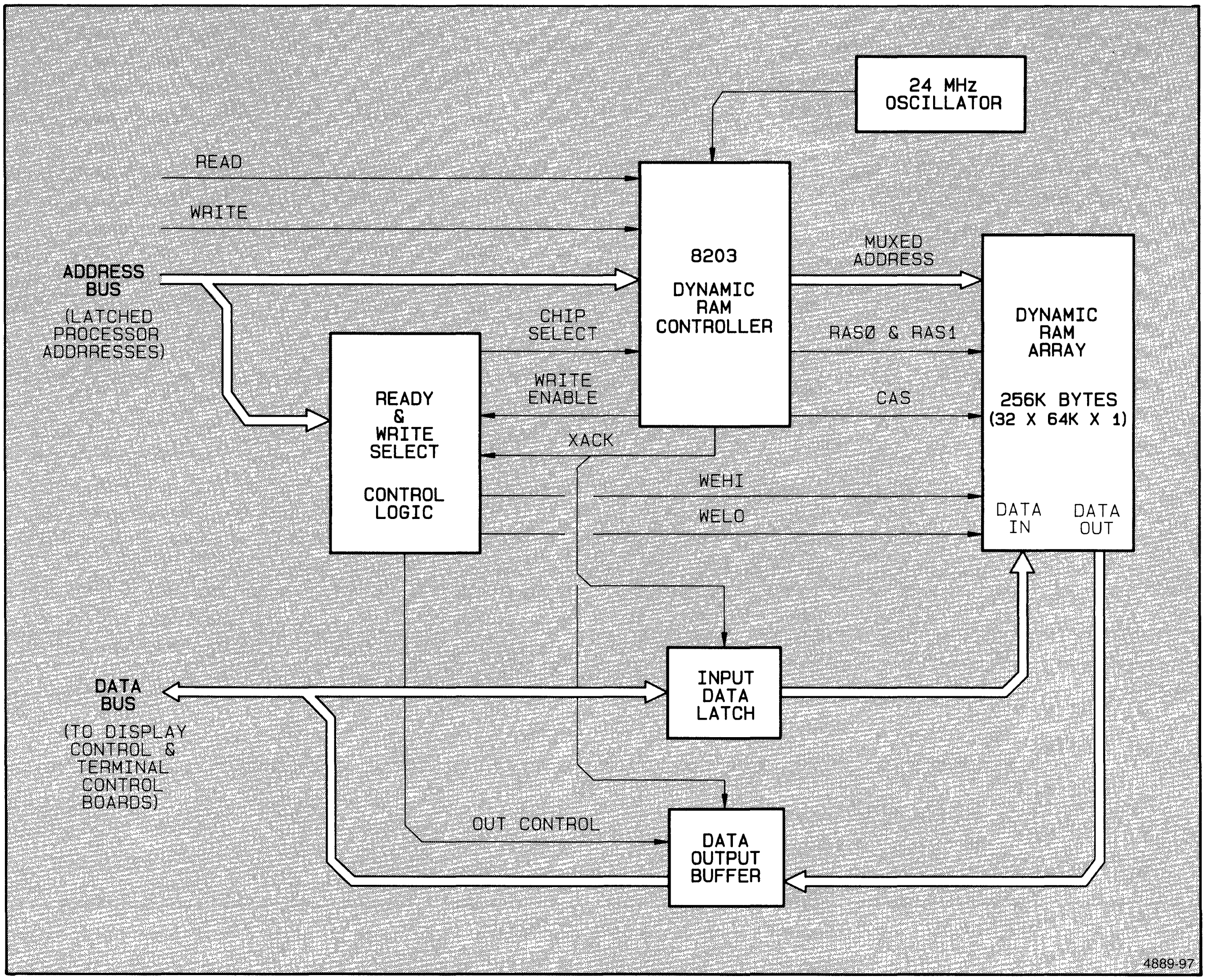


Figure 4-44. RAM3 Board Functional Block Diagram.

READY AND WRITE SELECT

The PAL in this block decodes the A16 thru A19 and A0 lines, which controls the PCS line to the 8203 RAM Controller. The PAL also sends the display ready signal (actually means memory ready) to the processor. The write enable (WE) signal from the 8203 is combined with the A0-1 and BHE-0 to generate the WEHI and WELO signals. The "write enable high" (WEH) and the "write enable low" (WELO) signals, from this PAL, control which half (high byte or low byte) of memory is written by the processor.

DATA OUTPUT BUFFERS

Data output from the RAMs on this board are buffered by two 74LS373 chips, which are enabled by the control PAL. These chips latch the data onto the processor bus's 16 data lines (AD0 thru AD15).

INPUT DATA LATCHES

These two 74LS244s latch the 16 data bits from the processor data bus until the bits are placed on the memory data bus.

RAM CONTROLLER

This block multiplexes the RAM address lines and provides the RAM refresh signals. The 8203 RAM Controller performs the memory refresh operations needed to maintain the data in the dynamic memory devices. It performs these functions:

- Arbitrates between processor access cycles and refresh cycles
- Multiplexes the memory addresses
- Provides the memory control strobes (RAS, CAS, and WE)
- Generates the acknowledge signal used to latch memory read data into the output data latch
- Generates the XACK (transfer acknowledge) handshake signal that signifies the completion of a memory operation.

RAM BLOCK

The memory on this board consists of 256K bytes of RAM in a 64K by 16-bit array. This functions as auxiliary memory to the processor.

CLOCK

The clock for the RAM3 board is a four-pin 24.0 MHz crystal oscillator requiring only a +5V supply.

POWER SUPPLY MODULE THEORY (620-0003-00,15)

The Power Supply Module supplies power to all other boards in the terminal. Without the Power Supply Module, the terminal cannot run. The board provides the following voltages:

- +21 Volts
- +12 Volts
- −12 Volts
- +5

If the +5 volt supply rises to a value of + 6.25 volts (+ or − 0.50 volts), or if any of the current limits are exceeded, circuitry on the board senses this and shuts the power supply down.

The Power Supply Module consists of the following functional blocks:

- AC Power
- EMI Filtering
- Line Select
- Rectifier and Filter
- Kick Start
- Pulse Width Modulator (PWM)
- Base Drive
- Primary Snubber
- Housekeeping & Regenerative Drive
- Main Transformer
- Control Loop Sense and Drive
- +21 Volt Outputs
- +12 and −12 Volt Outputs
- + and −12 Volt Current Limit
- Over Voltage Protect
- +5 Volt Output
- +5 Volt Current Limit

Each of these blocks is discussed briefly in the first part of this section, and discussed more thoroughly later on.

OVERVIEW

The Power Supply Module is based on a discontinuous mode fly-back, high-efficiency, switching type design. This type of supply provides the advantages of lower weight, smaller volume, and reduction in size over conventional supplies. The principle of a switching supply is shown in the simplified drawing of Figure 4-45.

A switching supply uses a Pulse Width Modulator (PWM) to produce a signal with a given pulse width. The pulse width is varied by the PWM, to keep the supplies in regulation as line voltage and load fluctuates. The PWM is shown on Figure 4-45 as a controlled switch.

The transformer is switched on and off at a fixed rate (in this case, at 25 KHz). During the on time, energy is stored in the primary coil of the transformer. During the off time, this energy is released to the secondary, where a capacitor and diode are connected. During the off time of the secondary, the capacitor supplies the output voltage. The diode provides isolation of the two windings.

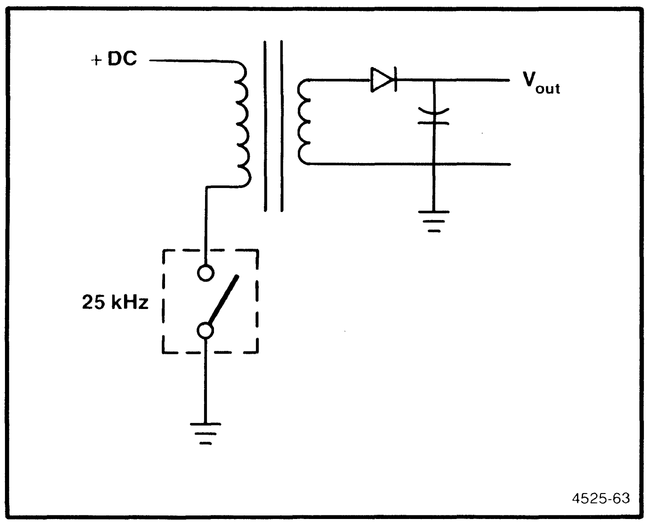


Figure 4-45. A Switching Supply.

Simplified Descriptions of Blocks

The following text gives a short and simplified description of each of the blocks shown in Figure 4-46. The next part of this section contains the more detailed descriptions of the circuit blocks.

AC Power. AC power acts as an input to the power supply (the AC Power Block).

EMI Filter. The EMI Filter block eliminates high frequency noise created by the switching of the power supply. This filter prevents such noise from flowing back into the AC lines.

Rectifier and Filter and Line Select. The Rectifier and Filter block rectifies the AC voltage to a high voltage DC signal (between 200 and 400 volts). The setting of the Line Select switches tells the Rectifier which of two methods to use to accomplish this.

Kick Start. The Kick Start is used to start the Pulse Width Modulator (PWM) when the power supply is first turned on.

Pulse Width Modulator (PWM). The PWM supplies a 25 KHz pulse used by the Base Drive block.

Housekeeping and Regenerative Drive, Base Drive, and Primary Snubber. Using the pulse supplied by the PWM, these blocks act together to chop the high voltage DC and deliver it to the primary coil of the Main Transformer.

Main Transformer. The Main Transformer transfers energy from the high voltage, line connected dc side, to the low voltage secondary side.

Voltages. The secondary transformer outputs are rectified to form the output voltages of the supply.

Over Voltage and Current Limit. These blocks sense if a voltage has risen excessively high, or if the current limit of the supply is exceeded, and breaks the control loop back to the PWM. This causes the supply to shut down.

Control Loop Sense and Drive. This block forms a feedback loop back to the PWM. The loop senses load and line variations, and adjusts the PWM pulse-width to keep the supplies in regulation. If current flow in the loop is broken, the supply shuts down.

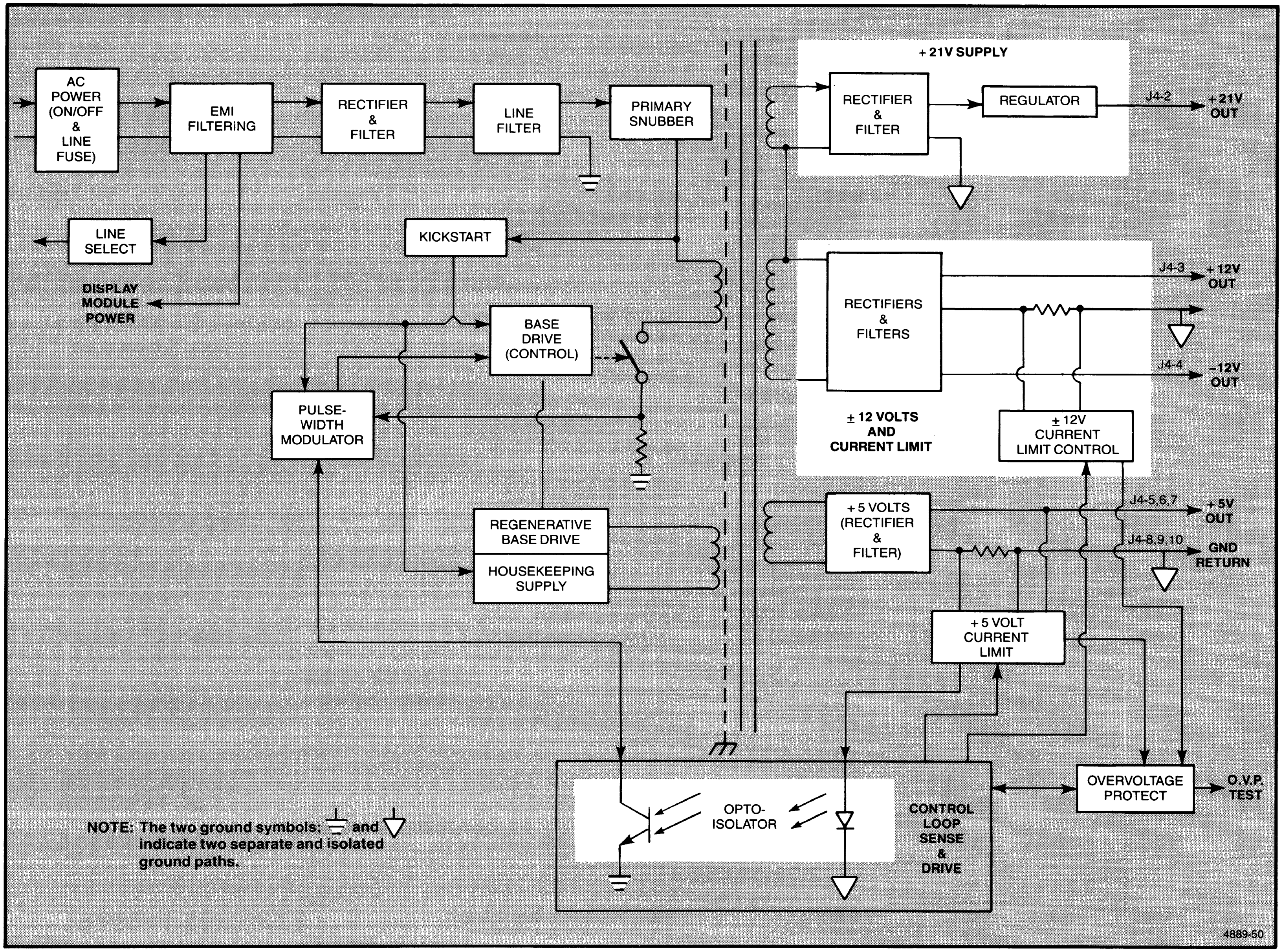


Figure 4-46. Power Supply (620-0003-00,15) Detailed Block Diagram.

DETAILED DESCRIPTIONS OF CIRCUIT BLOCKS

During the following discussion, refer to the Power Supply Module schematic, along with the block diagram. The block diagram shows how each block relates to one another, while the schematics are used when describing how each block functions.

AC Power

The AC Power section consists of the AC plug, a fuse, and the power switch.

AC power comes into the supply via a power cord connected to the AC plug. The power supply is protected by a 4A fuse and turned on by the power switch. The fuse is mounted on the power supply circuit board, and is not an externally accessible part.

EMI Filtering

The EMI filtering section is used to keep high frequency (Khz range and up) noise created by the switching of the supply from getting back onto the AC line. The filtering of this section does not affect the 60 Hz input signal, which is delivered to the Rectifier and Filter block. The EMI Filtering block consists of a thermal resistor, a series of capacitors and inductors, and two power resistors.

One of the inductors is a common-mode rejection transformer. This transformer has its two coils connected to opposites sides of the AC line, hence current is flowing in equal and opposite directions, creating a net flux of zero. When a high frequency signal enters this transformer, it meets a high opposing inductance. The signal then takes the alternate path (through the capacitors) to ground.

A thermistor limits surge current to the two main 100 μf capacitors (in the Rectifier and Filter block) when power to the supply is first turned on. The thermistor then heats up, which lowers its resistance, while the supply is operating. The thermistor normally runs hot during operation of the supply.

Two power resistors, working with an energy storing capacitor, isolate the high frequency switching noise that is generated by the converter. This prevents such noise from going back into the AC line.

Line Select

The Line Select block consists of two switches. The setting of these switches depends on which AC input (115 or 230 volts) the supply is operating from.

CAUTION

The line select switches must both be set to the same setting. Failure to do this could result in damage to the power supply or the monitor.

One switch selects the AC input for the power supply, the other selects the input for the Display Module's deguass coil and its power supply. The setting of the line select switch determines if the diode bridge in the Rectifier and Filter block acts as a voltage doubler or a full-wave bridge (see the next block description).

Rectifier and Filter

The Rectifier and Filter block changes the AC input signal to a high voltage DC signal (200 to 360 volts) for use by the Primary Snubber, Main Transformer, and Kick Start blocks. The main components of the Rectifier and Filter block are: a diode array, a warning light, the two 100 μf capacitors, and two zener diodes. To better understands how this circuit works, assume that all capacitors with a value less than 1 μf are open circuits (these capacitors are for high frequency filtering and appear as an open circuit to 60 Hz).

The setting of the AC line-select switch determines how the AC input is rectified into DC. With the switch set to the 115 V position, the switch acts as a short circuit, and a voltage doubler circuit is created (see Figure 4-47). The voltage across the 100 μf capacitors is approximately 300 volts.

When the switch is set to the 230 Volt position, the switch acts as an open circuit. The circuit then acts as a full-wave bridge (see Figure 4-48), and voltage across the capacitors is approximately 300 volts. Therefore, in either configuration, the same voltage is developed across the capacitors.

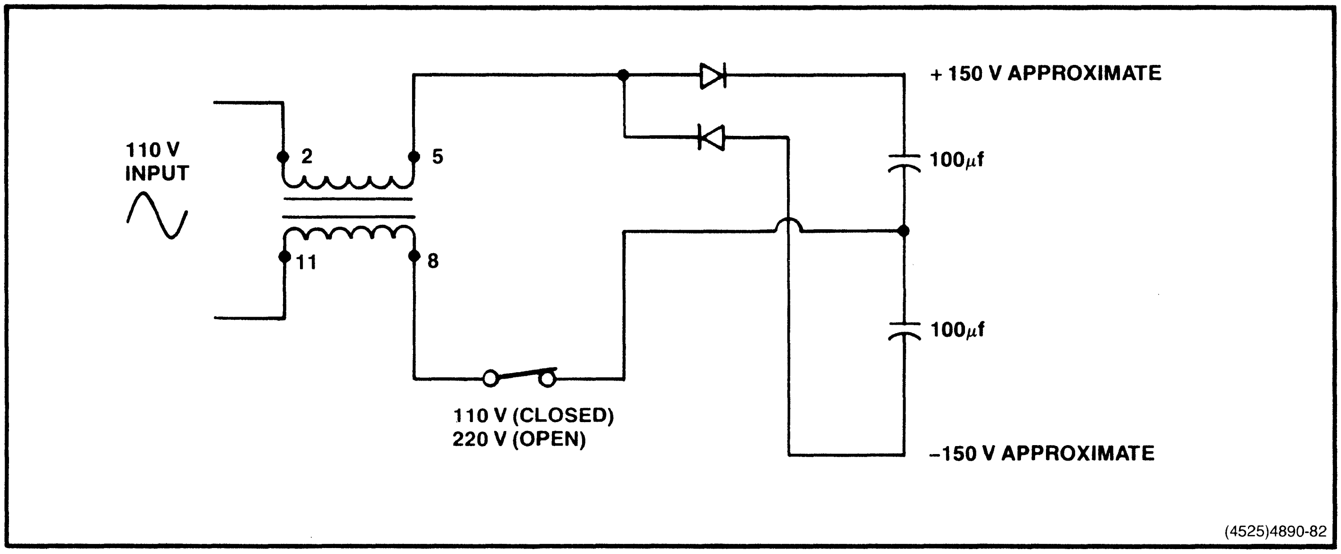


Figure 4-47. Rectifier and Filter Block When Used as a Voltage Doubler.

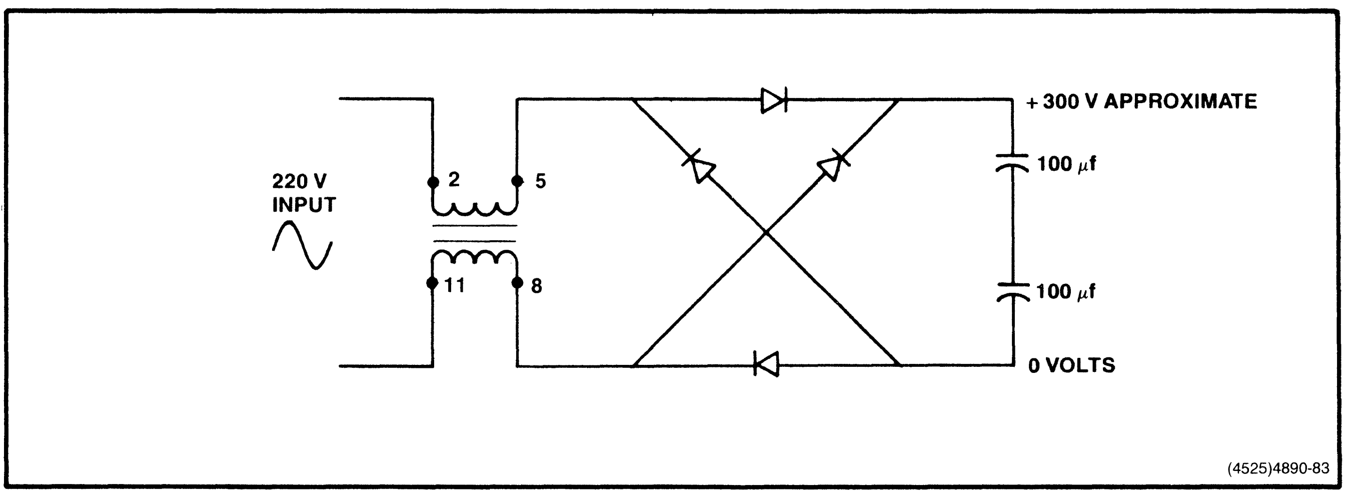


Figure 4-48. Rectifier and Filter Block as a Full-Wave Bridge.

The two capacitors each have a 150 Kohm resistor and a 200 volt zener diode in parallel. The resistors set the discharge time of the capacitor after the power is turned off (discharge time is less than five minutes). The zener diode is a surge suppression device that helps to absorb any transients that occur on the AC line. These diodes conduct at 200 volts, preventing the capacitors from overcharging (maximum charge is 200 volts, or 400 volts across the two capacitors).

A warning light in this block shows that dangerous voltages exist in the supply. This light flashes when the power supply is on, and continues flashing after the supply is unplugged until the capacitors discharge to a safe level.

Kick Start

The Kick Start circuitry is initialized when the power supply is first turned on and is used to start the Pulse Width Modulator operating. Input voltage to this block is the + 300 volts (approximate) from the Rectifier and Filter Block. The components of this block that are used for the Kick Start are: one resistor, a capacitor, a 16 volt zener diode, and an SCR. After the housekeeping supply comes up (which maintains the PWM after it starts switching), the Kick Start circuitry resets — so it will be ready to start the PWM at the next power-up. The components used to reset the Kick Start are a 12 volt zener diode, two resistors, and a transistor.

When the supply is first turned on, the 16V zener diode prevents gate current from flowing in the SCR. This allows the capacitor to charge up to the 16V zener voltage, at which point the zener conducts, injecting current into the SCR gate and turning it on. The capacitor then begins discharging into the PWM and base drive circuitry, furnishing a 16 volt supply for start-up.

After this occurs, the reset circuitry in this block resets the Kick Start. The 12 volt zener is turned on, causing the transistor to turn on. This, in turn, discharges the capacitor connected to the SCR. The SCR is then reset and ready to start the PWM the next time the power supply is turned on.

Pulse Width Modulator (PWM)

The PWM provides regulation of the supply voltages by controlling the width of its 25 KHz output pulse. This is a function of the feedback signal received from the Control Loop Sense and Drive block.

After the Kick Start block has furnished a supply voltage to the PWM, it begins switching.

Pin 2 (Vz) produces an output voltage of approximately 8.4 volts dc. This voltage is fed back to an RC network connected to pin 5. This RC network sets the 25 KHz switching rate of the PWM by placing a semi-sawtooth wave on Pin 5 (this waveform is shown in Figure 4-49).

The width of the pulse is set by the voltage on pin 4, which is predominately controlled by an op-amp inside the PWM chip. In this particular case, the op-amp has a gain of about .75, and acts as an input port for the Control Loop Sense and Drive block.

The output of the PWM is a 25 KHz pulse on pin 7 that has a minimum voltage of 0.1 volts and a maximum voltage of 0.7 volts. This pulse drives the Base Drive block. The Base Drive block then switches the main transformer.

The feedback signal enters pin 3, which controls the PWM in combination with the voltage on pin 4.

Primary current limit is sensed on pin 6. If the primary current reaches a level sufficient to raise this pin 0.52 volts, the PWM shuts down (stopping the output pulse).

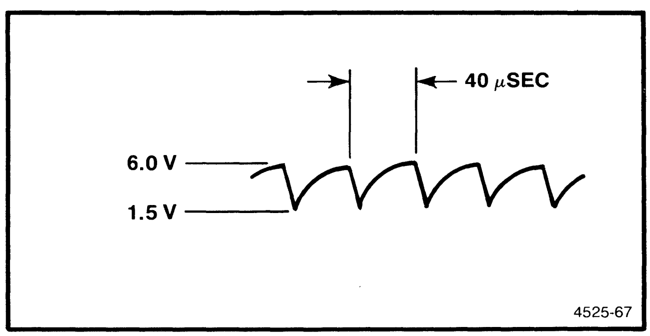


Figure 4-49. RT, CT Input of the PWM.

Maintenance Test

This circuit limits the width of the PWM pulse when power is applied to the supply. This block consists of a transistor that is used to manually control the pulse width during testing/ maintenance. This circuit allows you to manually control the voltage on pin 2 of the test connector (using a special test fixture).

Base Drive

The Base Drive block chops the primary voltage (+ 300 volts dc) to provide switching of the primary winding (pins 7 and 8) of the main transformer. This is accomplished by alternating a switching transistor between on and off states. The main components of this block are two transistors (the base drive and primary switching transistors), a series of diodes, and a capacitor.

The output pulse of the PWM is fed directly to the base of the base drive transistor, where it is used to turn on and off this transistor. When the base drive transistor is on, the switching transistor is off, and vice versa.

When the base drive transistor is off, its collector is high, causing current to flow through the three diodes and into the base of the primary switching transistor. At the same time, the Housekeeping and Regenerative drive also supplies current through the resistors, diodes, and into the base of the switching transistor. These two current supplies ensure that the switching transistor remains turned on. The voltage drop across the diodes is approximately 2 volts, which causes the capacitor to charge to + 2 volts.

When the base drive transistor turns on, its collector is pulled low. The capacitor now applies a negative two volts to the base of the switching transistor, ensuring fast turn off.

This cycle is repeated for each pulse from the PWM.

Primary Snubber

The Primary Snubber consists of two diodes, a capacitor, and a high wattage resistor.

When the primary switching transistor (in the Base Drive block) is starting to turn off, a voltage spike of up to a 800 volts or more occurs. This is the result of energy stored in primary leakage inductances. The snubber acts to steer current through the capacitor and diodes back into the primary (+ 300 volts) supply, preventing the high current from going through the switching transistor. After the transistor has completed turning off, the resistor rapidly discharges the capacitor, dissipating about 3 watts of power through the resistor.

Housekeeping and Regenerative Drive

This block forms a closed loop into the base drive block, and supplies drive for both halves of the transformer cycle (on and off times). The components of this block are a transformer winding, three diodes, a capacitor, and resistors.

When the primary switching transistor (in the Base Drive block) is turned on, pin 3 of the winding is polarized positive. This provides extra base drive current to the transistor, ensuring enough current to operate near the saturated region. When the switching transistor is turning off, pin 3 goes to ground.

The capacitor and diode connected to pin 2 delivers supply voltages to the Base Drive and PWM blocks. When the switching transistor is off, pin 2 is at approximately + 15 volts, and the capacitor charges. When pin 2 is low, the capacitor supplies the + 15 volts.

Main Transformer

The Main Transformer provides power from the primary to the secondary in order to develop the individual voltage supplies.

The Main Transformer is configured in a fly-back type of configuration. During the on time of the primary (as determined by the switching transistor), energy is stored in the primary coil. During the off time of the primary, this energy is released into the secondary coils. The energy released is filtered to become the individual voltage sources. A more thorough discussion of this process is covered at the beginning of this section.

Control Loop Sense and Drive

This block of circuitry forms a loop from the secondary windings of the transformer back to the PWM. When this loop is closed, the PWM is allowed to function. The loop senses the load on the supplies, and feeds back to the PWM, telling it to widen or narrow the PWM pulse width. When this loop is opened, such as when an overvoltage protect block opens it, the power supply shuts down. The primary components of this block are the opto-isolator, control regulator, capacitor, and a series of resistors.

As the +5 volt supply is initialized (when the power supply is first turned on) the REF pin of the Control Regulator approaches +2.5 volts. When the REF pin reaches +2.5 volts, the Control Regulator turns on and begins to shunt excess drive current from opto-isolator. Current through the opto-isolator (which is held at a fixed value) feeds back to the PWM and maintains the PWM pulse-width. The current through the opto-isolator is modulated by the control regulator and varies with the load on the supplies. The opto-isolator current then adjusts PWM pulse-width accordingly to maintain regulation.

The cathode of the Control Regulator can be brought to ground by an over current or over voltage condition on the supplies. This stops current through the opto-isolator, breaking the control loop, and the power supply shuts down.

+21 Volt Output

Approximately 27 volts appears across the secondary winding of the main transformer. A series regulator chip then drops this voltage down and regulates it to +21 volts, for use in the EPROMs. The main components in this block are three capacitors, two resistors, a diode, and the series regulating chip.

+12 and −12 Volts

When the secondary of the transformer is on, the diodes conduct and the capacitor charges. The output of the secondary is +12 and −12 volts, which is delivered as the output voltages. When the secondary is off, the diodes are reversed biased, preventing discharge of the capacitor back into the transformer. The charge of the capacitor carries the supply through until the secondary is again turned on.

+12 and −12 Volt Current Limit

This block senses whether the current limit of the + or − 12 volt supplies is being exceeded. If so, this block causes the power supply to shut down (by breaking the loop formed in the Control Loop Sense and Drive block). This block consists of two transistors, resistors, and a diode.

If current through one of the + or − 12 volt capacitors is sensed by the resistor, one of the two transistors begins conducting (depending on which supply was sensed). This shunts drive current away from the opto-isolator and shuts down the supply.

Over-Voltage Protector

This block allows an over voltage (a runaway voltage) on the +5 volt supply to shut down the power supply. The main components of this block are a Silicon Controller Rectifier (SCR), zener diode, capacitor, and resistors.

If the + 5 volt supply rises above +5.6 volts, the zener diode turns on and begins conducting. When the zener has sourced enough current to raise it another 0.6 volts, the SCR turns on. This, in turn, pulls the cathode of the control regulator (in the Control Loop Sense and Drive block) to ground, no current goes through the opto-isolator, the control loop is broken, and the supply shuts down.

+5 Volt Output

The +5 volt supply basically operates the same way as the + and 12 volt supplies. The capacitor charges during the on time of the secondary winding, and then supplies the output voltage when the transformer is off. The diodes provide isolation when the secondary has turned off. The remaining components in this block (capacitors, inductor, and a resistor) are used to filter out any noise created by the switching of the supply. Since this voltage is used for all of the TTL devices in the terminal, it is important that the supply be free of high frequency noise.

+5 Volt Current Limit

This block senses whether the +5 Volt supply has exceeded the current limit. If this happens, this block causes the supply to shut down. The main components of this block are two transistors, a zener diode, and a sense resistor.

The +12 volt supply is used to set the zener diode at +10 volts. This provides a constant voltage for this circuit to use. Current flows down through the 10 Kohm resistor and turns on Q257. The voltage at the base of Q352 is set by the 330 ohm resistor. The current sense resistor is connected between the two emitters of the transistors. When the current through this resistor gets large enough, it raises the emitter of Q257 to a higher voltage. When this voltage plus the collector-emitter voltage of Q257 equals approximately +0.65 volts, Q352 turns on. This shuts down the opto-isolator (no current flows), the control loop is broken, and the supply shuts down.

POWER SUPPLY MODULE THEORY (620-0019-00,01)

The Power Supply Module supplies power to all other boards in the terminal. Without the Power Supply Module, the terminal cannot run. The board provides the following voltages:

- +12 Volts
- −12 Volts
- +5 Volts

If the +5 volt supply rises to a value of +6.25 volts (±0.50 volts), or if any of the current limits are exceeded, circuitry on the board senses this and shuts the power supply down.

The Power Supply Module consists of the following functional blocks:

- AC Power
- EMI Filtering
- Line Select
- Rectifier and Filter
- Kick Start
- External PWM Control & Soft Start
- Pulse Width Modulator (PWM)
- Base Drive & Main Switching Transistor
- Primary Snubber
- Housekeeping & Primary Current Limit
- Main Transformer
- Control Loop Sense and Drive (and Opto-Isolator)
- +12 and −12 Volt Outputs
- + and −12 Volt Current Limit
- +5 Volt Overvoltage Protection
- +5 Volt Output
- +5 Volt Current Limit

NOTE

Earlier versions of this Power Supply contained a 21 Volt Supply (to support the EEPROM on the earlier Terminal Control Boards).

Each of these blocks is discussed briefly in the first part of this section, and discussed more thoroughly later on.

OVERVIEW

The Power Supply Module is based on a discontinuous mode fly-back, high-efficiency, switching type design. This type of supply provides the advantages of lower weight, smaller volume, and reduction in size over conventional supplies. The princinple of a switching supply is shown in the simplified drawing of Figure 4-45.

A switching supply uses a Pulse Width Modulator (PWM) to produce a signal with a given pulse width. The pulse width is varied by the PWM, to keep the supplies in regulation as line voltage and load fluctuates. The PWM is shown on Figure 4-45 as a controlled switch.

The transformer is switched on and off at a fixed rate (in this case, at 25 KHz). During the on time, energy is stored in the primary coil of the transformer. During the off time, this energy is released to the secondary, where a capacitor and diode are connected. During the off time of the secondary, the capacitor supplies the output voltage. The diode provides isolation of the two windings.

Simplified Descriptions of Blocks

The following text gives a short and simplified description of each of the blocks shown in Figure 4-46. The next part of this section contains the more detailed descriptions of the circuit blocks.

AC Power.

AC power acts as an input to the power supply (the AC Power Block).

EMI Filter. The EMI Filter block eliminates high frequency noise created by the switching of the power supply. This filter prevents such noise from flowing back into the AC lines.

Rectifier and Filter and Line Select. The Rectifier and Filter block rectifies the AC voltage to a high voltage DC signal (between 200 and 400 volts). The setting of the Line Select switches tells the Rectifier which of two methods to use to accomplish this.

Kick Start. The Kick Start is used to start the Pulse Width Modulator (PWM) when the power supply is first turned on.

Soft Start & External PWM Control. This block provides a controlled turn-on for the supply in two ways: by manual control while troubleshooting, or by slow charging of the soft start capacitor during normal turn-on.

Pulse Width Modulator (PWM). The PWM supplies a 25 KHz pulse used by the Base Drive block.

Housekeeping, Base Drive, and Primary Snubber. Using the pulse supplied by the PWM, these blocks act together to chop the high voltage DC and deliver it to the primary coil of the Main Transformer.

Main Transformer. The Main Transformer transfers energy from the high voltage, line connected dc side, to the low voltage secondary side.

Voltages. The secondary transformer outputs are rectified to form the output voltages of the supply.

+5 Volt Overvoltage Protection and Current Limit. These blocks sense if a voltage has risen excessively high, or if the current limit of the supply is exceeded, and causes the supply to shut down.

Control Loop Sense and Drive. This block forms a feedback loop back to the PWM. The loop senses load and line variations, and adjusts the PWM pulse-width to keep the supplies in regulation.

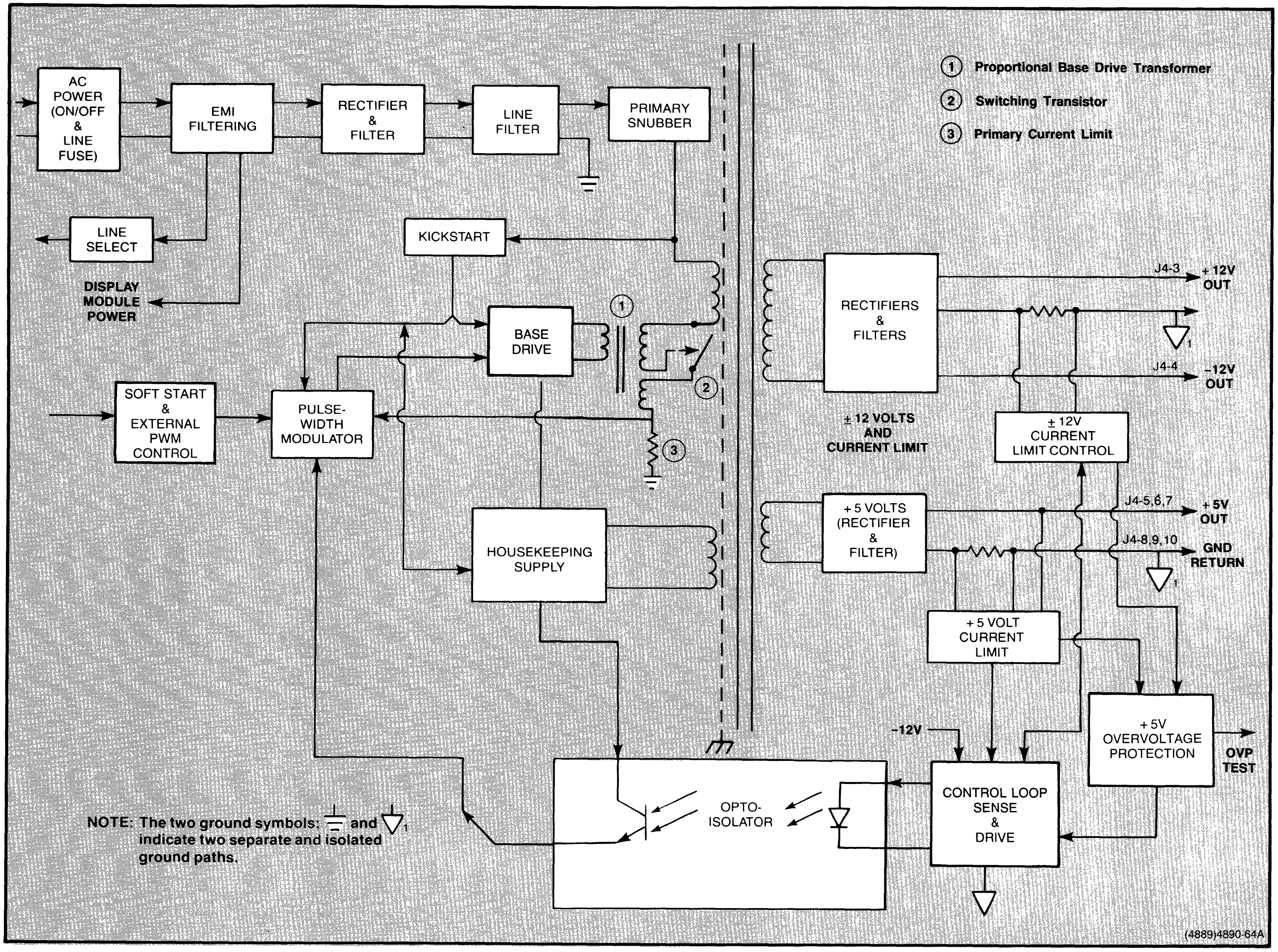


Figure 4-50. Power Supply (620-0019-00,01) Detailed Block Diagram.

DETAILED DESCRIPTIONS OF CIRCUIT BLOCKS

During the following discussion, refer to the Power Supply Module schematic, along with the block diagram. The block diagram shows how each block relates to one another, while the schematics are used when describing how each block functions.

AC Power

The AC Power section consists of the AC plug, a fuse, and the power switch.

AC power comes into the supply via a power cord connected to the AC plug. The power supply is protected by a 4A fuse and turned on by the power switch. The fuse is mounted on the power supply circuit board, and is not an externally accessible part.

EMI Filtering

The EMI filtering section is used to keep high frequency (KHz range and up) noise created by the switching of the supply from getting back onto the AC line. The filtering of this section does not affect the 60 Hz input signal, which is delivered to the Rectifier and Filter block. The EMI Filtering block consists of a thermal resistor, two series capacitors and an inductor, and two power resistors.

The inductor is a common-mode rejection transformer. This transformer has its two coils connected to opposites sides of the AC line, hence current is flowing in equal and opposite directions, creating a net flux of zero. When a high frequency signal enters this transformer, it meets a high opposing inductance. The signal then takes the alternate path (through the capacitors) to ground.

A thermistor limits surge current to the two main 100 μF capacitors (in the Rectifier and Filter block) when power to the supply is first turned on. The thermistor then heats up, which lowers its resistance, while the supply is operating. The thermistor normally runs hot during operation of the supply.

Two inductors, working with an energy storing capacitor, isolate the high frequency switching noise that is generated by the converter. This prevents such noise from going back into the AC line.

Line Select

The Line Select block consists of two switches. The setting of these switches depends on which AC input (115 or 230 volts) the supply is operating from.

CAUTION

The line select switches must both be set to the same setting. Failure to do this could result in damage to the power supply or the monitor.

One switch selects the AC input for the power supply, the other selects the input for the Display Module's deguass coil and its power supply. The setting of the line select switch determines if the diode bridge in the Rectifier and Filter block acts as a voltage doubler or a full-wave bridge (see the next block description).

Rectifier and Filter

The Rectifier and Filter block changes the AC input signal to a high voltage DC signal (200 to 360 volts) for use by the Primary Snubber, Main Transformer, and Kick Start blocks. The main components of the Rectifier and Filter block are: a diode bridge, a warning light, the two 220 μF capacitors, and two zener diodes. To better understands how this circuit works, assume that all capacitors with a value less than 1 μF are open circuits (these capacitors are for high frequency filtering and appear as an open circuit to 60 Hz).

The setting of the AC line-select switch determines how the AC input is rectified into DC. With the switch set to the 115 volt position, the switch acts as a short circuit, and a voltage doubler circuit is created (see Figure 4-47). The voltage across the 220 μF capacitors is approximately 300 volts.

When the switch is set to the 230 volt position, the switch acts as an open circuit. The circuit then acts as a full-wave bridge (see Figure 4-48), and voltage across the capacitors is approximately 300 volts. Therefore, in either configuration, the same voltage is developed across the capacitors.

The two capacitors each have a 47 Kohm resistor and a 200 volt zener diode in parallel. The resistors set the discharge time of the capacitor after the power is turned off (discharge time is less than two minutes). The zener diode is a surge suppression device that helps to absorb any transients that occur on the AC line. These diodes conduct at 200 volts, preventing the capacitors from overcharging (maximum charge is 200 volts, or 400 volts across the two capacitors).

A warning light in this block shows that dangerous voltages exist in the supply. This light flashes when the power supply is on, and continues flashing after the supply is unplugged until the capacitors discharge to a safe level.

Kick Start

The Kick Start circuitry is initialized when the power supply is first turned on and is used to start the Pulse Width Modulator operating. Input voltage to this block is the +300 volts (approximate) from the Rectifier and Filter Block. The components of this block that are used for the Kick Start are: two resistors, a capacitor, a 16 volt zener diode, a signal diode, and an SCR. After the housekeeping supply comes up (which maintains the PWM after it starts switching), the Kick Start circuitry resets — so it will be ready to start the PWM at the next power-up. The components used to reset the Kick Start are a 12 volt zener diode, two resistors, and a transistor.

When the supply is first turned on, the 16 volt zener diode prevents gate current from flowing in the SCR, while the 20K resistor allows leakage current to flow to the return. This allows the capacitor to charge up to the 16 volt zener voltage, at which point the zener conducts, injecting current into the SCR gate and turning it on. The capacitor then begins discharging into the PWM and base drive circuitry, furnishing a 16 volt supply for start-up.

After this occurs, the reset circuitry in this block resets the Kick Start. The 12 volt zener is turned on, causing the transistor to turn on. This, in turn, discharges the capacitor connected to the SCR. The SCR is then reset and ready to start the PWM the next time the power supply is turned on.

The signal diode prevents the reverse voltage from causing breakdown of the cathode-gate junction, after reset.

Soft Start & External PWM Control

This circuit limits the width of the PWM pulse when power is applied to the supply. This block consists of a transistor, capacitor, and resistor that are used to manually control the pulse width during testing and turn-on. This circuit allows you to manually control the voltage on the pin 4 of the PWM (using a special test fixture) during maintenance. Then, during normal turn-on, the capacitor in this circuit has a charging characteristic that provides a controlled voltage at Pin 4; this controls the rate of converter turn-on.

Pulse Width Modulator (PWM)

The PWM provides regulation of the supply voltages by controlling the width of its 25 KHz output pulse. This is a function of the feedback signal received from the Control Loop Sense and Drive block.

After the Kick Start block has furnished a supply voltage to the PWM, it begins switching.

Pin 2 (Vz) produces an output voltage of approximately 8.4 volts dc. This voltage is fed back to an RC network connected to pin 5. This RC network sets the 25 KHz switching rate of the PWM by placing a semi-sawtooth wave on Pin 5 (this waveform is shown in Figure 4-49).

The width of the pulse is set by the voltage on pin 4, which is predominately controlled by an op-amp inside the PWM chip. In this particular case, the op-amp has a gain of about .75, and acts as an input port for the Control Loop Sense and Drive block.

The output of the PWM is a 25 KHz pulse on pin 7 that has a minimum voltage of 0.1 volts and a maximum voltage of 0.7 volts. This pulse drives the base drive block. The Base Drive block then switches the main transformer, via the main switching transistor.

Primary current limit is sensed on pin 6. If the primary current reaches a level sufficent to raise this pin 0.52 volts, the PWM shuts down (stopping the output pulse).

Base Drive and Main Switching Transistor

This block chops the primary voltage (+ 300 volts dc), via the main switching transistor, which interrupts the current in the primary winding (pins 7 and 8) of the main transformer. This is accomplished by alternating a switching transistor between on and off states. The main components of this block are: three transistors, two resistors and diodes, a current source capacitor, and a proportional base drive transformer (T235). The transistors are labeled by functions as follows: main switching transistor (Q233), base drive transistor (Q237), and the charging transistor (Q139).

The output pulse of the PWM is fed directly to the base of the base drive transistor, where it is used to turn on and off the switching transistor. When the base drive transisitor is on, the switching transistor is off, and vice versa.

The following discussion is depicted in Figure 4-50. When the base drive transistor is on, the current source capacitor (C137) is discharged through CR136; and the charging transistor is held off by the reverse bias provided by this diode. The current is limited by R336 through the control winding of the base drive transformer. When the base drive transistor is turned off, the energy stored in the core of the transformer is released into the base of the switching transistor, turning it on. As current begins to flow through the switching transisitor, it is fed back to the base (via transformer action) as a fixed ratio of collector current, ensuring adequate base drive under all conditions. During this 'on' time of the switching transistor, the charging transistor turns on and charges the current source capacitor to the Housekeeping Supply voltage. When the PWM turns on the base driver, the energy stored in the capacitor is used to turn off the switching transistor through the control winding of the transformer. The remaining diode is used during core reset of the transformer.

This cycle is repeated for each pulse from the PWM.

Primary Snubber

The Primary Snubber consists of two diodes, a capacitor, and a high wattage resistor.

When the primary switching transistor is starting to turn off, a voltage spike of up to a 800 volts or more occurs. This is the result of energy stored in primary leakage inductances. The snubber acts to steer current through the capacitor and diodes back into the primary (+ 300 volts) supply, preventing the high current from going through the switching transistor. After the transistor has completed turning off, the resistor rapidly discharges the capacitor, dissipating about 3 watts of power through the resistor.

Housekeeping and Primary Current Limit

Resistor, R325, acts as a primary current sense resistor, whose output is fed to Pin 6 of the PWM. When this voltage level reaches 0.52 volts (nominal) the output of the PWM is inhibited, turning on the base drive transistor.

CR137 and C336 form a housekeeping supply which provides power for the primary side control circuitry (while the converter is running).

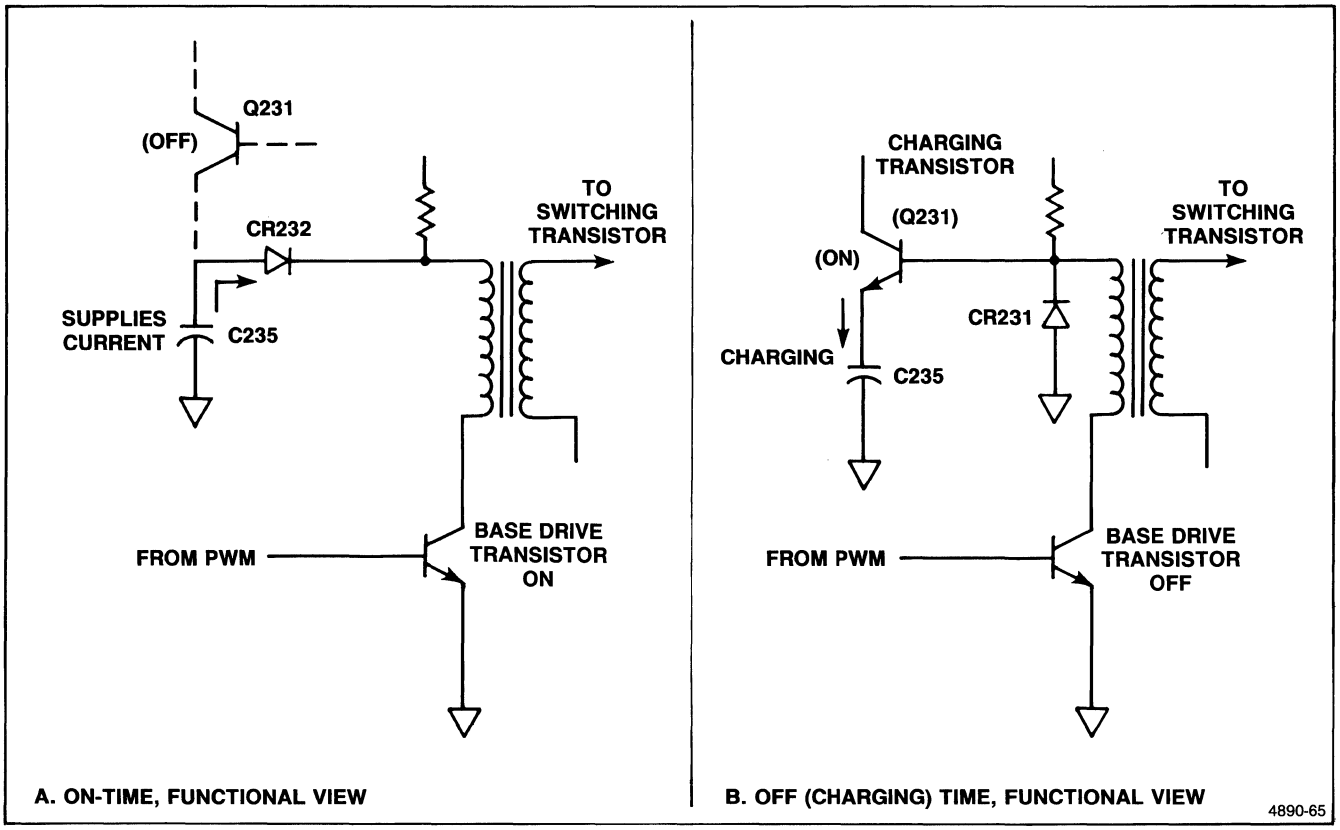


Figure 4-51. Base Drive Circuit and Current Source Capacitor.

Main Transformer

The Main Transformer provides power from the primary to the secondary in order to develop the individual voltage supplies.

The Main Transformer is configured in a fly-back type of configuration. During the on time of the primary (as determined by the switching transistor), energy is stored in the primary coil. During the off time of the primary, this energy is released into the secondary coils. The energy released is filtered to become the individual voltage sources. A more thorough discussion of this process is covered at the beginning of this section.

Control Loop Sense and Drive

This block of circuitry forms a loop from the secondary windings of the transformer back to the PWM. When this loop is closed (as in normal operation), the PWM is allowed to function. The control regulator senses the voltage on the supplies, and feeds back to the PWM, telling it to widen or narrow the PWM pulse width. When this loop is opened, by the Overvoltage Protect block or Current Limit block, the power supply shuts down. The primary components of this block are the opto-isolator, control regulator, capacitor, and a series of resistors.

As the +5 volt supply is initialized (when the power supply is first turned on) the REF pin of the Control Regulator approaches +2.5 volts. When the REF pin reaches +2.5 volts, the Control Regulator turns on and begins to conduct drive current through the opto-isolator. Current through the opto-isolator feeds back to the PWM and maintains the PWM pulse-width. The current through the opto-isolator is modulated by the control regulator and varies with the load on the supplies. The opto-isolator current then adjusts PWM pulse-width accordingly to maintain regulation.

The cathode of the Control Regulator can be brought to ground by an over current or over voltage condition on the supplies. This increases the drive current through the opto-isolator, which causes the power supply to shut down.

+12 and –12 Volts

When the secondary of the transformer is on, the diodes conduct and the capacitor charges. The output of the secondary is +12 and –12 volts, which is delivered as the output voltages. When the secondary is off, the diodes are reversed biased, preventing discharge of the capacitor back into the transformer. The charge of the capacitor carries the supply through until the secondary is again turned on.

+12 and –12 Volt Current Limit

This block senses whether the current limit of the ±12 volt supplies is being exceeded. If so, this block causes the power supply to shut down (by increasing the opto-isolator drive current in the Control Loop Sense and Drive block). This block consists of two transistors, resistors, and a diode.

If excessive current through the load on either supply is sensed by the 0.75Ω resistor, the potential developed across the resistor causes one of the two transistors to begin conducting (depending on which supply was sensed). This shunts drive current away from the opto-isolator and shuts down the supply.

+5 Volt Over-Voltage Protector

This block allows an over voltage (a runaway voltage) on the +5 volt supply to shut down the power supply. The main components of this block are a Silicon Controller Rectifier (SCR), zener diode, capacitor, and resistors.

If the +5 volt supply rises above +5.6 volts, the zener diode turns on and begins conducting. When the zener has sourced enough current to raise it another 0.6 volts, the SCR turns on. This, in turn, pulls the cathode of the control regulator (in the Control Loop Sense and Drive block) to ground, no current goes through the opto-isolator, the control loop is broken, and the supply shuts down.

+5 Volt Output

The +5 volt supply basically operates the same way as the + and −12 volt supplies. The capacitor charges during the on time of the secondary winding, and then supplies the output voltage when the transformer is off. The diodes provide isolation when the secondary has turned off. The remaining components in this block (capacitors, inductor, and a resistor) are used to filter out any noise created by the switching of the supply. Since this voltage is used for all of the TTL devices in the terminal, it is important that the supply be free of high frequency noise.

+5 Volt Current Limit

This block senses whether the +5 volt supply has exceeded the current limit. If this happens, this block causes the supply to shut down. The main components of this block are two transistors, and a sense resistor.

Current from the +5 volt sense line flows down through the 4.64 Kohm resistor and turns on Q109. The voltage at the base of Q111 is set by the 383 ohm resistor. The current sense resistor is connected between the two emitters of the transistors. When the current through this resistor gets large enough, it raises the emitter of Q109 to a higher voltage. When this voltage plus the collector-emitter voltage of Q109 equals approximately +0.55 volts, Q111 turns on. This breaks the control loop and the supply shuts down.

DIGITAL PIGGYBACK AND VIDEO INTERFACE BOARDS THEORY

The 4109 may use either of these boards to convert the digital output from the Display Control Board into an analog signal for the monitor. This analog signal is also applied to the 4109's External Video connectors.

WHERE EACH BOARD IS USED

The terminal contains either a Digital Piggyback board or one of two versions of a Video Interface board. The Digital Piggyback and early version Video Interface boards are nearly identical in function but have different physical layouts and mounting locations. The later version Video Interface board mounts the same as the early version Video Interface board, but it has a somewhat different function. These three boards were originally installed in terminals in the following order:

- The *Digital Piggyback* board is used in terminals with serial numbers up to B019999.
- The *early version Video Interface* board is used in terminals with serial numbers beginning at B020000. This board's part number is 670-9045-00.
- The *later version Video Interface* board is used in terminals shipped after February 1986. This board's part number is 670-9045-02.

NOTE

The later version Video Interface board will only operate in terminals that have the 119-2023-00 (or newer) Display Module.

The Digital Piggyback board is mounted piggyback fashion on the Display Module's Video board (hence the "piggyback" part of its name). The Video Interface board is mounted on the bottom of the terminal, and the three RGB OUT connectors are fastened to the board.

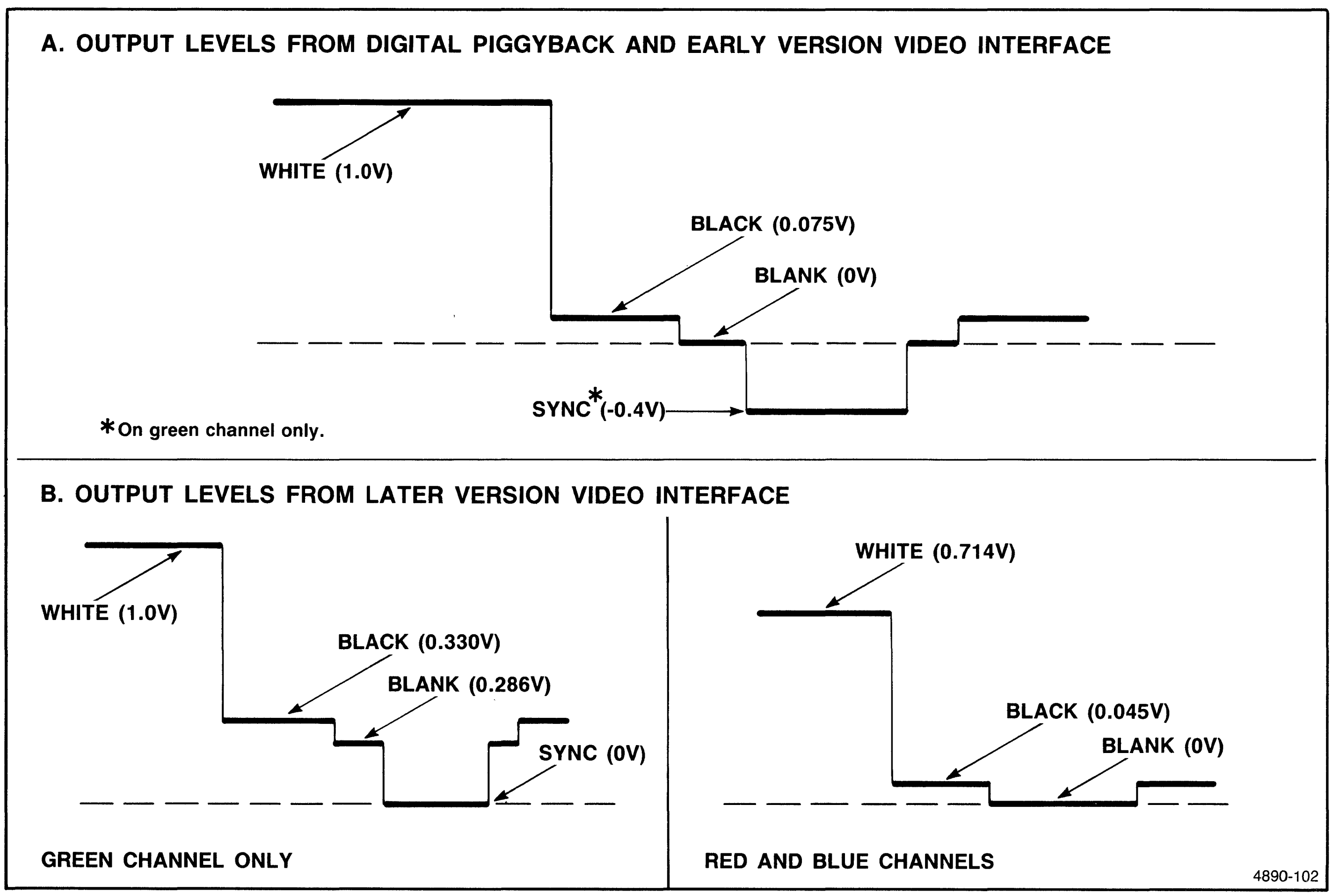


Figure 4-52. Video Levels.

OVERVIEW AND INTERFACING

In the following discussion, where the three versions of the board are similar, they are referred to collectively as "the interface board."

The interface board accepts digitally encoded video signals from the Display Control board (three color signals plus sync). The composite sync signal is carried on the green color channel.

The Digital Piggyback board and early version Video Interface board convert these digital video signals into analog RS-170 signals for the External Video connectors. The IA-RS-170 standard is normally used with monochrome monitors but is used here to generate color levels specified between the limits of 0.075V for black, and 1.0V for "white" (full intensity). These boards convert the three color signals so they conform to this standard. The output to the internal monitor is more like the RS-330 color standard.

The later version Video Interface board uses a slightly different DAC and converts digital video into analog video according to the RS-330 standard (which is intended for color monitors). The only differences between the two versions of the board are in the levels and the fact that sync does not go negative on the later version board. These differences are shown in Figure 4-52.

The circuitry, on all three versions of the interface board, consists of three DACs and three unity-gain amplifiers (one each per channel). See Figure 4-53.

The three DACs make the signals for the Display Module. The additional circuitry buffers the three color signals and places them on the three BNC video output connectors (labeled RED, GREEN, BLUE on the rear panel); these signals are intended to drive an external 60 Hz, non-interlaced color display monitor.

THEORY OF OPERATION

The primary function of the interface board is digital-to-analog conversion of the three color signals. The three-channel DAC is designed specifically for color video applications. Incoming data first enters a 12-bit latch (contained in the DAC). Then each color signal passes through a 4-bit DAC. Two additional inputs accept TTL-level control signals for the DAC. One of these signals, DACBLANK, forces the output channels to the RS-170 or RS-330 "blanking" level (depending on which DAC is used). The other signal, CSYNC, causes the incoming sync pulses to appear on the green output channel.

The DAC's data inputs are parallel-terminated by a resistor network. This network's Vcc input is lowered by the amount of one diode drop; this decreases the network's power consumption. The DAC's analog current outputs are terminated into 200 ohms and produce signals at twice the RS-170 or RS-330 level. These outputs are split in two directions.

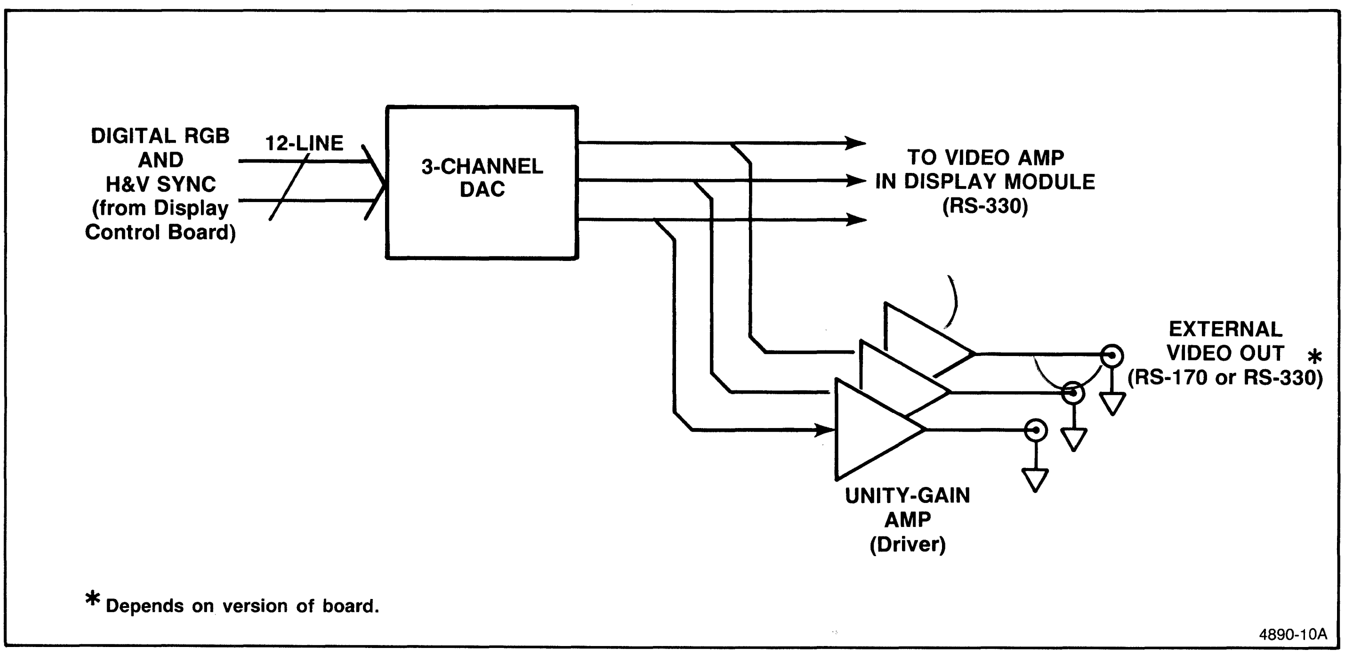
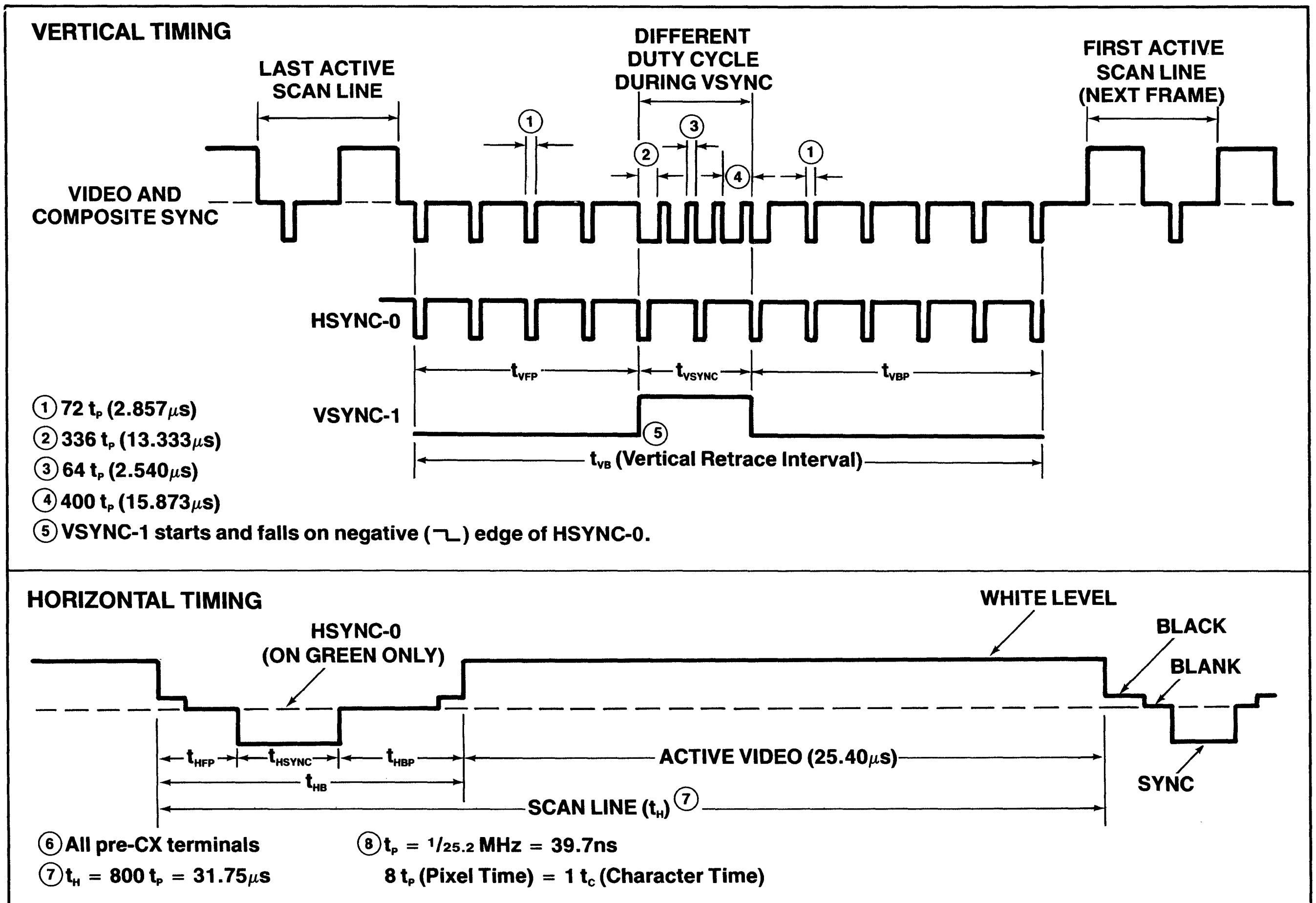


Figure 4-53. Block Diagram of Digital Piggyback and Video Interface Boards.

- The first part of the signal is halved and sent to the Display Module. The Digital Piggyback board trasmits this signal via three connectors (P54, P56, and P58); the Video Interface boards use a multi-pin connector, J56.
- The second part (also halved) is buffered by unity-gain amplifiers, series-terminated, and fed to the three BNC connectors on the rear panel of the terminal. These are the three external video output signals. Three pots trim the voltage levels of these signals (on the Digital Piggyback and early version Video Interface boards only).

Figure 4-54 shows the details of vertical and horizontal timing for the output signals from the interface board.

Another connector, J57, brings power into the board and also passes sync and control signals to it. The 5VON signal tells the DCB that the interface board has 5V power.



Vertical Parameters	Vertical Time	Number of Horizontals	Horizontal Parameters	Horizontal Time	Number of Clocks
t_{VB} (Vertical Blanking)	1428.6µs	45t_H (7)	t_{HB} (Horizontal Blanking)	6.350µs	160 t_P (8)
t_{VFP} (V Front Porch)	222.2µs (285.7µs) (6)	7t_H	t_{HFP} (H Front Porch)	.794µs	20 t_P
t_{VSYNC} (V Sync)	190.5µs	6t_H	t_{HSYNC} (H Sync)	2.857µs	72 t_P
t_{VBP} (V Back Porch)	1015.9µs (952.4µs) (6)	32t_H	t_{HBP} (H Back Porch)	2.698µs	60t_P

4890-81B

Figure 4-54. Typical Output Signals from the Digital Piggyback and Video Interface Boards.

CX TERMINAL IBM HOST INTERFACE

The CX-series terminals contain a special interface board and a coaxial connector. This allows the terminal to communicate with an IBM host via an IBM 3274 or 3276 Control Unit. In this application, the user enters a Setup command to send all host I/O through the Coax Hostport (instead of the RS-232 port). The CX Interface board connects to the terminal's main processor via the main address and data busses, see Figure 4-6. The interface board resides at address location 017B to 01FF in Processor I/O space. For more details about the CX terminal, see Appendix F.

NOTE

> *The* CX Interface Test Fixture Manual *explains the operation of the CX Interface Board in greater detail.*

FUNCTIONAL DESCRIPTION

Figure 4-55 shows how the IBM host passes data to and from the CX terminal. The host first sends commands and data from its front-end processor to a Control Unit via a "channel" or telecom line/modems to the Control Unit. The transmissions over this line are referred to as the "outbound" and "inbound" data streams and conform to the IBM 3270-series data stream format. Such data is encoded in EBCDIC[2] (versus ASCII) and enclosed in communications "packets." The Control Unit receives this data and converts it into the IBM coax code format, which it sends to the terminal. The CX Interface board then decodes this coax formatted data and passes the information to the terminal's main processor.

2 Extended Binary Coded Decimal Interchange Code.

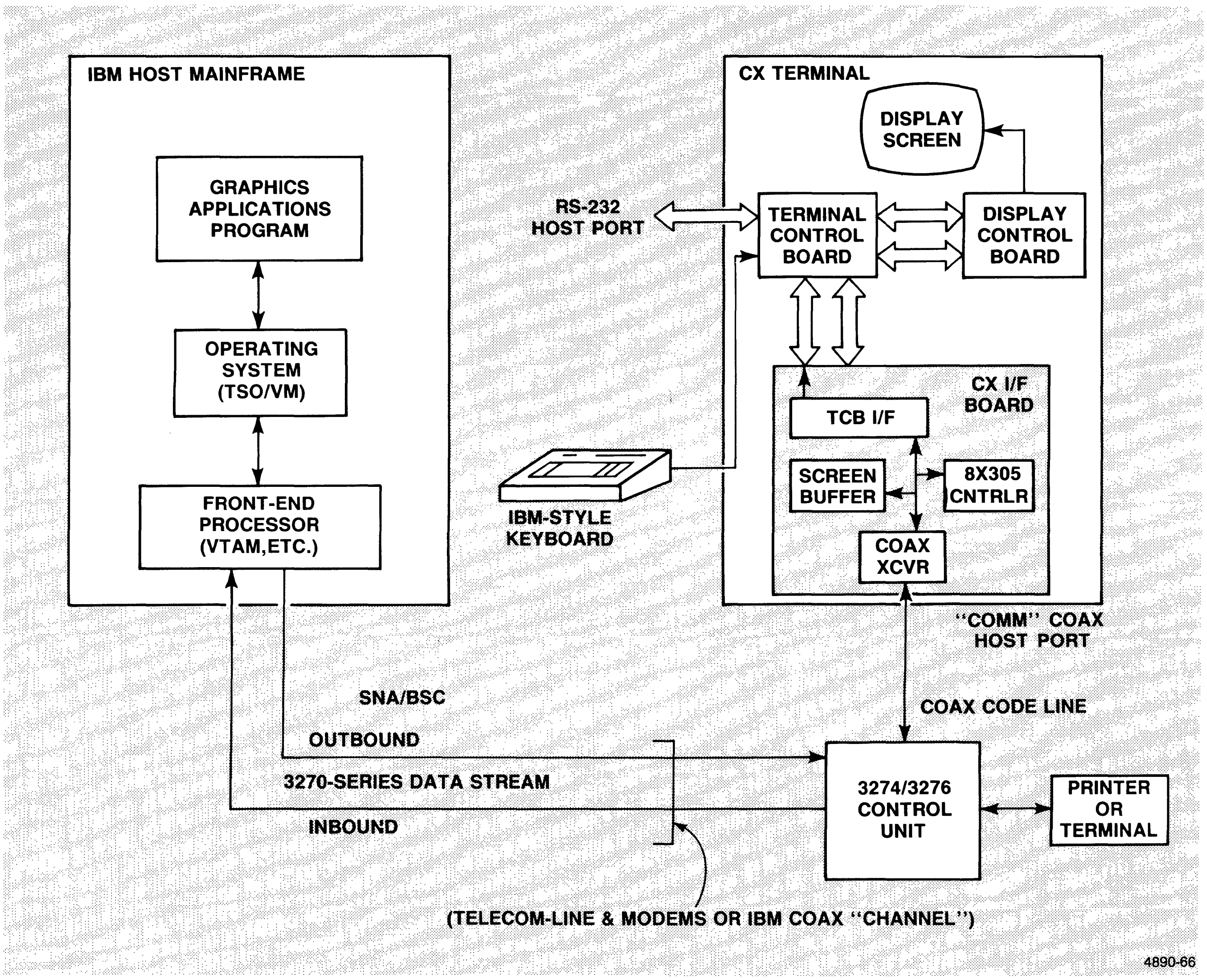


Figure 4-55. Block Diagram of CX Interface and IBM System.

In the IBM system, the terminal is a slave to the Control Unit (which assumes many of the intellegent functions of most modern RS-232 terminals). While the user is communicating with the host, the Control Unit is receiving host messages and passing them to the terminal. At the same time, the Control Unit is polling the terminal to see if the user wants to send a command or data back to the host.

When the user presses a key, the terminal sends a keyscan code in response to the next poll from the Control Unit. The Control Unit converts this code to a character code, using a special "coax code" character set.[3] It sends the character code back to the terminal's "screen buffer." The terminal then displays whatever text is stored in this screen buffer on the display screen.

To send text onward to the host computer, the user presses the ENTER key. The Control Unit then reads text from the terminal's screen buffer and sends that text onward to the computer. In so doing, the Control Unit converts the characters from the coax code, stored in the terminal's screen buffer, into the EBCDIC code used by the host computer. The CX Interface board contains this screen buffer.

[3] **This "character code" depends on which keyboard is installed. Each foreign language keyboard has its own unique set of character codes.**

BLOCK DESCRIPTION

Figure 4-56 is a functional block diagram of the CX Interface board. The board contains these four functional blocks:

- Terminal Control Board Interface
- Microcontroller
- Screen Buffer
- Coax Transceiver

The Terminal Control Board Interface is a set of buffers that pass data back and forth to the main processor (on the Terminal Control Board).

The 8X305 microcontroller on this interface board is responsible for several tasks:

- Decoding the Coax-Coded stream according to one of two translation methods (determined by the TMETHOD command in Setup)
- Providing special symbols for the "operator information" line, appearing across the bottom of the display screen
- Provides other 3279 emulation features

The Screen Buffer is an 8K x 8-bit static RAM. It stores the character codes, which are then read by the Terminal Control Board and displayed on the screen.

The Coax Transceiver passes the data to and from the coax connector (from the CX data bus). The primary elements of this block are a biphase transmitter and a biphase receiver. These chips connect to the coax connector via an isolation transformer and switch.

NOTE

The CX Interface board contains an LED. When lit, this indicator says that the 8X305 and its related hardware are functioning properly.

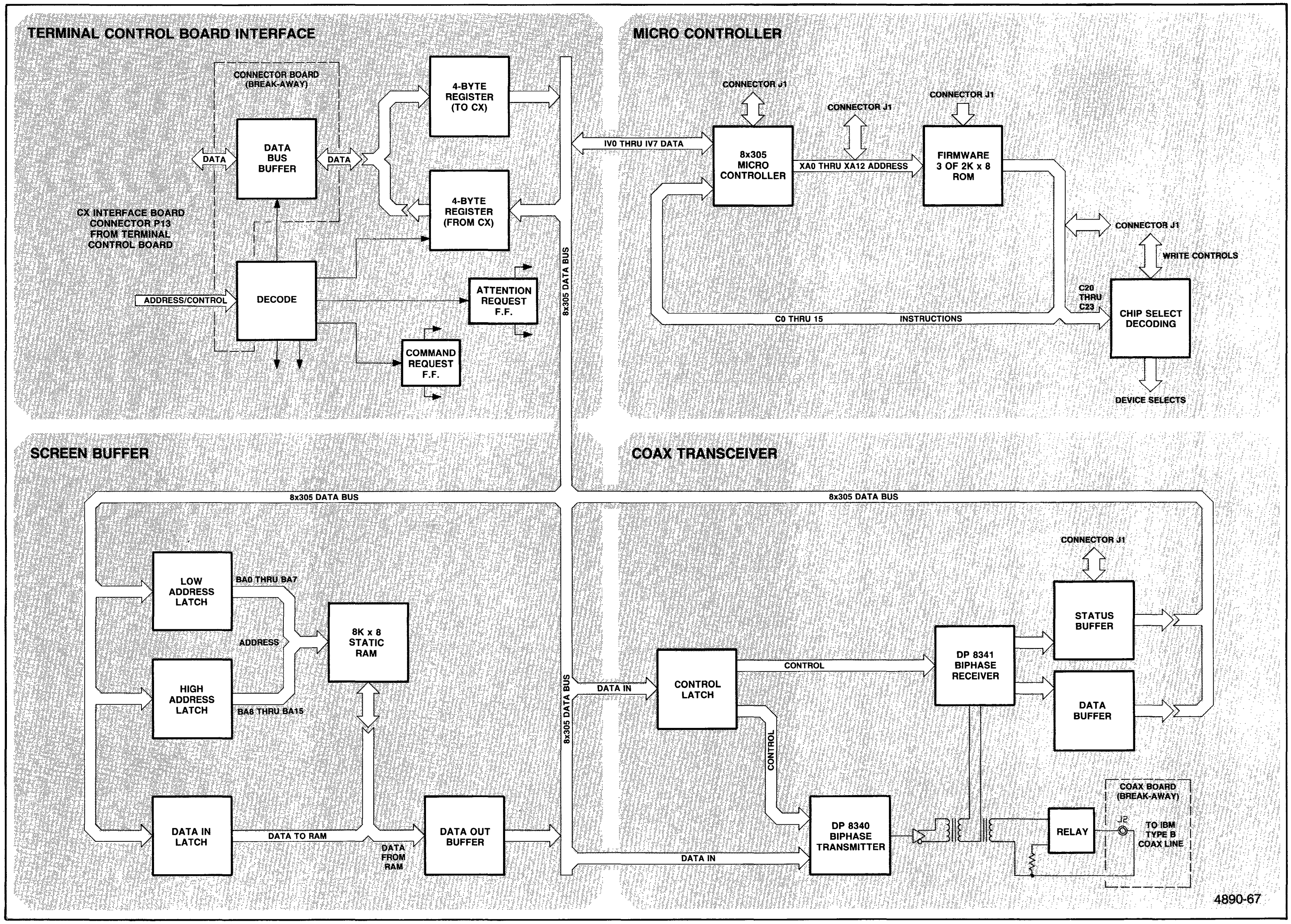


Figure 4-56. CX Interface Board Functional Block Diagram.

Section 5

CHECKS AND ADJUSTMENTS

This section describes the checks and adjustments for the terminal. The Display Module is the main analog part of the terminal and is the focus of attention in this section. (The Power Supply Module has no adjustments.)

The first part of this section lists the performance check procedures for the terminal (excluding the Display Module). The remainder of the section deals with the adjustment procedures for the two different types of the Display Modules used in the terminal.

ADJUSTMENT TOOLS

These adjustment procedures require the use of certain "tools." These tools include: test equipment, test fixtures, hand tools, and adjustment patterns (provided by Self Test). To put the test patterns on the screen, go into the Adjustment part of Self Test and press certain Function Keys (see Tables 5-2 and 5-3). Appendix C provides a complete description of Self Test.

RECOMMENDED TEST EQUIPMENT

Table 5-1 lists the test equipment needed to check and adjust the terminal. The listed equipment specifications are the minimum required to perform these tests. If alternate equipment is to be used, it must meet or exceed these specifications.

Table 5-1

RECOMMENDED TEST EQUIPMENT

Description of Equipment	Equipment Minimum Specification	Example
Variable Autotransformer	Voltage range: 0 to 140 V. Power handling: 0 to 1500 W.	General Radio W8MT3VM.
Oscilloscope (dual trace)	Vertical: 5 mV/div. Time base: 10 ns/div. 80 MHz	TEKTRONIX SC 504
Scope probe	Attenuation: 10:1 Resistance: 10 MΩ Capacitance: 10 pF Length: 1 meter	TEKTRONIX P6108
Digital Voltmeter	0 — 100V DC & AC (p-p) 0.1 % accuracy	TEKTRONIX DM 501
High Voltage Probe	30 kV	FLUKE Model 80K-40 (40 kV probe)
Photometer and Luminance Probe	Capable of reading 100 ft-lamberts max	TEKTRONIX J16, with J6503 probe
Flat blade screwdrivers	1/8 inch diameter non-conductive, 5 inches long and 10 inches long	003-0489-00 and 003-0001-00
Alignment tool	1/10 inch diameter, non-conductive	No TEK part number.
Display graticule	Contains screen adjustment pattern	TEKTRONIX 067-1181-00
RTV silicon adhesive/sealant	—	Dow-Corning 3145
Degaussing coil		003-1322-00
Magnifying eyepiece	Magnification: 10X or greater	

USING SELF TEST

The recommended procedure for checking and adjusting the terminal involves using the Self Test program, in ROM, to call certain test patterns to the display screen. To call a particular test pattern press one or more function keys, located along the top of the keyboard. Table 5-2 defines the first level of Adjustment Self Test function keys. At this level, pressing F5 puts you into the next level of functions (the display patterns mode). Table 5-3 defines the key functions for this level of Self Test.

Table 5-2

SELF TEST ADJUSTMENT KEYS

Key Name	Key Function
F1	Reset Non-volatile Parameters
F2	Keyboard Switch Test
F3	RS-232 Interface Menu
F4	Hard Copy Menu
F5	Display Patterns Menu
F6	Graphics Tablet Menu
F7	Exit the current menu
F8	Exit Self Test

Table 5-3

DISPLAY PATTERNS MENU

Key Name	Key Function
F1	Calls Grid Pattern.
F2	Calls Gray Scale Pattern.
F3	Calls White Screen Pattern.
F4	Calls Color Pattern.
F5	Calls "H" Pattern.
F6	Calls Crosshair Pattern.
Shifted F1	Sets video amplifier to 0 level.
Shifted F2	Sets video amplifier to maximum level.
Shifted F3	Calls the Dot Pattern.
Dialog key	Toggles the red video on and off.
Setup key	Toggles the green video on and off.
SCopy key	Toggles the blue video on and off.
Shifted Dialog key	Increments the red intensity level.
Shifted Setup key	Increments the green intensity level.
Shifted SCopy key	Increments the blue intensity level.
Menu	Turns menu (dialog) on or off.
F7	Exits back to Adjustments Menu.
F8	Exits Self Test

PERFORMANCE CHECK AND FUNCTIONAL CHECK PROCEDURES

FUNCTIONAL CHECKS

The functional check procedure for the terminal consists of running Extended Self test and doing the Performance Checks. Self Test verifies the functional operation of the logic boards and low-voltage Power Supply Module. The Performance Checks verify the functional operation of the Display Module.

Appendix C contains the complete description of the Self Test program, including operating information and error messages. The Self Test display test patterns provide a general indication that the major parts of the Display Module are functional. Table 5-3 indicates the function keys needed to call these display patterns to the screen.

To perform the functional check procedure, you will need certain special test fixtures; the host port, peripheral ports, and copier port checks require use of special loopback connectors. See NOTE.

NOTE

Contact a service representative at your nearest TEKTRONIX Field Office for information about acquiring these special test fixtures.

PERFORMANCE CHECK PROCEDURE

The performance check procedure for the terminal consists of the functional check procedure for the terminal and the functional check procedure for the Display Module. The functional check procedures for the Display Module are printed in the separate service manual for each type of Display Module. The titles of these manuals are listed in Section 1 (Optional Accessories).

The performance check procedures verify that the terminal performs according to the specifications listed in Section 2 of each of the Display Module service manuals.

ADJUSTMENT PROCEDURES

The adjustment procedures for the terminal pertain only to the Display Module. Since there are two different types of displays used in this terminal, this section includes separate adjustment procedures for each of these Display Modules. You can easily recognize the earlier display by its large sheet metal chassis and numerous circuit boards. This display corresponds to the GMA301. The later version display (119-2023-00) has a smaller chassis and fewer circuit boards.

ADJUSTMENT PROCEDURE FOR THE GMA301-TYPE DISPLAY MODULE

The following steps summarize the adjustments for the earlier version Display Module (used in terminals with serial numbers *up to and including B019999*). These adjustments should be performed in this sequence:

- Horizontal and Vertical Hold adjustments
- CRT Cutoff adjustment
- Digital Piggyback board adjustments
- Video amplifiers adjustments
- Focus adjustment
- Vertical deflection adjustments
- Horizontal deflection adjustments
- Pin-cushion correction adjustments
- Purity check
- Convergence adjustment
- Video offset adjustments

These checks and adjustments are listed as independent items; however, the success of these checks depends on performing them in the above sequence.

STEP-BY-STEP PROCEDURE

The following procedures will set the Display Module according to the specifications in Section 2.

NOTE

All test points and adjustments for the GMA 301-type Display Module are shown in Figure 5-1 (on a foldout page at the end of this section).

Horizontal and Vertical Hold Adjustments

This procedure requires use of the Self Test Grid Pattern. Run Self Test; from the main menu, select F6 (Adjustment Menu). See Tables 5-2 and 5-3, again.

The horizontal hold procedure is first, followed by vertical hold. Figure 5-1 shows the locations of the horizontal and vertical hold adjustments, R155 (labeled I in figure) and R105 (labeled C).

1. From the main Adjustment Menu (in Self Test), press Function Key F5, Display Pattern Menu. Then press Function Key F1; this displays the "grid pattern".
2. Adjust – H HOLD (R155 on the Main Video board) clockwise until sync is lost, and note the position of the potentiometer.
3. Adjust – R155 counterclockwise until sync is lost, and note this second position of the potentiometer.
4. Adjust – R155 so it is centered between these two positions.
5. Use a jumper wire to short across pins 6 and 7 of U381 on the Display Control board (shown in Figure 5-2). Observe loss of sync on the screen. Then, remove the jumper wire and verify that sync comes back. If sync is not restored, adjust R155 accordingly.
6. Adjust – V HOLD (R105) clockwise until sync is lost, and note the position of the potentiometer.
7. Adjust – R105 counter-clockwise until sync is lost, and note this second position of the potentiometer.
8. Center the potentiometer between these two positions, or center it between breakup and the opposing end of the pot adjustment.
9. Use a jumper to short across pins 7 and 8 on U381: refer to Figure 5-2 again. Observe the loss of sync on the screen. Then disconnect the jumper and verify that sync is restored. If sync does not come back, adjust R105 accordingly.

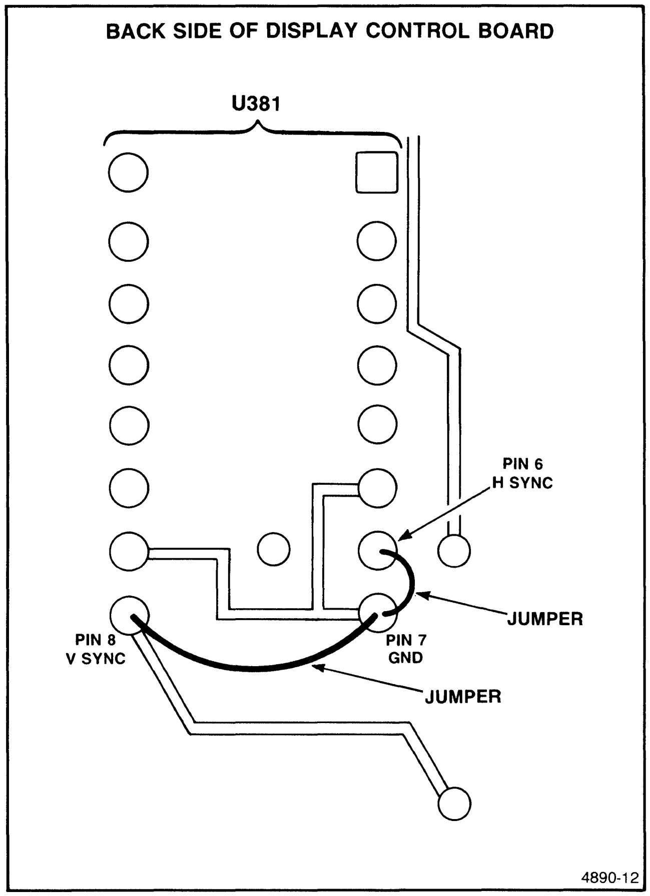


Figure 5-2. Jumpers on U381 To Remove Sync (Back Side of Display Control Board).

CRT Cutoff Adjustment

The following procedure is relatively complicated. Therefore, first read through the procedure while referring to Figure 5-3, to see the entire process in perspective. Then, go back and perform the procedure step-by-step.

1. **Power up the terminal, run Adjustment Self Test, and call the Display Pattern Menu (F5). Display a black screen by turning off all three guns; toggle these Function Keys to turn off the three guns:**
   - Dialog (to turn off red gun)
   - Setup (to turn off green gun)
   - SCopy (to turn off blue gun)

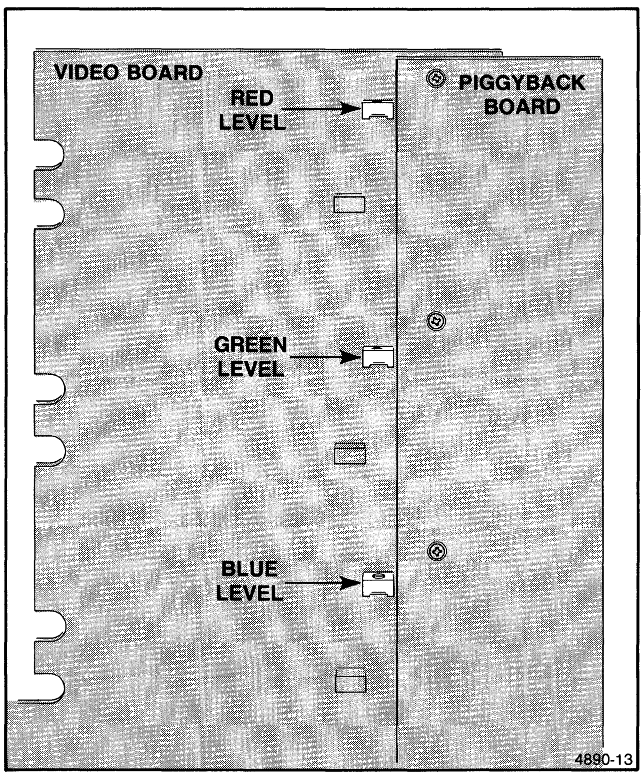


Figure 5-3. CRT Cutoff Adjustment Locations.

WARNING

Lethal voltages are present on the Socket board and H. V. board. Exercise caution while performing the following steps.

1. Adjust – G2 fully counterclockwise. This control is labeled SCREEN; it is the upper control on the HV divider on the High Voltage board. See Figure 5-4.

2. Adjust – the front panel BRIGHTNESS control to minimum (fully counterclockwise).

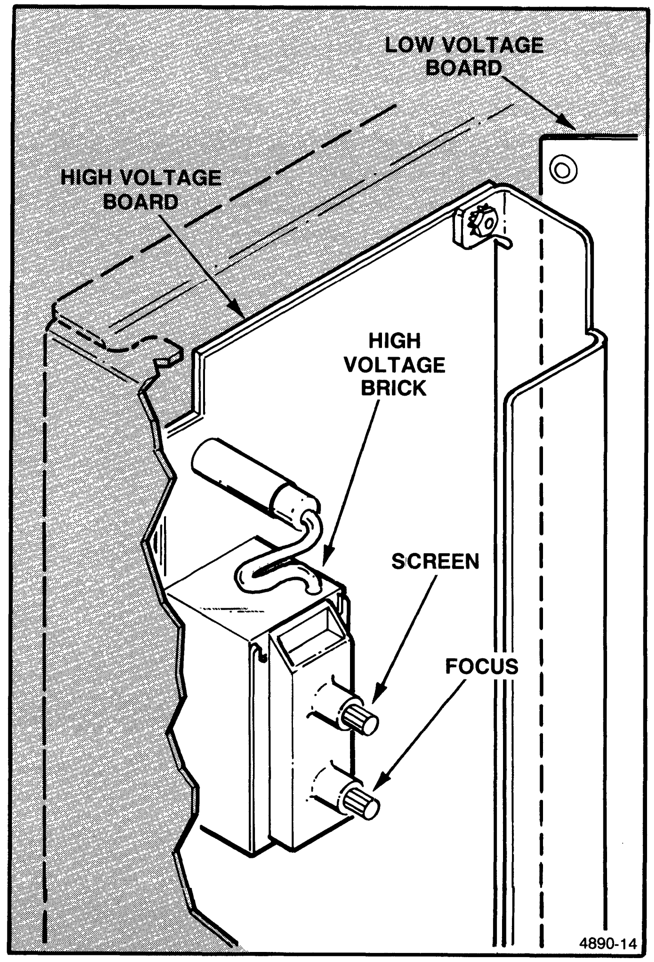


Figure 5-4. Screen Control on H.V. Board.

3. Set the oscilloscope controls according to Table 5-4.

Table 5-4

SCOPE SETTINGS NUMBER 1

Control	Setting
Sweep speed	10 ms/div
Volts/div	10 V/div
Triggering:	
Source	Input
Slope	– (minus)
Coupling	DC
Mode	Automatic

4. Connect a 10X oscilloscope probe to the video output. The most accessible point is where the white wire with red stripe connects to the Socket board. This is shown in Figure 5-5.

5. Adjust – RED LEVEL (S , R182) for a reading of 69 to 71 V.

NOTE

For each color level check, the scope should display a flat dc voltage pattern. If not, go to "Video Offset Adjustments" at the end of this section.

6. Connect the scope probe to the green video output. This point is where the white wire with green stripe connects to the Socket board.

7. Adjust – the front panel BRIGHTNESS control to minimum again.

8. Adjust – GREEN LEVEL (U , R382) for a reading of 69 to 71 V.

9. Connect the scope probe to the blue video output. This is the point where the white wire with blue stripe connects to the Socket board.

10. Adjust – BLUE LEVEL (W , R582) for a reading of 69 to 71 V.

11. Power down the terminal.

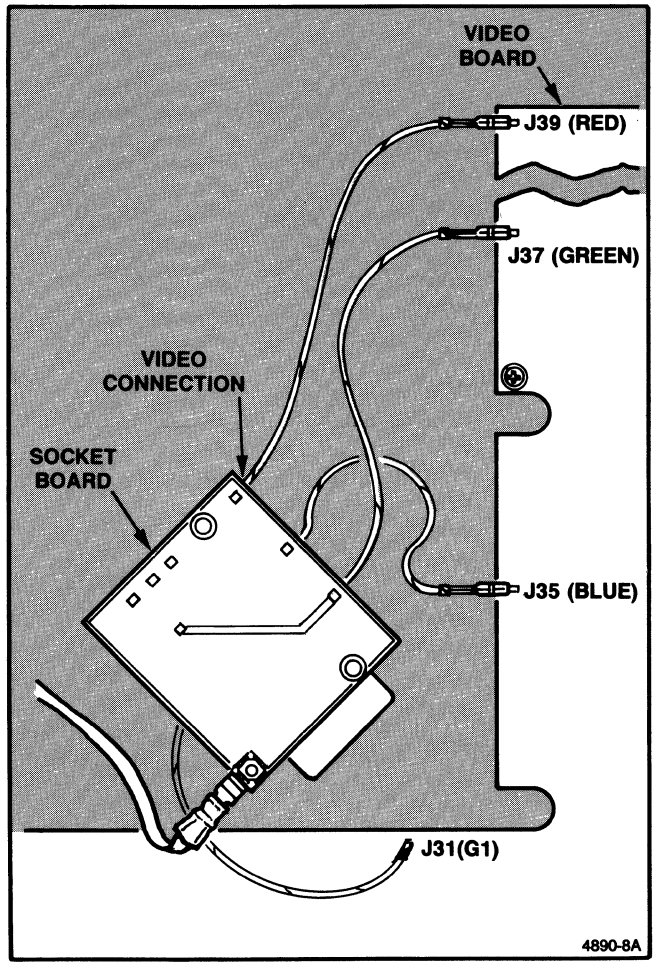


Figure 5-5. Video Signal Connection on Socket Board.

12. Remove – the jumper from J53 on the center of the Deflection board. Use needle-nose pliers to access and remove this jumper. Then, power up the terminal. See Figure 5-6.

13. Adjust – the SCREEN control counterclockwise until the first color just appears as a faint line across the center of the screen.

14. Adjust – the first color's LEVEL control counter-clockwise until that color just disappears. (Note: if the first color to appear is red, then adjust the LEVEL pot labeled "R182.")

15. Adjust – the SCREEN control until the second color shows across the center of the screen.

16. Adjust – the LEVEL pot, for the second color, counter-clockwise until that color just disappears.

NOTE

If any of the first colors reappear, adjust the corresponding pot(s) counter-clockwise until they also disappear.

17. Adjust – the SCREEN control until the last (third) color becomes barely visible.

NOTE

Use a X10 magnifier to observe the display while setting the level controls in the next step.

18. Adjust up – the other two LEVEL controls until the faint raster line becomes a gray line. This adds enough color from the other two guns to make gray.

19. Power down the terminal and install the jumper on J53 (on the Deflection board). Then power up the terminal again.

This adjustment procedure balances the bias levels on the three control grids in the crt. This produces a true white and precedes the final color balance procedure (under the "Video Adjustments" heading, later).

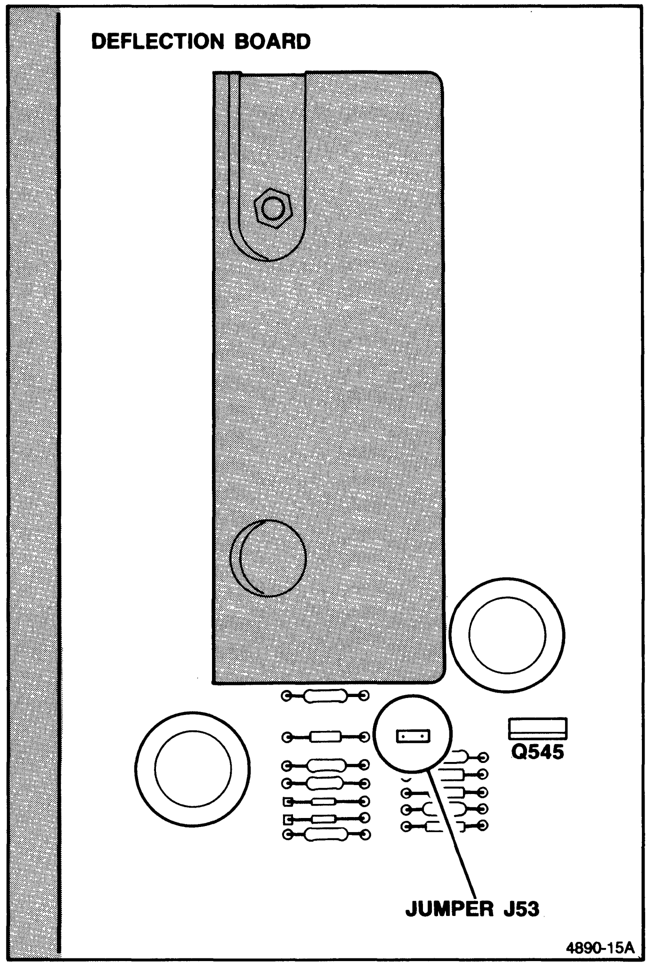


Figure 5-6. Removing Jumper from J53.

Digital Piggyback Board Adjustments

The Digital Piggyback board (DPB) accepts digital video from the Display Control board and sends analog video to the Display Module.

1. Set the oscilloscope according to Table 5-5.

Table 5-5

SCOPE SETTINGS NUMBER 2

Control	Setting
Sweep speed	5 ms/div
Volts	.2 V/div
Channel	1 – DC
Trigger	Neg
Slope	Neg
Mode	Auto

2. Power up the terminal, enter Self Test, and display a white screen. (Press function keys F6, F5, and F3.)
3. Connect – the scope probe to the center conductor of the Red BNC output connector on the rear panel of the 4109.
4. Adjust – RED ADJUST (R211 on the DPB) for 2.0 volts DC; read on the scope.
5. Connect – the scope probe to the center conductor of the Green BNC connector.
6. Adjust – GREEN ADJUST (R111) for 2.0 volts DC.
7. Connect – the scope probe to the center conductor of the Blue BNC connector.
8. Adjust – BLUE ADJUST (R11) for 2.0 volts DC.

Video Adjustment

This procedure sets the video amplifiers for each of the three colors and balances the RGB outputs to the crt.

1. The color gain potentiometers are:

   Red gain – R280 (indicated by T in Figure 5-1)
   Green gain – R480 (indicated by V)
   Blue gain – R680 (indicated by X)

2. Turn the front panel's BRIGHTNESS control to maximum (CW).
3. Turn – GREEN GAIN (R480) fully clockwise (maximum).
4. Enter Adjustment Self Test and put a white screen on the display.
5. Press – the Dialog and SCopy keys; this turns off the red and blue guns, filling the screen with green. While reading the photometer,

   Adjust – INTENSITY LIMITER (R780) to produce 3.7 ft-lamberts.[1]

6. Press – the Setup and SCopy keys; this turns off green and makes the screen blue. While reading the photometer,

   Adjust – BLUE GAIN (R680) to produce 0.5 ft-lamberts.[2]

7. Press – the Dialog and SCopy keys; this turns off blue makes the screen red. Using the photometer,

   Adjust – RED GAIN (R280) for 1.0 ft-lamberts.[3]

8. Press – the Setup and SCopy keys, which makes a white screen. Using the photometer, you should verify a reading of 5.2 ft-lamberts.[4]
9. Select – the gray scale pattern by pressing the F2 key.
10. If adjusted correctly, the first level of gray will be difficult to see in a normally lit room; reduce the ambient light or shade the screen to see all shades of gray.
11. With a white screen, set BRIGHTNESS (on front panel) to maximum.

    Adjust – INTENSITY LIMITER, O in Figure 5-1, to achieve a reading of 6.9 ft-lamberts (4.5 to 5.2 μw/cm^2).

[1] 1.3 μw/cm^2 ($\pm$15%)
[2] 1.1 μw/cm^2 ($\pm$15%)
[3] 0.8 μw/cm^2 ($\pm$15%)
[4] 3.1 to 3.3 μw/cm^2 ($\pm$15%)

Focus Adjustment

WARNING

⚠ *Use extreme caution when performing this adjustment. Lethal voltages are present on the Low Voltage board and on the High Voltage board.*

The focus adjustment is a simple procedure. The control device for focus is located on the HV board. This control, labeled FOCUS, is (N) in Figure 5-1. You may turn this control by hand, or you may use an adjusting tool.

1. With the power on, use Self Test to place the "H" pattern on the screen.

2. Rotate the FOCUS knob back and forth while viewing the screen and observing the effect on focus.

3. Adjust the FOCUS control to achieve the best overall screen focus, viewing all parts of the "H" pattern. This is purely a visual check as focus is not measurable.

This completes the focus adjustment.

Vertical Deflection Adjustments

This procedure adjusts the vertical deflection (or vertical size) and the vertical position of displayed screen images. This procedure also includes adjustments for size and symmetry on the vertical axis.

1. Run Self Test and call up the grid pattern (use function key F5, then F1). Then, install the alignment graticule.

2. Adjust – VERT POS (R130) so the horizontal center line of the displayed grid pattern is aligned with center line on the graticule.

3. Adjust – VERTICAL LINEARITY (R115) so the displayed squares appear symmetrical in the vertical direction.

4. Adjust – VERT SIZE (R125) (E) in Figure 5-1, so the vertical size of the pattern border measures 268 mm (± 2 mm), or so it aligns with the graticule's grid border.

   a. See Figure 5-7A. If the vertical size of the pattern is less than 268 mm, adjust VERT SIZE clockwise (CW).

   b. If the vertical height is greater than 268 mm, adjust VERT SIZE counter-clockwise (CCW).

5. Repeat steps 2 and 3 (step 4 affects steps 2 and 3).

Horizontal Deflection Adjustments

This procedure sets the horizontal size, linearity, and position of displayed images on the screen.

1. Run Self Test and call up the grid pattern (use function key F5, then F1).

2. Install the graticule, if not already on the screen.

3. Adjust – HORIZ POS (R165) so the pattern's vertical center line is aligned with the center line on the graticule.

4. Adjust – HORIZ LINEARITY (L360) so all the displayed squares appear symmetrical in the horizontal direction. Use a 3 inch plastic hex driver to turn the core of this inductor. See (Z) in Figure 5-1.

5. If the horizontal size of the grid pattern does not match the graticule size:

   Adjust – HORIZ SIZE (R170); see (K) in Figure 5-1. The pattern should measure 357 mm (± 2 mm) across; see Figure 5-7B. (Turning HORIZ SIZE clockwise decreases the width of the displayed pattern.)

6. Adjust – HRAMP BALANCE (R145) so the outer vertical lines on the displayed pattern are perpendicular to the horizontal lines on this pattern.

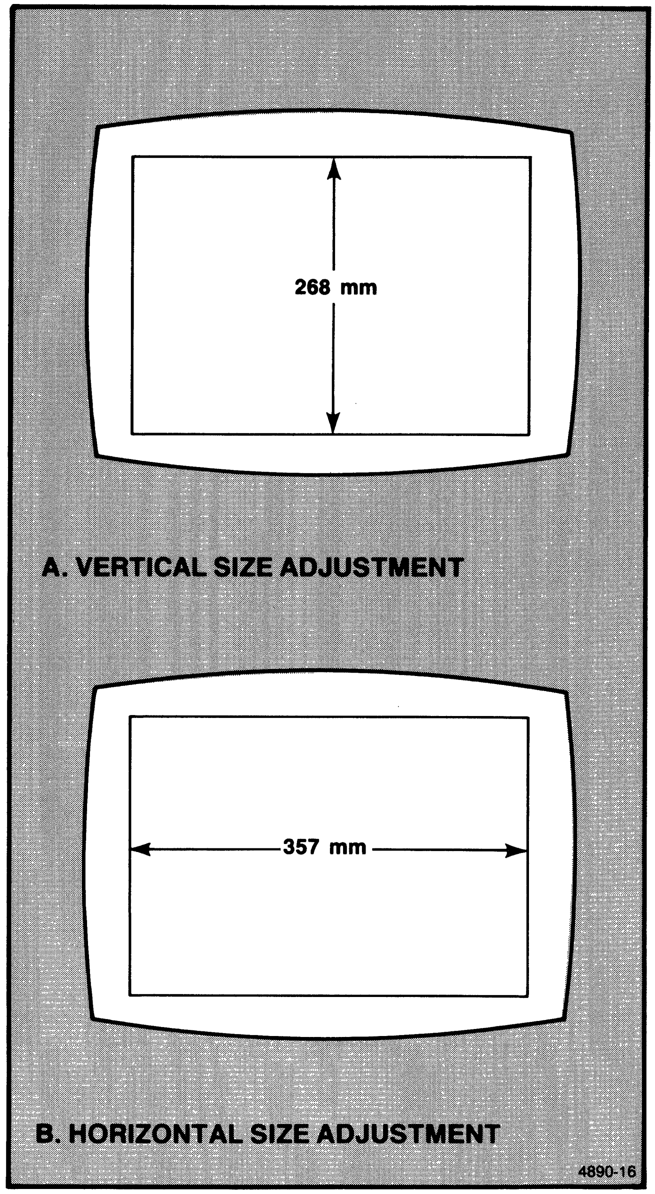


Figure 5-7. Deflection Adjustments.

Pin-Cushion Adjustment

Pin-cushion effect is shown in Figure 5-8. This amounts to either a shrinking or bulging of the sides or top and bottom of the displayed image.

1. Run Self Test and call up the grid pattern.
2. Place the alignment graticule on the screen.
3. Compare the displayed grid pattern with the graticule.
4. If the pin-cushion effect is noticeable along the sides of the display:

   Adjust – the SIDE PIN COR control, R180 (L on Figure 5-1). Adjust to achieve optimum alignment of the sides of the displayed image with the graticule pattern.

5. If pin-cushion effect is noticeable along the top and bottom of the display:

   Adjust – the T&B PIN COR control, R140 (G in Figure 5-1). Adjust this control to achieve optimum alignment of the top and bottom of the displayed images with the graticule pattern.

NOTE

If pin-cushion adjustment is major, then readjust the horizontal and vertical size.

Purity Check

Continuing with power on and Self Test active, place a red field on the screen (press Dialog Key). Check for a pure red screen (absence of other hues). If color is not pure, continue with this procedure. Otherwise, go to the Final Convergence procedure, next.

Purity adjustment:

1. With the terminal turned on, press the DEGAUSS button on the front of the terminal. This automatically degausses the crt. If this step does not fully degauss the crt, do step 2.
2. Turn power off, wait two minutes, and turn power back on while pressing the DEGAUSS button.[1] Degaussing during power-up causes the degauss coils to pass extra current, which should be sufficient to degauss the crt.

   If the crt is still not fully degaussed after step 2, proceed. Call Self Test again, and obtain a red field (use the Dialog key).

3. Place an external degaussing coil next to the crt. Energize the coil and move over and around the crt, in circular motions both directions. Now slowly move the coil away from the front of the crt. At a distance of 8 to 10 feet, turn the degauss coil perpendicular to the display and turn off the coil.
4. Examine the red field and evaluate the purity. Was the degaussing procedure sufficient to make a pure field? If not, repeat step 3 until purity is obtained.

If the above degaussing steps do not produce purity, the crt is defective or an unusually large external magnetic field is present. If a purity problem persists in a magnetic-shielded environment, replace the crt. (The purity rings on the crt are set and sealed by the manufacturer, so they are not field-adjustable.)

[1] Leaving power off two minutes allows the power-up thermistor to cool off. Otherwise, on-off-on does not degauss.

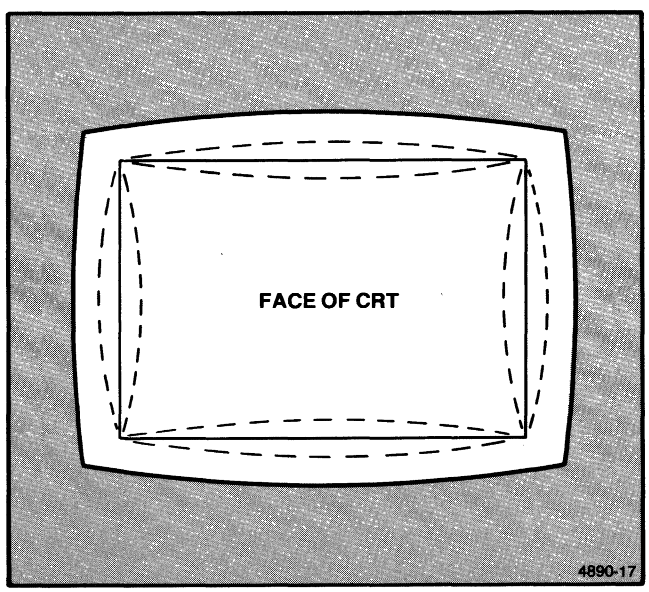


Figure 5-8. Pin-Cushion Effect.

Convergence Adjustment

The following adjustments are located on the Convergence board.

1. Display the Grid Pattern by pressing function key F1.
2. Adjust – SLEW TIME (R662 on the Convergence board) to maximum, fully clockwise. See (A) on Figure 5-1.
3. Display the red/blue grid pattern by pressing the Setup and Menu function keys.
4. Adjust – the RED/BLUE convergence control pairs in the sequence shown in Figure 5-9. Observe the corresponding part of the screen, where the adjustment should take effect.

NOTE

The RED/BLUE convergence control pairs are illustrated with dark lines and the MG/GRN (magenta/green) convergence control pairs with light lines.

5. Check – for misconvergence of the worse-case line pair; verify that it is less than 0.3 mm using the Convergence Checker.
6. If out of spec:

   Adjust – the appropriate pair(s) of RED/BLUE convergence controls to bring the display within specification.
7. Repeat steps 5 and 6 until all the red/blue lines meet the specification.
8. Press the Setup key to display the white grid pattern.
9. Adjust – the MG/GRN convergence control pairs in the sequence shown in Figure 5-9. Observe the corresponding display screen pattern while making the adjustments.
10. Check – for misconvergence of the worse-case line pair is less than 0.3 mm using the Convergence Checker.
11. If out of spec:

    Adjust – the appropriate pair(s) of MG/GRN convergence controls to bring the display within specification.
12. Repeat steps 10 and 11 until all the magenta/green lines are within specification.
13. Adjust – SLEW TIME (R662) slowly CCW until a loss of convergence is noted at the display's left edge; then,

    Readjust – this control CW until the display's left edge is reconverged.
14. Press Function Key F8, to exit Self Test.

This completes the adjustment procedures for the Display Module and for the terminal.

Video Offset Adjustments

There are three OFFSET ADJUSTs on the video board (R268, R468, and R668). You should not have to perform this adjustment unless you've replaced one of the analog multiplier chips (U270, U470, or U670).

1. Setup the scope as in Table 5-4.
2. Display a white screen (function key F4).
3. Turn the BRIGHTNESS control to minimum (CCW).
4. Place the scope probe on the video output of the channel that you are checking; use the connections to the socket board as shown in Figure 5-5.
5. Observe the scope; there should be no signal (only a flat line). If so, the OFFSET ADJUST is set properly. If not, do step 6.
6. Adjust the OFFSET ADJUST until the scope shows a flat dc line.
7. Repeat these steps for each of the other two color channels as required.

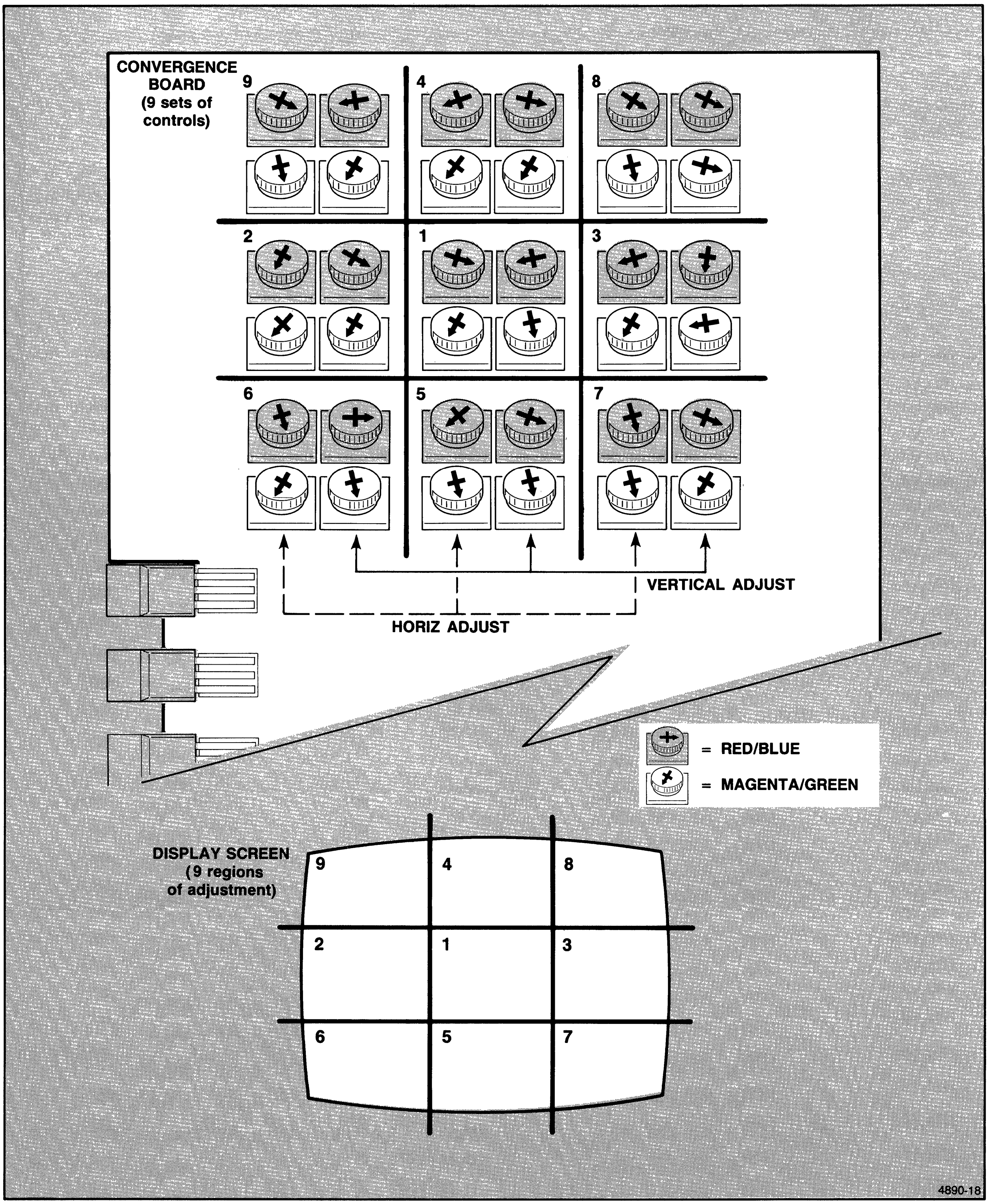


Figure 5-9. Relationship of Convergence Controls to Display Screen Locations and Adjustment Sequence.

ADJUSTMENT PROCEDURE FOR THE 119-2023-00 DISPLAY MODULE

The following steps summarize the adjustment procedures for the later version Display Module (used in terminals with serial number *B020000 and up*):

- Display Module power supply adjustments
- High voltage supply check
- Horizontal and vertical hold adjustments
- Grid bias and white balance checks and adjustments
- Coarse deflection adjustment
- Focus adjustment
- High voltage stabilizer adjustment
- Purity and coarse convergence
- Final convergence adjustment
- Vertical position adjustment
- Vertical deflection adjustment
- Horizontal deflection adjustment
- Pin-cushion correction adjustment

These checks and adjustments are listed as independant items; however, the success of this procedure depends on performing the steps in the above sequence.

Most of these procedures require that you display a pattern or color from the Display Pattern Menu. To do this, you must first enter Extended Self Test (as described in Appendix C) and select the Adjustment Procedures Menu (press key F6). From this menu select the Display Pattern Menu (press key F5). Then to display one of the patterns listed in the Display Pattern Menu (see Table 5-3), simply press the key that selects that pattern.

NOTE

***Allow a 40 minute warm-up period** before performing the following adjustments on the Display Module. Failure to provide adequate warmup will prevent the terminal from performing according to its published specifications.*

Table 5-6 summarizes the performance checks found in the adjustment procedures. You may use this to validate the performance of the Display Module without doing the detailed adjustment procedure.

Table 5-6

SUMMARY OF DISPLAY MODULE CHECKS

Step	Check	Expected Result
1	TP86 — on CRT Socket board	+ 101 volts
2	TP87 — on EHT board	+ 98 volts
3	High Voltage check	25 kV (± 1000V)
4	White balance (Z-axis) adjustment (White luminance = 20 ftL)	Red — 5 ftL Green — 13 ftL Blue — 2 ftL
5	Size check (coarse)	Pattern dimensions: 36 × 27 cm
6	Focus	Visual, "H's" distinct
7	Purity (degauss)	Visual, is red pure?
8	Convergence	Visual, alignment of R,B,G
9	Vertical size	Pattern border: 268 mm
10	Horizontal size	Pattern border: 357 mm
11	Pin-cushion effect	Visual, square corners and rectangular screen pattern
12	TP51 — on EHT board	420 volts p-p ± 20 volts

NOTE

The location of many of the Display Module's controls makes adjustment impossible while the terminal's logic boards are installed in their normal positions. Before adjusting the Display Module, unplug the Terminal Control board from its connector to the power supply. Then, lift the Terminal Control, RAM3, and Display Control boards out of the terminal. The DCB-to-Video Interface ribbon cable remains connected. Using an 067-0163-00 extender cable, reconnect the TCB to the power supply. Swing this end of the TCB away from the back of the terminal; this allows you to reach the adjustments on the Display Module's Socket board. See Figure 5-10.

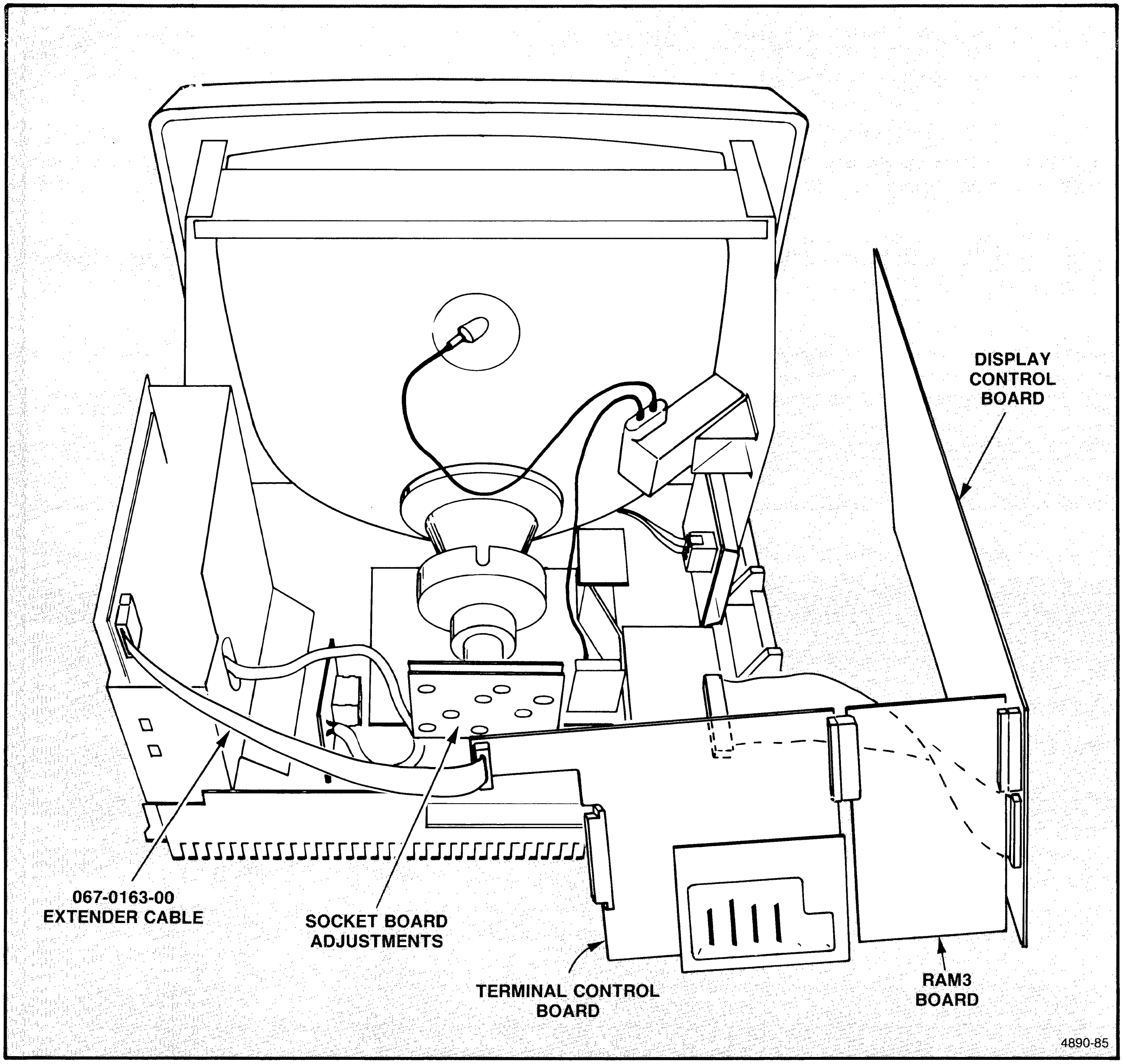


Figure 5-10. Positioning the Terminal's Logic Boards for Display Module Adjustments.

NOTE

All test points and adjustments for the 119-2023-00 Display Module are shown in Figure 5-11 (on page 5-17).

Display Module Power Supply Adjustment

WARNING

Use extreme caution when performing this adjustment procedure. Lethal voltages are present on the Socket board and the High Voltage assembly on the Main Video board.

Use the crt support frame for a ground point.

1. Check the +101 V output at TP86 on the Socket board.
2. Adjust VR811 on the Main board (labeled AVR — A in Figure 5-11) for a reading of +101 V ±2 V at TP86.
3. Check for +98 V (±2 V) at TP87. TP87 is located on the EHT board, which is mounted on top of the shield around the flyback transformer.
4. If necessary, adjust VR761 (labeled SUB AVR, R in Figure 5-11) for a reading of 98 V at TP87.

High Voltage Supply Check

NOTE

This check is not necessary if a complete adjustment was performed, a picture is present, and the adjustment checks were all within tolerance.

The high voltage anode button is located on top of the crt, just under the rubber boot on the end of the high voltage cable.

WARNING

Lethal voltages exist at the crt anode button, and proper precaution must be taken to prevent injury.

1. Power down the terminal and wait two minutes, allowing the high voltage to drain down.
2. With terminal power off, connect the Fluke high voltage probe to the crt anode button.

WARNING

Be sure to connect the ground wire of the high voltage probe to a chassis ground before turning on power to the terminal.

3. Set the voltmeter to the 200 V scale and connect the high voltage probe to the meter.
4. Power up the terminal and set the terminal's BRIGHTNESS control fully counterclockwise. The high voltage should read 25 kV ±1000 V.

NOTE

Replace the Display Module, if this reading does not match the specification. The probable cause of the problem is a defect in either the main board assembly or the crt.

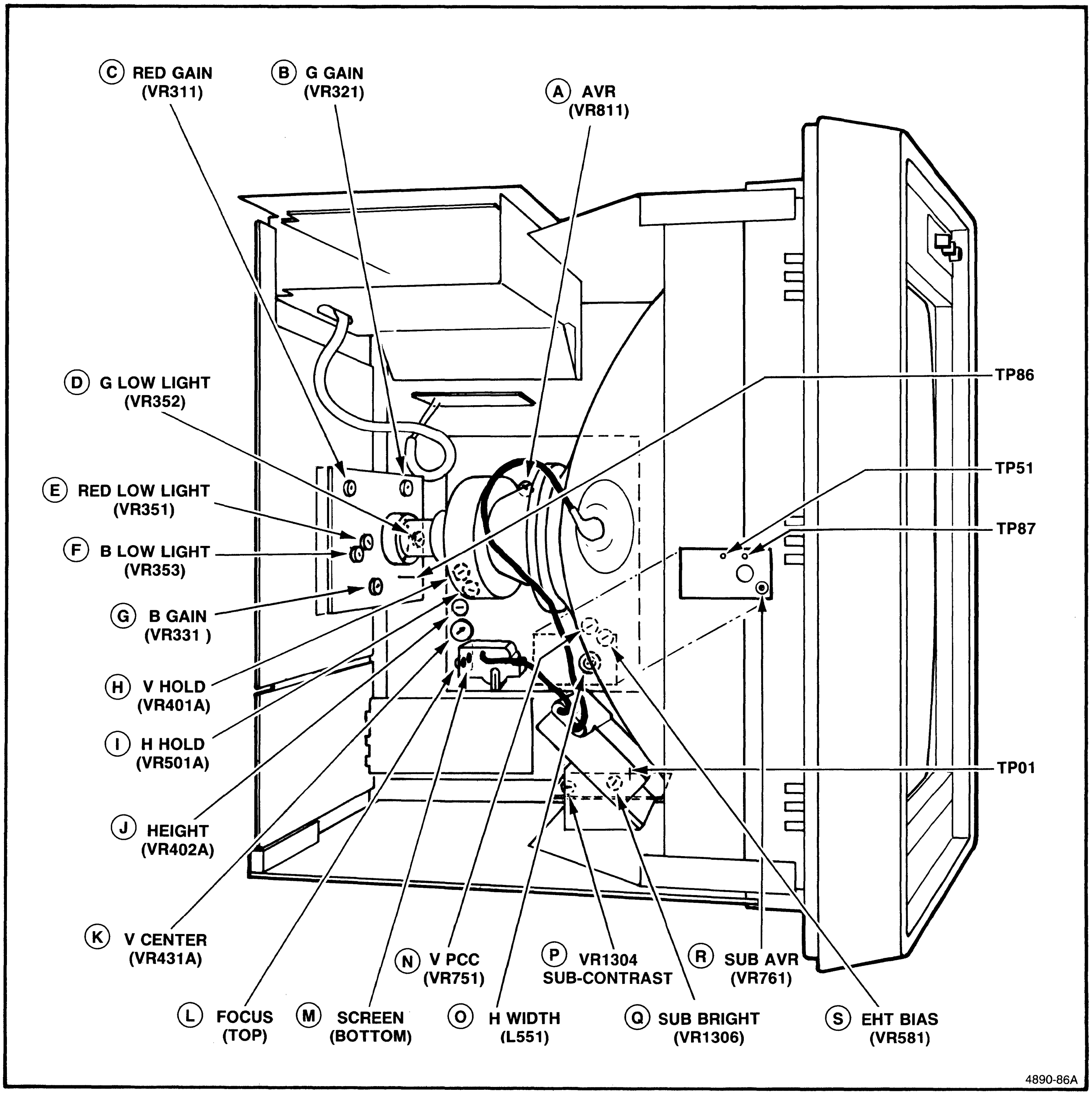


Figure 5-11. 119-2023-00 Display Module Test Points and Adjustments.

Horizontal and Vertical Hold Adjustments

The horizontal hold procedure is first, followed by vertical hold. Figure 5-11 shows the locations of the H HOLD and V HOLD adjustments, VR501A (I in Figure 5-11) and VR401A (H in Figure 5-11); these are on the Main board.

1. Display the grid pattern (press key F1).

2. Place the alignment graticule over the screen, and adjust VR501A (H HOLD) to align the displayed grid pattern with the alignment graticule. Then remove the graticule.

3. Adjust VR401A (V HOLD) clockwise until sync is lost, and note the position of the potentiometer. Then adjust VR401A counter-clockwise until sync is lost, and note this second position of the potentiometer.

4. Center the potentiometer between these two positions, or center it between breakup and the opposing end of the pot adjustment.

Grid Bias and White Balance Checks and Adjustments

In the following procedure, steps 1 through 3 are done with the power off.

1. Preset the following controls on the Display Module's Socket board to minimum (clockwise as viewed from the foil side):
   - B GAIN (VR331 — G in Figure 5-11)
   - R GAIN (VR311 — C)
   - G GAIN (VR321 — B)
   - B LOW-LIGHT (VR352 — F)
   - R LOW-LIGHT (VR351 — E)

2. Set the BRIGHTNESS control, on the front panel, to minimum.

3. Set VR352 (G LOW-LIGHT — D in Figure 5-11) to mid-position.

4. Attach an oscilloscope lead to TP01 on the Interconnect board (beneath the high voltage brick). Preset the scope to read a maximum signal of 10 VAC.

NOTE

TP01 monitors the red signal, only, but it indicates the amplitudes of the green and blue signals while the screen is displaying a white field. If the DIALOG key is pressed, this white field will disappear.

5. Power up the terminal and use Self Test to display a white field as follows:

   a. Press RESET and SELF TEST buttons simultaneously, and hold. After one second, release the RESET button. After another second, release the RESET button.

   b. When the terminal's bell has sounded, press these keys in the order given: F6, F5, and F3. The menus and the raster may or may not be visible on the screen (depends on how display was adjusted).

6. Turn the front panel BRIGHTNESS control to minimum (counterclockwise). Then, preadjust SUB BRIGHT Q (VR1306 on the interconnect board) for a back porch level of 1.8 volts, $\pm$ 0.2 volts. See Figure 5-12.

7. Turn the BRIGHTNESS control to maximum (clockwise). Then, preadjust SUB CONTRAST P (VR1304 on the interconnect board) for a maximum white level of 3.0 volts, $\pm$ 0.2 volts.

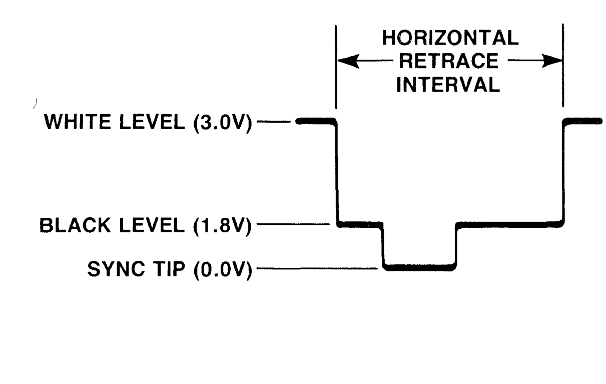


Figure 5-12. Preset the Video Signal for this Appearance at TP01.

8. Allow a 40-minute warmup time (after power-up).

9. Tape the luminance probe to the face of the crt.

10. Adjust the SCREEN control (G2) to obtain a green screen illuminated at 0.5 to 1.3 ftL (foot-lamberts). Ignore the retrace lines.

11. Increase VR353 (B LOW-LIGHT — G in Figure 5-11) to provide a blue-green screen. Ignore the retrace lines.

12. Increase VR351 (R LOW-LIGHT — E in Figure 5-11) to provide a gray screen. Ignore the retrace lines.

13. Decrease G2 (SCREEN — L in Figure 5-11) until the illuminated raster is almost extinguished.

14. Readjust VR351 and VR353 as necessary to balance the colors thus making a gray screen.

15. Decrease G2 (SCREEN — M) until the screen shows a barely perceptible amount of raster. Then decrease G2 slightly to just turn off the raster.

16. Set the front panel BRIGHTNESS control to maximum.

17. Go into Self Test and display a white screen; press F6, F5, and F3. The raster should not be visible yet.

18. Turn up the following controls, in the indicated order, to obtain the indicated readings on the photometer:
    - G GAIN — 13 ftL
    - R GAIN — 18 ftL
    - B GAIN — 20 ftL

19. Press key F2; this puts the gray scale on the screen.

20. Adjust SUB BRIGHT, VR1306 Q, so that the darkest level of black matches the border while keeping the next lighter shade of gray visible.

21. Press key F3; this places a white raster on the screen.

22. Adjust SUB CONTRAST, VR1304 P, to achieve a brightness level of 25 ftL on the screen.

Deflection, Coarse Adjustment

This procedure is the coarse adjustment of vertical and horizontal deflection. The fine adjustments for deflection come later.

1. Display the grid pattern on the screen (press key F1).

2. Install the graticule over the display screen.

3. Check to see if the borders of the grid pattern approximately match the graticule border (36 by 27 cm).

   If the pattern is off by a centimeter or more, proceed to the next step. But if the pattern approximately matches the graticule, skip the rest of this procedure and go to the next one.

4. Adjust VR402A (labeled HEIGHT — J in Figure 5-11) so the top and bottom of the grid pattern match the graticule (27 cm — refer back to Figure 5-7A). Adjusting VR402A clockwise increases the height of the pattern, and adjusting VR402A counter-clockwise decreases it.

5. Adjust L551 (O in Figure 5-11) so the sides of the grid pattern match the graticule (36 cm — refer back to Figure 5-7B). L551 is accessible through a hole in the circuit board above it. Use a non-metallic screwdriver (1/8″ flat-blade) to adjust L551. Turning the knob on this control counter-clockwise increases the width of the pattern, and turning the knob clockwise decreases it.

6. Remove the graticule from the screen.

Focus Adjustment

WARNING

Use extreme caution when performing this adjustment. Lethal voltages are present on the Socket board and on the High Voltage assembly (on the Main Video board).

1. Display the H pattern on the screen (press function key F5).

2. Check the overall focus of the H's on the screen. This is purely a visual check (not measurable). If the focus seems adequate, go on to the next procedure, but if you find the focus unacceptable, proceed to the next step.

3. Adjust the FOCUS control (the upper of the two knobs on the high voltage assembly — (L) in Figure 5-11) to achieve the best overall screen focus when viewing the displayed pattern. Also, display some alpha characters on the screen and verify that the focus remains good (you'll have to exit Self Test to do this).

This completes the focus check and adjustment

High Voltage Stabilizer Adjustment

Check for 420 V p-p $\pm$20 V at TP51 on the EHT board. If necessary, adjust VR581 (labeled EHT BIAS — (S) in Figure 5-11) to obtain the correct reading.

Purity and Coarse Convergence Adjustments

Purity check:

1. Place a red field on the screen (press F3 to display a white screen, then press the Setup and S Copy keys to turn off the green and blue guns).

2. Check for a pure red screen (absence of other hues). If the color is pure, go on to the Final Convergence Adjustment procedure. But if the color is not pure, continue with this procedure.

3. Press the DEGAUSS button on the front panel.

   If this is not sufficient to fully degauss the crt, proceed with the next two steps, as needed. Call Self Test again, and obtain red field.

4. Place an external degaussing coil next to the crt. Energize the coil and move over and around the crt, in circular motions both directions. Now slowly move the coil away from the front of the crt. At a distance of 8 to 10 feet, turn off the coil.

5. Examine the red field and evaluate the purity. If the color is pure, go on to the next procedure (Final Convergence). If the degaussing procedure wasn't sufficient to make a pure field, adjust the purity rings on the neck of the crt. These rings are located between the yoke and the crt neck socket.

Coarse convergence adjustment:

1. Turn off the terminal.

2. Remove the Display Control board.

3. Loosen the deflection yoke (unscrew the clamp) just enough to let it slide toward the rear on the crt neck (see Figure 5-13).

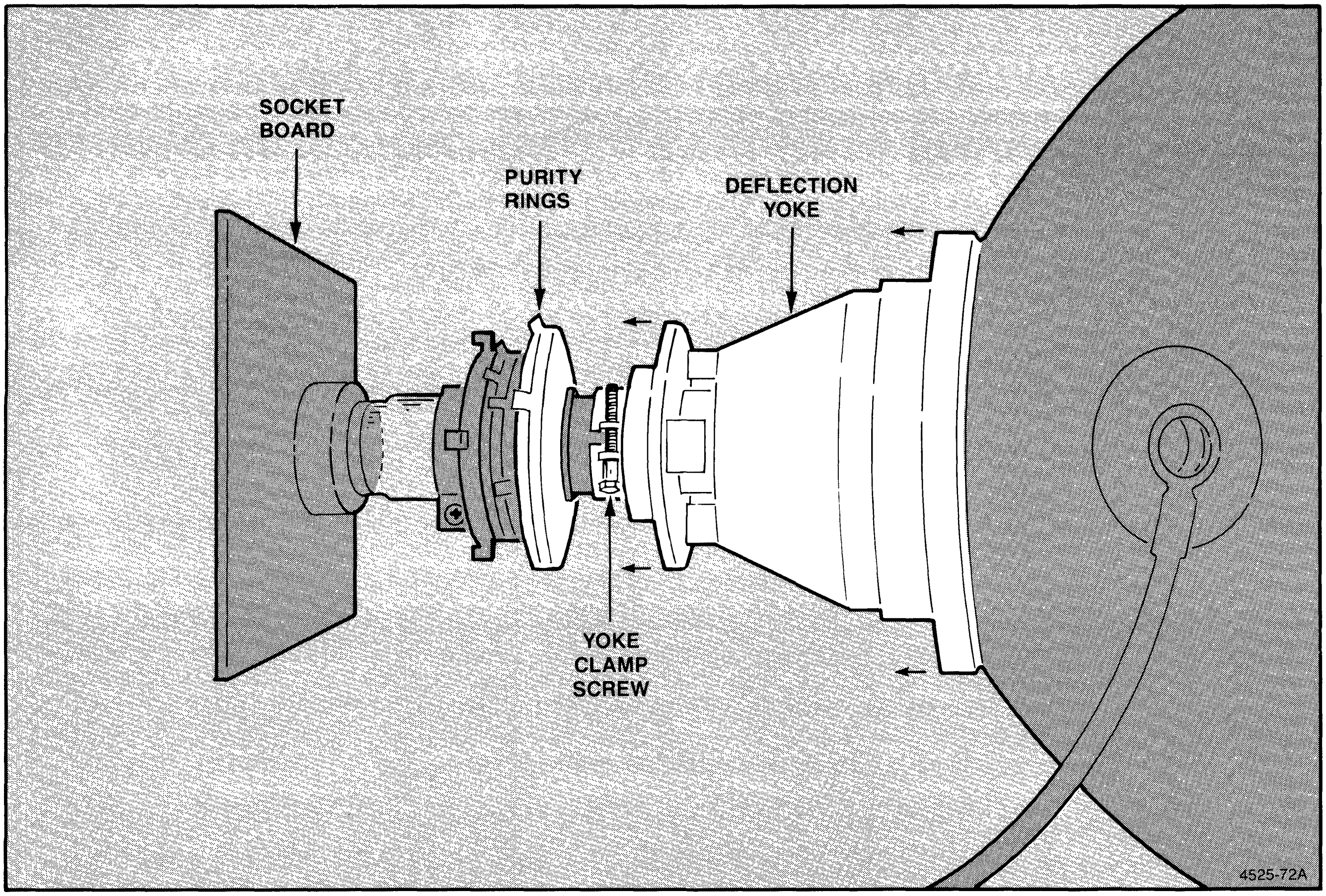


Figure 5-13. Yoke Clamping Screw and Purity Rings.

4. Free the wedges from the front of the yoke.

5. Use a sharp knife to remove paint from the purity and convergence rings, then loosen the threaded clamp ring (refer to Figure 5-14). This allows you to rotate the rings.

6. Install the Display Control board in the terminal.

7. Power up the terminal, and place a red field on the screen.

WARNING

Use extreme care in the following steps. Lethal voltages are present in the adjustment area.

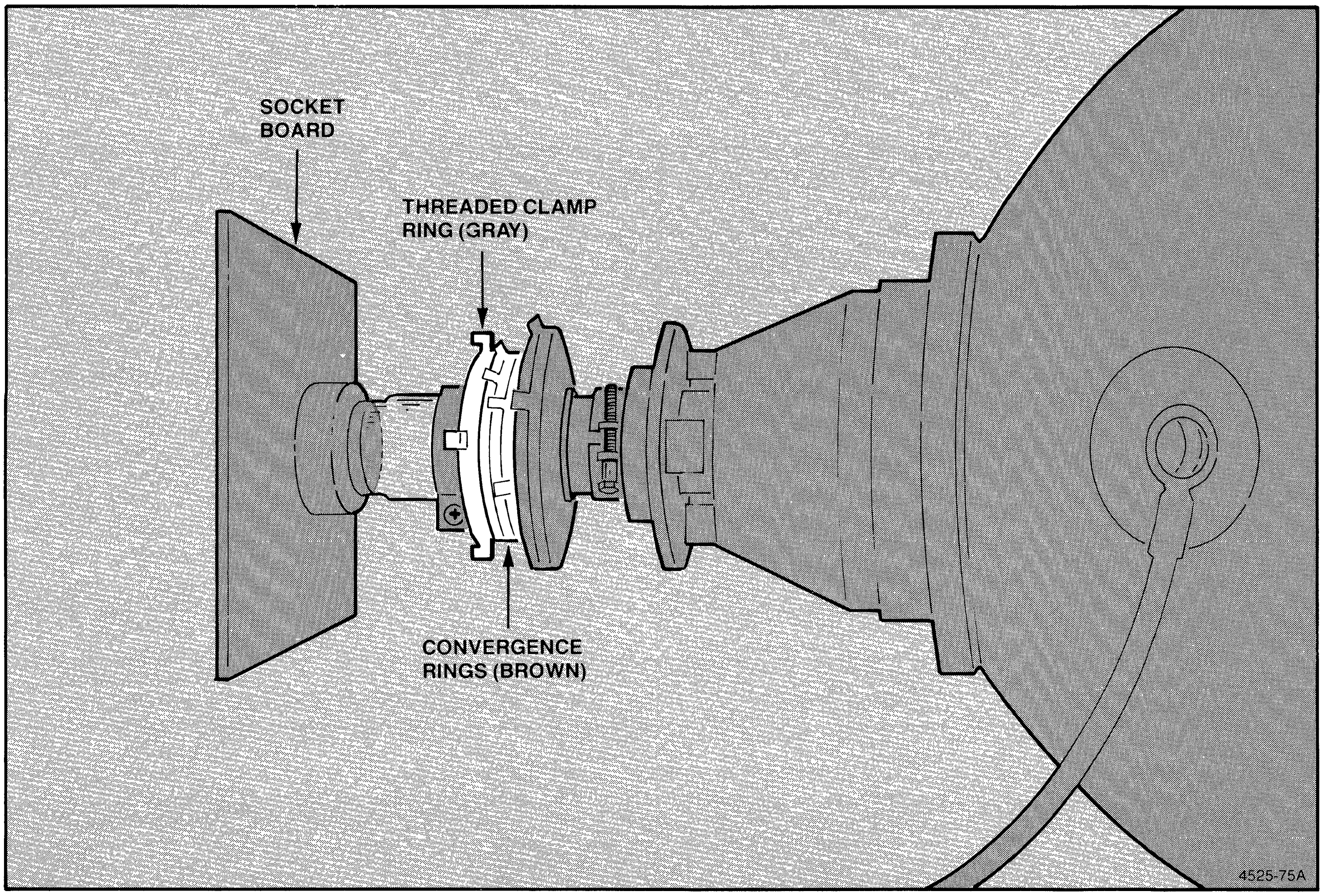


Figure 5-14. Convergence Rings and Threa(Clamp Ring.

8. Adjust the purity rings (refer again to Figure 5-13) to obtain the purest red ball in the center of the display.

9. Slowly move the yoke forward until the most uniform and pure red field is obtained over the entire screen. Examine the field with a hand magnifier and readjust the yoke and purity rings slightly for the best red beam landing (the least illumination of blue and green phosphor dots by the red beam).

10. Tilting the yoke left-right or up-down affects convergence. Using the top two wedges, position the yoke to achieve the best overall convergence. (See NOTE.) Use RTV silicon compound to secure the wedges in position. Refer to Figure 5-15.

NOTE

Insert the wedges between the yoke and the crt funnel, with the adhesive side touching the crt. The adhesive will stick to the crt. The wedges are placed 120 degrees apart; two on the top, and one on the bottom. See that the opening of the yoke is equidistant from the crt all around the funnel (refer back to Figure 5-15).

11. Turn the terminal power off, and remove the Display Control board.

12. Tighten the yoke clamp (loosened in Step 3) and install the lower wedge, but don't tighten the threaded clamp ring. This completes the purity and coarse convergence procedure.

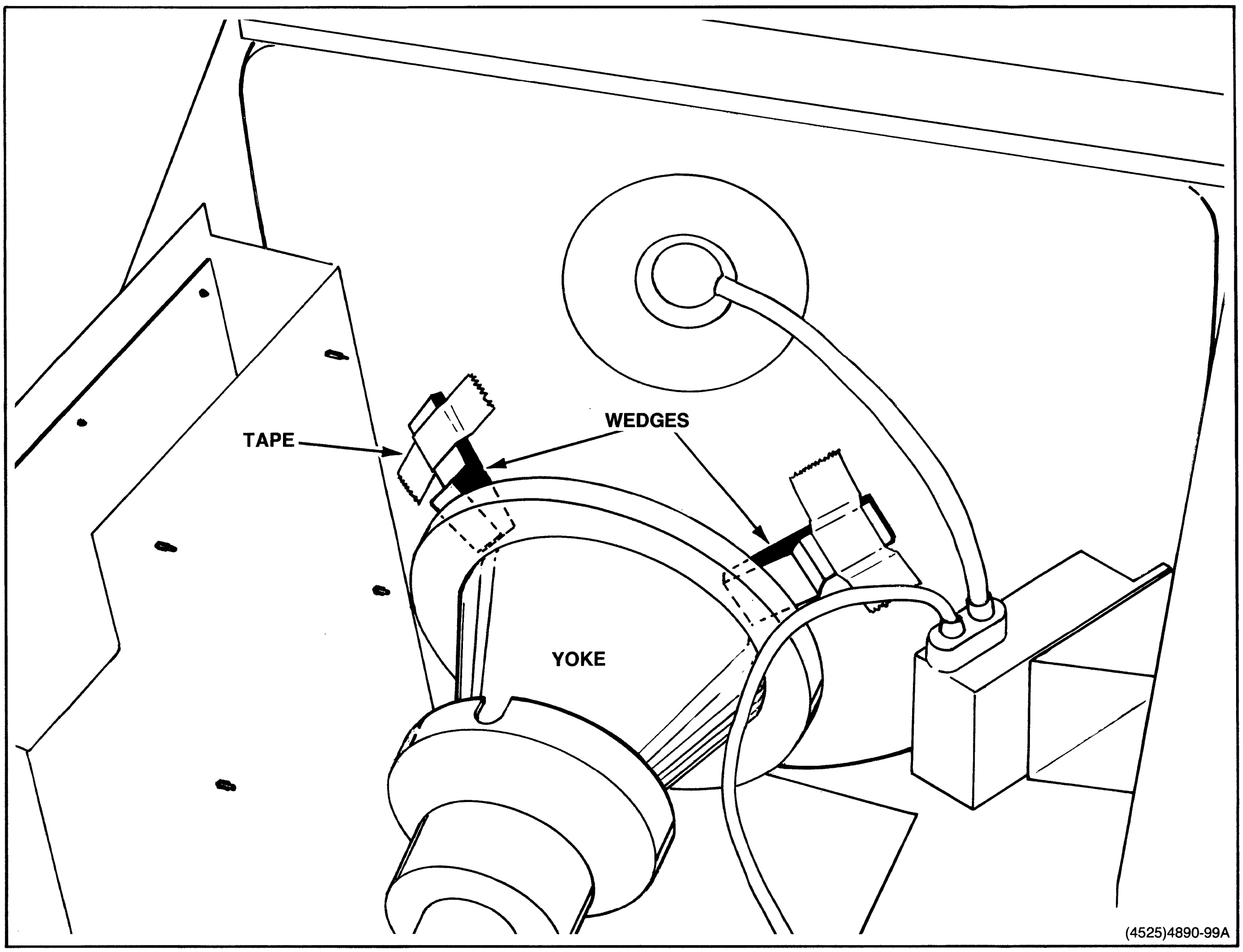


Figure 5-15. Placing Wedges between Yoke and CRT Funnel.

Final Convergence Adjustment

Before adjusting for Final Convergence, do the Purity and Coarse Convergence procedure (immediately preceding this adjustment).

1. Display the grid pattern on the screen (press key F1).

2. Using the grid pattern, check the convergence over the entire screen.

NOTE

The convergence specification is 0.3 mm between red and green, and between green and blue (over the entire screen). Refer to Figure 5-16.

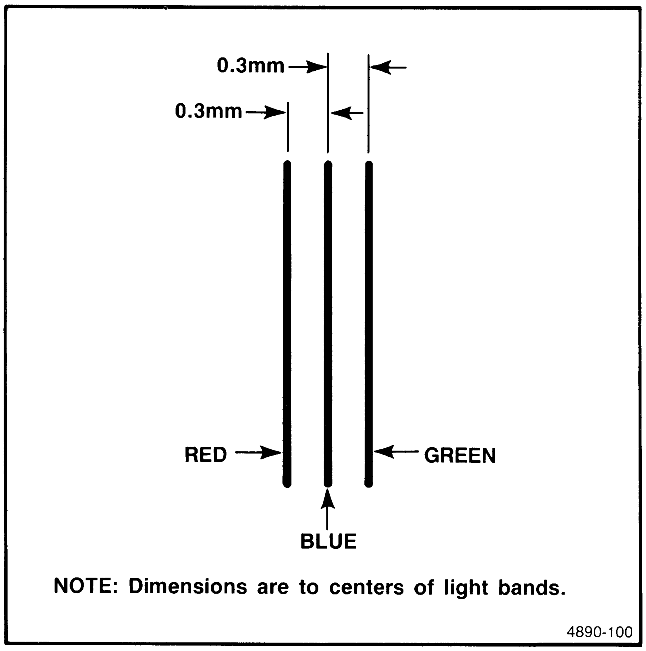


Figure 5-16. Measuring Convergence.

3. If convergence meets the specification, skip the rest of this procedure and go on to the vertical position adjustment. Otherwise, proceed to the next step.

4. Press the Setup key; this turns off the green gun (leaving only the red and blue guns on).

NOTE

Scrape off the paint that fastens the rings to each other. Then loosen the threaded gray clamp-ring (Figure 5-14) to allow smooth movement of the convergence rings.

5. Match the red and blue images at the center of the screen by rotating the four-pole magnet (the center pair of convergence rings, on the neck of the crt). Refer back to Figure 5-14.

6. Turn on the green gun (press Setup key).

7. Match up the red, green, and blue images at the center of the screen, by rotating the six-pole magnet (rear pair of rings).

8. If necessary, nudge the yoke from side to side to achieve the best overall convergence on the whole screen. Secure the yoke in the optimum position by pressing in the wedges and tightening the yoke fastening screw.

CAUTION

In the following step, DO NOT place the tape-magnets closer than 20 mm from the HV anode cap. And do not tape them over paper labels.

9. If the convergence on the fringe areas is still not acceptable, place one or more thin tape-magnets around the funnel to achieve the best effect. Then, press these magnets onto the funnel. Verify convergence around all edges of screen.

10. Check purity. If purity was adversely affected by this procedure, repeat the purity adjustment. If you must adjust purity, recheck convergence when finished.

11. Tighten the threaded clamp ring.

Vertical Deflection Adjustment

This is a final check and adjustment of vertical position and vertical deflection (or vertical size).

1. Display the grid pattern on the screen (press key F1).

2. Install the alignment graticule on the screen.

3. If the grid pattern and graticule are not aligned, adjust VR431A (V CENTER — K in Figure 5-11) to align the center horizontal line of the grid pattern with the center horizontal line of the graticule.

4. Adjust VR402A (HEIGHT — J in Figure 5-11) so top and bottom lines of the grid pattern match the alignment graticule (measure 268 mm $\pm$2 mm).

Horizontal Deflection Adjustment

This is a final check of horizontal size.

1. Display the grid pattern on the screen (press key F1).

2. Install the alignment graticule on the screen (if it isn't already there).

3. If the grid pattern isn't aligned horizontally with the graticule , adjust VR501A (H HOLD — I in Figure 5-11) to align the center vertical line of the grid pattern with the center vertical line of the graticule.

4. If necessary, adjust L551 (H WIDTH — O in Figure 5-11) so the horizontal width of the grid pattern matches the graticule (measures 357 mm $\pm$2 mm). This control is accessible through a hole in the circuit board above it. Using a non-metallic screwdriver (1/8″ flat-blade), turn the knob on L551.

Pin-Cushion Adjustment

The pin-cushion effect is shown in Figure 5-8. Pin-cushioning is either a shrinking or bulging of the sides of the displayed image.

1. Display the grid pattern (press key F1).

2. Install the alignment graticule on the screen and compare the displayed grid pattern with the graticule.

3. If there is noticeable pin-cushioning, adjust VR751 (V PCC — N in Figure 5-11) so the sides of the display align with the graticule.

This completes the adjustment procedures for the Display Module and for the terminal.

EARLY VERSION VIDEO INTERFACE & DIGITAL PIGGYBACK ADJUSTMENTS

This procedure is used to adjust both the Digital Piggyback and *early version* Video Interface boards. There are three pots on each of these boards, which set the RGB output levels of the board to match the specification. (If your terminal uses the later version Video Interface board, go to the next procedure.)

These adjustments correspond to the waveforms shown in the A part of Figure 4-52 (near end of Theory of Operation section).

1. Power up the terminal and use Self Test to obtain the white field on the screen. (Press function keys F6, F5, then F3).

2. Connect a 75 ohm terminator (011-0055-00) to the "Red" BNC connector (external video out).

3. Then connect the scope probe adapter (013-0084-00) to the terminator. Plug the scope probe into this adapter.

4. Adjust R287 (red), on the Video Interace board, for 1 volt (peak-to-peak) through the terminator, as measured with the scope.

5. Connect the terminator/connector to the "green" BNC, and adjust R288 to obtain a scope reading of 1 volt (p/p), excluding sync.

6. Likewise, connect the terminator to the "blue" BNC and adjust R289 to obtain a reading of 1 volt (p/p).

Your interface board is now calibrated to produce a standard output to the BNC connectors and to the terminal's monitor.

LATER VERSION VIDEO INTERFACE ADJUSTMENTS

This procedure is used to adjust only the *later version* Video Interface board. The later version board uses a different DAC chip and only requires one adjustment, instead of three.

1. Power up the terminal and use Self Test to obtain the white field on the screen. (Press function keys F6, F5, then F3).

2. Connect a 75 ohm terminator (011-0055-00) to the "Green" BNC connector (external video out).

3. Connect the scope probe adapter (013-0084-00) to the terminator. Plug the scope probe into this adapter.

4. Adjust Rnnn (Full Scale adjustment on DAC) to obtain a scope reading of 1 volt maximum (0.7 volt p/p, excluding sync) on the "Green" BNC connector. The resulting waveform is shown in the B part of Figure 4-52 (near end of Theory of Operation section).

Your later version Video Interface is now calibrated to produce a standard output to the BNC connectors and to the terminal's monitor.

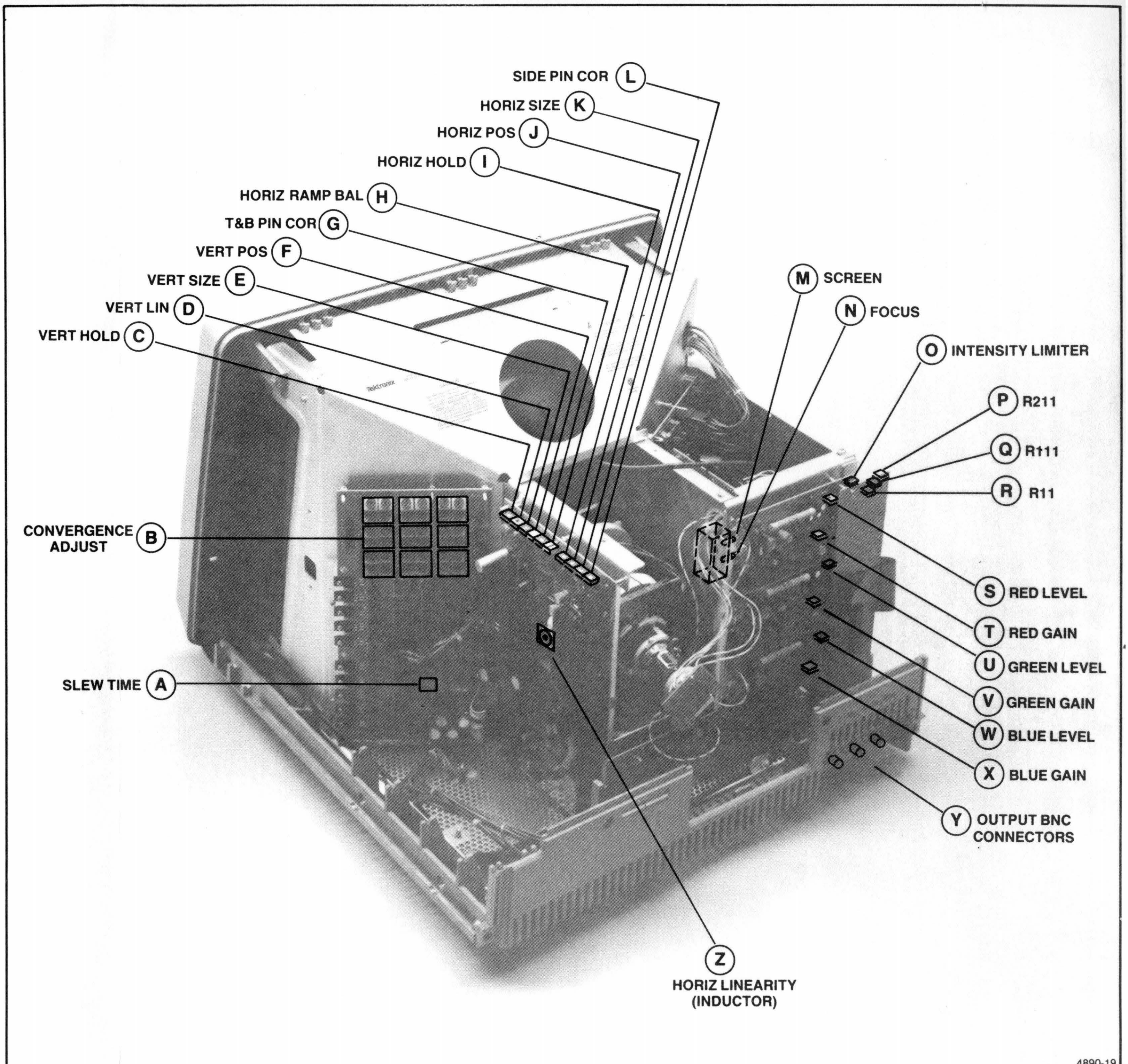


Figure 5-1. Display Module Test Points and Adjustments.

Section 6

MAINTENANCE

This section contains the disassembly and reassembly procedures required for trouble shooting, calibration, and repair access to the 4109 and CX4109 terminals. This section contains the preventive and corrective maintenance procedures for the terminal (including a summary of maintenance information for the Power Supply Module and the Display Module).

SAFETY CONSIDERATIONS

Before performing any of the maintenance procedures listed in this section, carefully read the Service Safety Summary at the front of this manual.

PREVENTIVE MAINTENANCE

The terminal is designed to require very little routine or preventive maintenance. No routine lubrication or cleaning is required. If cleaning or maintenance is deemed necessary (due to an adverse operating environment), perform the following procedures on a yearly P-M schedule.

CLEANING AND PREVENTIVE MAINTENANCE

Read ALL of the warnings and cautions in this cleaning section before attempting any of the cleaning procedures given here.

CAUTION

To avoid damage to the plastics used in the Display Module and keyboard, do NOT use cleaning agents that contain benzene, acetone, toluene, xylene, or similar chemicals.

Cleaning the CRT Screen

Clean the face of the display crt using a soft cloth dampened with a solution of mild detergent and water.

WARNING

Disconnect the line power cord before cleaning any parts inside the terminal. Dangerous voltages exist inside the display module and may cause injury if contacted.

Occasionally, remove any accumulated dust from the inside of the Display Module. Dust conducts electricity under high humidity conditions. The terminal's interior is best cleaned with a vacuum cleaner. Remove any remaining dust with a soft bristle brush (paint brush) or a cloth dampened with mild detergent and water solution. To clean narrow spaces, use a cotton-tipped applicator.

CAUTION

Static charge can be generated by a brush with synthetic bristles. Such static charges will damage solid state components, so use a brush with natural soft bristles. (Read the Static Protection tips in the Disassembly Procedures, later in this section.)

Cleaning the Keyboard

This procedure describes how to clean off the residue of liquids, such as coffee, soft drinks, and so forth, that have been spilled on the keyboard.

CAUTION

The cleaning procedure uses water, so try to avoid getting water on any parts susceptible to water damage, and dry thoroughly.

CAUTION

Do not tear or lose the exposed foil contacts on the foam switch pads.

NOTE

Drying times may be shortened by forced air drying at a maximum temperature of 165° F (60° C).

1. Refer to the Keyboard Removal procedure in this section in order to separate the keyboard assembly into the printed circuit board and the switch and frame assembly.

2. Use a soft artists' brush to remove any dust or foreign matter from the key contacts (foil on the bottom of the foam switch pads).

3. Wash the frame assembly thoroughly in clean, lukewarm water. Avoid damaging the foam pads.

4. Shake the excess water out of the assembly, and set it on blocks to dry in the air for about two to four days. Cleaning off the residue left by some cleaning fluids may require more than one washing.

5. Wash the circuit board thoroughly in clean lukewarm water. Use a soft sponge or cloth to dry the board.

6. Set the circuit board on blocks to dry in the air for about one day.

7. Reassemble the keyboard assembly.

WARNING

If a dampened cloth is used for cleaning any parts of the terminal that are only accessible with the cover removed, take extreme care to NOT leave any remaining water or moisture in the terminal when the cover is reinstalled. This situation could provide a potentially lethal shock hazard to the user when power is reapplied to the terminal.

ROUTINE VISUAL INSPECTION

Inspect the terminal occasionally for such defects as broken connections, damaged circuit boards, loose connectors, heat damaged parts, broken structural foam mounting features (circuit board retainers), and general mechanical fitness. If the terminal is used in a high vibration environment, pay particular attention to connectors, cable strain relief, and the crt mounting bracket. Refer to the parts replacement procedure for appropriate details.

The corrective procedure for most visible defects is repair or replacement; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the unit. It is important to correct the cause of overheating to prevent a recurrence of the damage.

FUSE REPLACEMENT

The terminal contains two fuses — one on the Power Supply Module circuit board, and one on the Display Module's LV board.

Power Supply Module Fuse

The Power Supply's fuse is mounted at the bottom of the power supply circuit board. This fuse's only function is that of fire protection, in the event of a malfunction/overload. (The Power Supply Module contains automatic current limiting protection.) If the fuse burns out, first check for a possible overload that should be corrected. Then replace the fuse with one of the proper value as indicated in Table 6-1. This fuse is referred to as F505 on the circuit board, schematic, and in the Replaceable Electrical Parts (Section 9).

See Figure 6-5, in the Disassembly Procedures, for the location of this fuse.

Display Module Fuse

The current-protection fuse in the Display Module is located on the top-left corner of the LV board. This fuse is labeled F125 and is shown in Figure 6-18, later in this section. Table 6-1 shows the proper values for this fuse. See the 4109 Display Module service manual for more detailed information about the function of this fuse.

Table 6-1

FUSE REPLACEMENT VALUES

Location	Voltage Selected	Fuse Amperage
F505 on Power Supply Module circuit board	110V (nominal)	4.0 A (slow blow)
	220V (nominal)	4.0 A (slow blow)
F125 on Display Module LV circuit board	110V	3.2 A (slow blow)
	220V	1.6 A (slow blow)

DISASSEMBLY/REASSEMBLY PROCEDURES

This part of the maintenance section describes procedures for removing and disassembling modules or major pieces of the terminal. A set of procedures at the end of this section describes the repair and replacement of components and smaller assemblies in the terminal.

These procedures require only those tools common to a service tool kit.

Unless a specific reassembly procedure is given, perform assembly by following the disassembly procedures in reverse order.

NOTE

Unless otherwise stated, all screws mentioned in these procedures are POZIDRIVE®.

⚠ ELECTROSTATIC DISCHARGE PRECAUTIONS

This product contains components that are highly sensitive to electrostatic discharge. To prevent damage to such components and to maintain product reliability, **do NOT** touch or remove the circuit boards or components from the terminal until the following conditions are met.

⚠ Handling Static-Sensitive Components

Handle all static-sensitive components (such as ROMs, EEROMs, custom logic chips, etc.) in a static-safeguarded work area. A static-safe area is any area capable of controlling static charge on conductive and nonconductive materials, and people.

⚠ Transportating Static-Sensitive Components

Transport all static-sensitive components in static-shielded containers. A *static-shield* container will protect its contents from static discharge as well as static fields.

REMOVING THE COVER PANELS

Top Panel

The terminal's wrap-around top panel is fastened by five screws in the rear, and retainer tabs in the front. The top panel is a three-piece unit, but is designed for removal as one piece. Remove the five screws shown in Figure 6-1A. Then pull the top panel back and up; this will release the retainer tabs in front. Now, lift the panel off.

Rear Panel

To repair and service the terminal you must remove the rear panel, also. The rear panel contains the ROM Access door. This panel attaches to the terminal base with two screws, shown in Figure 6-1B.

NOTE

When removing the rear panel from a CX4109, tip the top of this panel out at about a 20° angle; then lift it straight out in that direction. This allows the threaded boss, on the bottom of the rear panel, to clear the CX Interface board connector (on the end of the Terminal Control board).

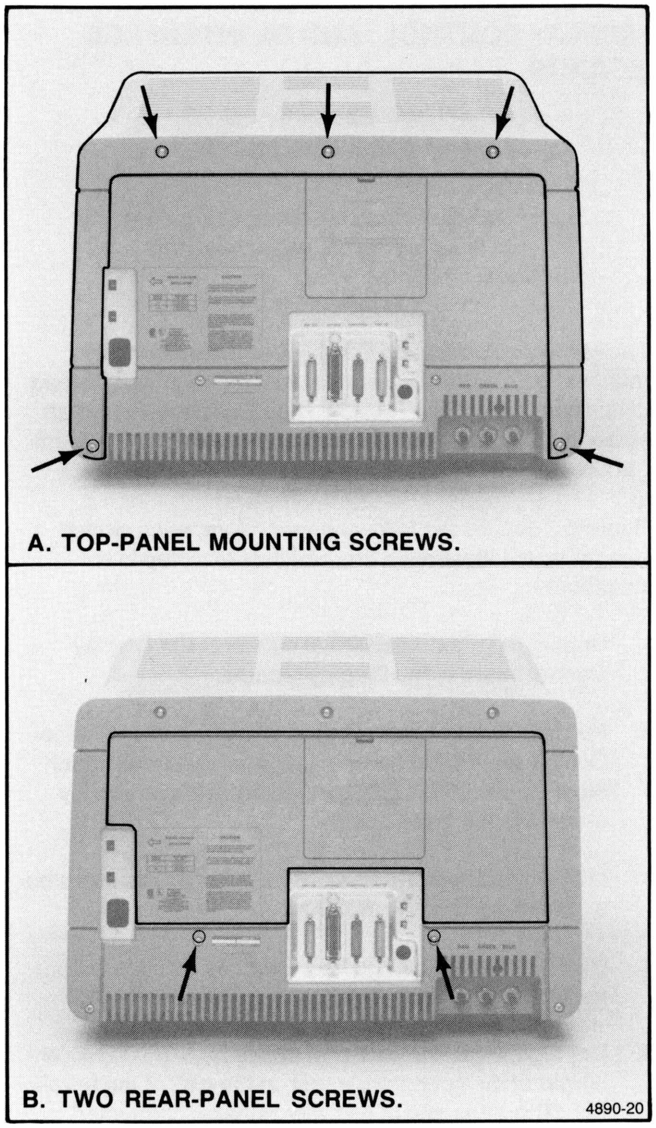


Figure 6-1. Removing Cover Panels.

REMOVING THE TERMINAL CONTROL, RAM3, DISPLAY CONTROL, AND CX INTERFACE BOARDS

CAUTION

Read "Handling Static-Sensitive Components" (previous heading) before performing this procedure.

The Terminal Control and Display Control boards are mounted across the side and back of the terminal (instead of in a card cage). The RAM3 is mounted between the aft end of the Display Control board and one end of the Terminal Control board.

Figure 6-2 depicts the following procedure; each circled number on the illustration corresponds to a step in the procedure.

1. Unplug the ribbon cable that connects the Display Control board to the Display Module.
2. Pull the Display Control board away from the Terminal Control and RAM3 boards; they are attached to each other by two 96-pin DIN connectors. This physically separates the three boards.
3. Lift the Display Control board up out of its retainer slots, and remove from the terminal.
4. Now the RAM3 board is free. Remove this board from the terminal by lifting it out of its dove-tail mounts.
5. Unplug the ground-wire that attaches to the upper-left corner of the connector panel, at the rear of the terminal. (The other end of this wire remains connected to the power supply.)
6. The Terminal Control board attaches to the power supply via a 10-pin connector on the upper-left extension of the board. Unplug the board from this connector by gently springing it away from the power supply.

If you are disassembling a 4109 terminal, skip Steps 7, 8, and 9; then do Step 10. If disassembling a CX4109, do all of these steps.

7. Unplug the CX Connector Board (attached to the CX Interface board via a ribbon cable) from the end of the Terminal Control board.
8. Unscrew the mounting nut for the coax connector labeled "COMM"; push this connector (with small circuit board) through the base and inside the terminal. This connector also attached to the CX Interface board with a ribbon cable.
9. Lift the CX Interface board and its attached assemblies out of the terminal.
10. Remove the Terminal Control board by lifting it straight up and out of the terminal. (The terminal's main connector panel is mounted tothis board, and slides in vertical grooves that secure it to the back of the terminal cabinet.)

CAUTION

Before installing the Terminal Control, RAM3, Display Control, and CX Interface boards in the terminal, observe the following. First, see that all pins on the 96-pin connectors are straight. Then, place the boards in the terminal, align the connectors, and carefully push them together. Carelessness can easily result in bent pins, which may cause the power supply to "crowbar" (which shuts down the supply).

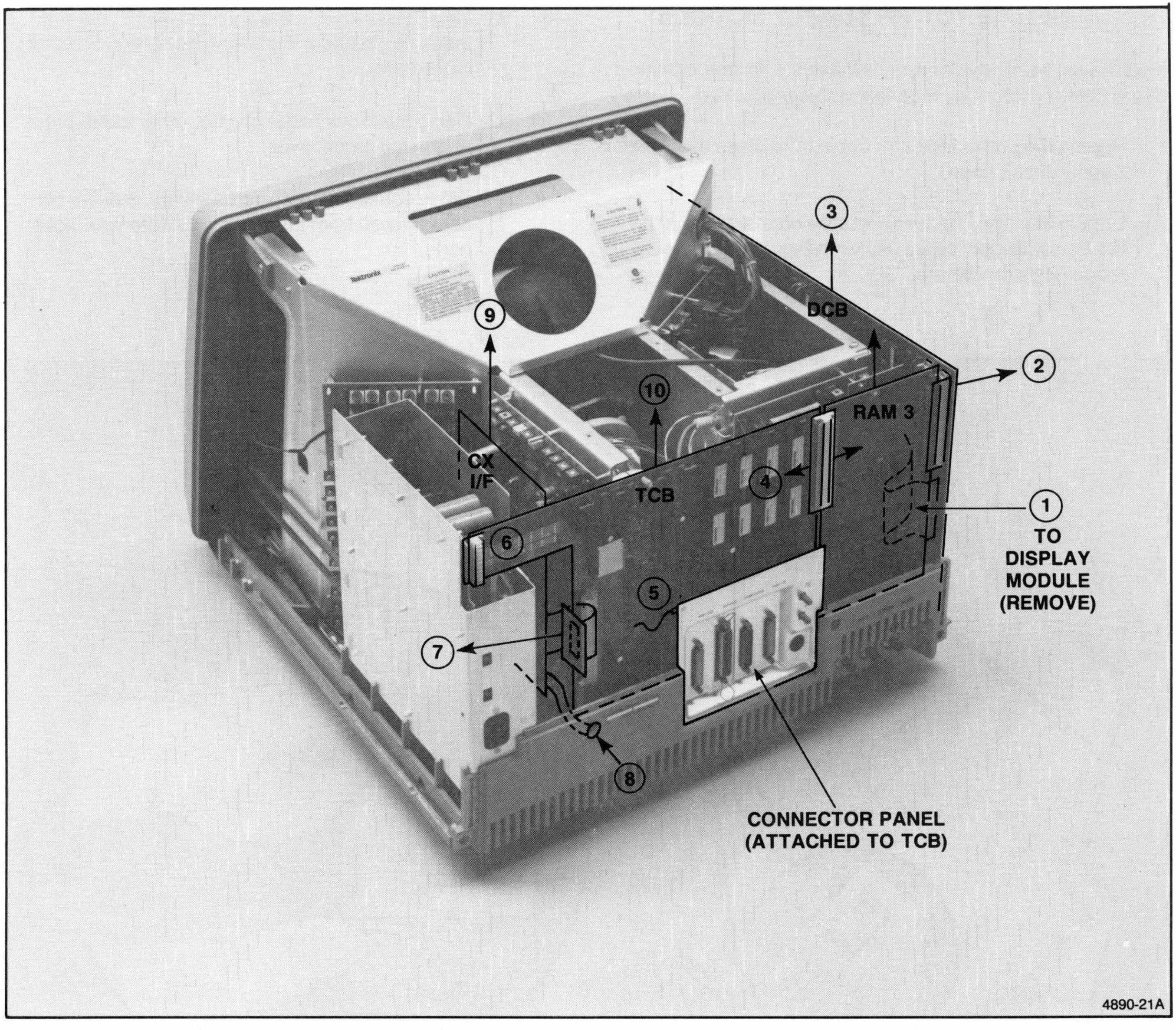


Figure 6-2. Terminal Control, RAM3, Display Control and CX Interface Circuit Boards.

REMOVING THE POWER SUPPLY MODULE

If you haven't already done so, remove the Terminal Control board from the terminal; then follow this procedure.

1. Unplug the power indicator cable from J8 on the Power Supply circuit board.

2. Unplug the nine-conductor square connector at J2 on the Power Supply board. Refer to Figure 6-3 while reading this procedure:

   a. Using the cutout in the chassis, place your right index finger under the connector and press on its catch-lever.

   b. Using the index finger on your other hand, press on the top catch-lever.

   c. While squeezing both catch-levers, pull the connector away from the receptacle with your right hand.

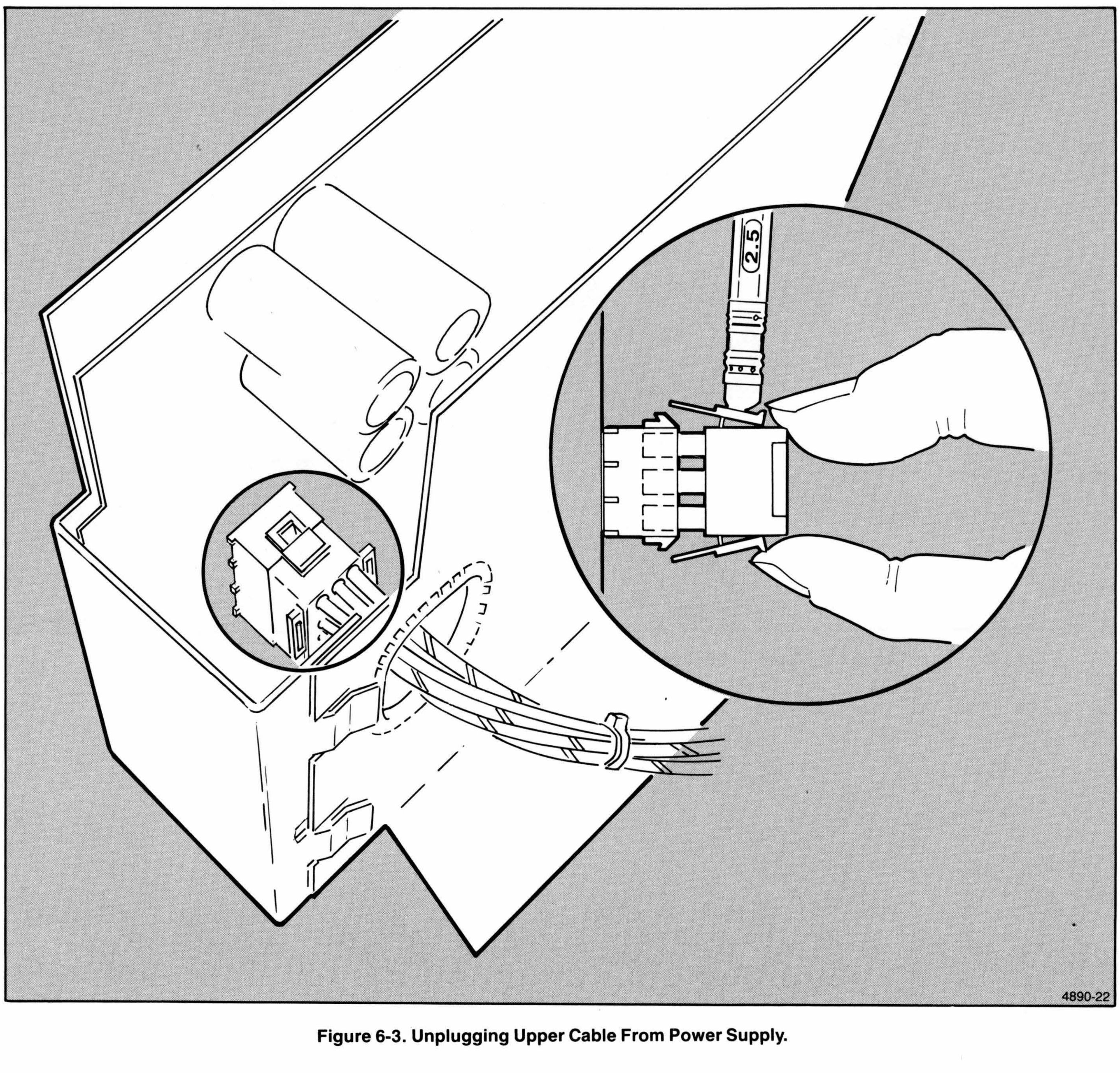


Figure 6-3. Unplugging Upper Cable From Power Supply.

3. Remove the arm that connects the power switch (mounted on the power supply) to the POWER button (on the front of the terminal). This arm attaches to the switch via a fork that stradles the switch plunger. Pull forward and the fork will release from the switch.

4. Remove the arm for the DEGAUSS switch in the same manner.

5. Unscrew the two Power Supply mounting screws, on the outside edge of the terminal. See Figure 6-4.

6. Pull the Power Supply Module up and away from the terminal just enough to reach under the chassis; then unplug the three-wire connector from J3 on the circuit board.

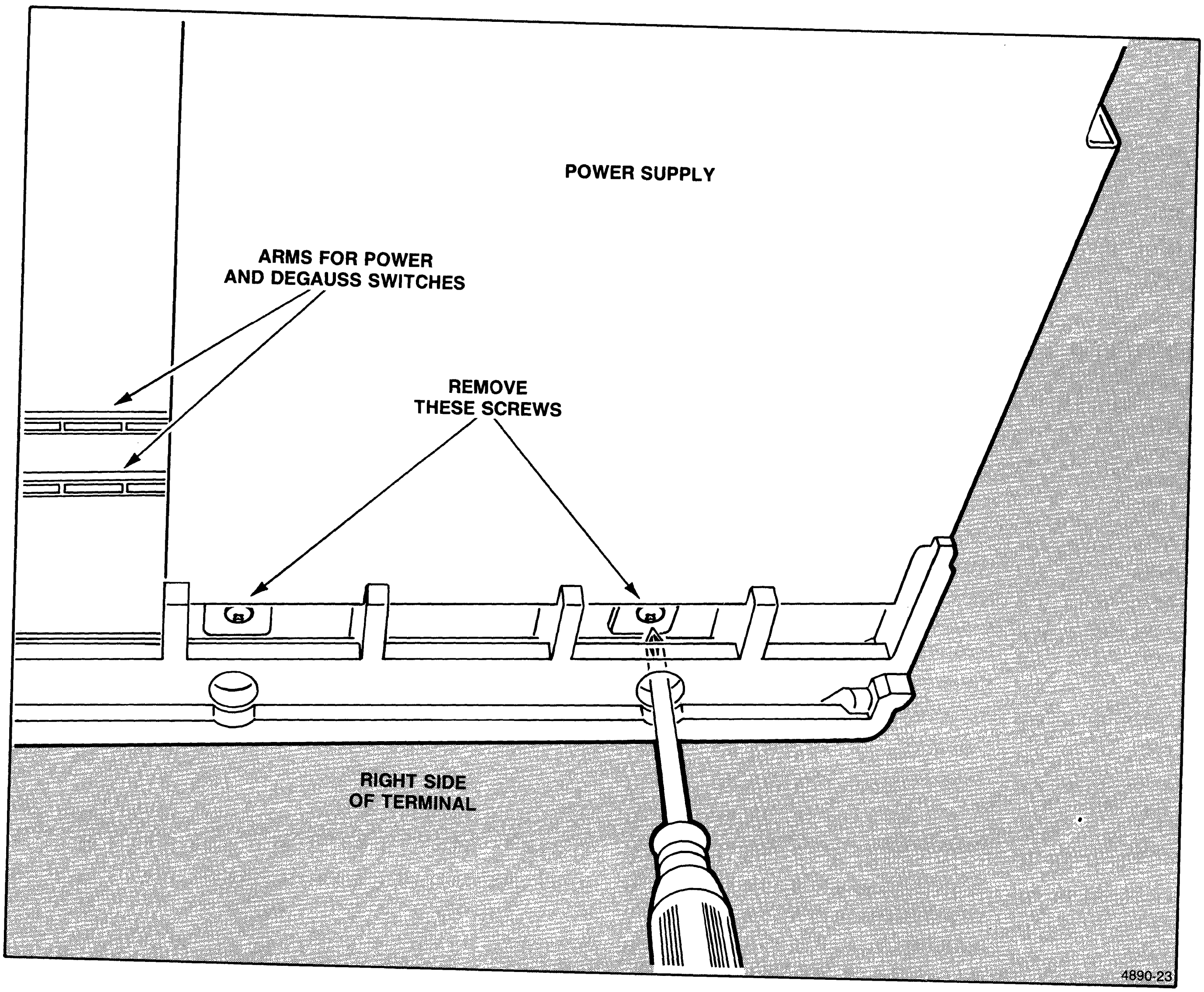


Figure 6-4. Power Supply Mounting Screws.

DISASSEMBLING THE POWER SUPPLY MODULE

Position the Power Supply Module as shown in the left side of Figure 6-5. The circled numbers in the figure correspond to each of the following steps.

1. Unscrew the screw called out in this figure. This screw fastens the access panel that you will remove next.

2. Slip the access panel from under the two dovetails (near the screw).

3. Open the access panel out around the four hinge tabs (on the other end of the chassis).

4. Slip the tabs out of their slots and remove the access panel.

Now you can access the circuit board and other internal parts for inspecting, adjusting, and removing or replacing components.

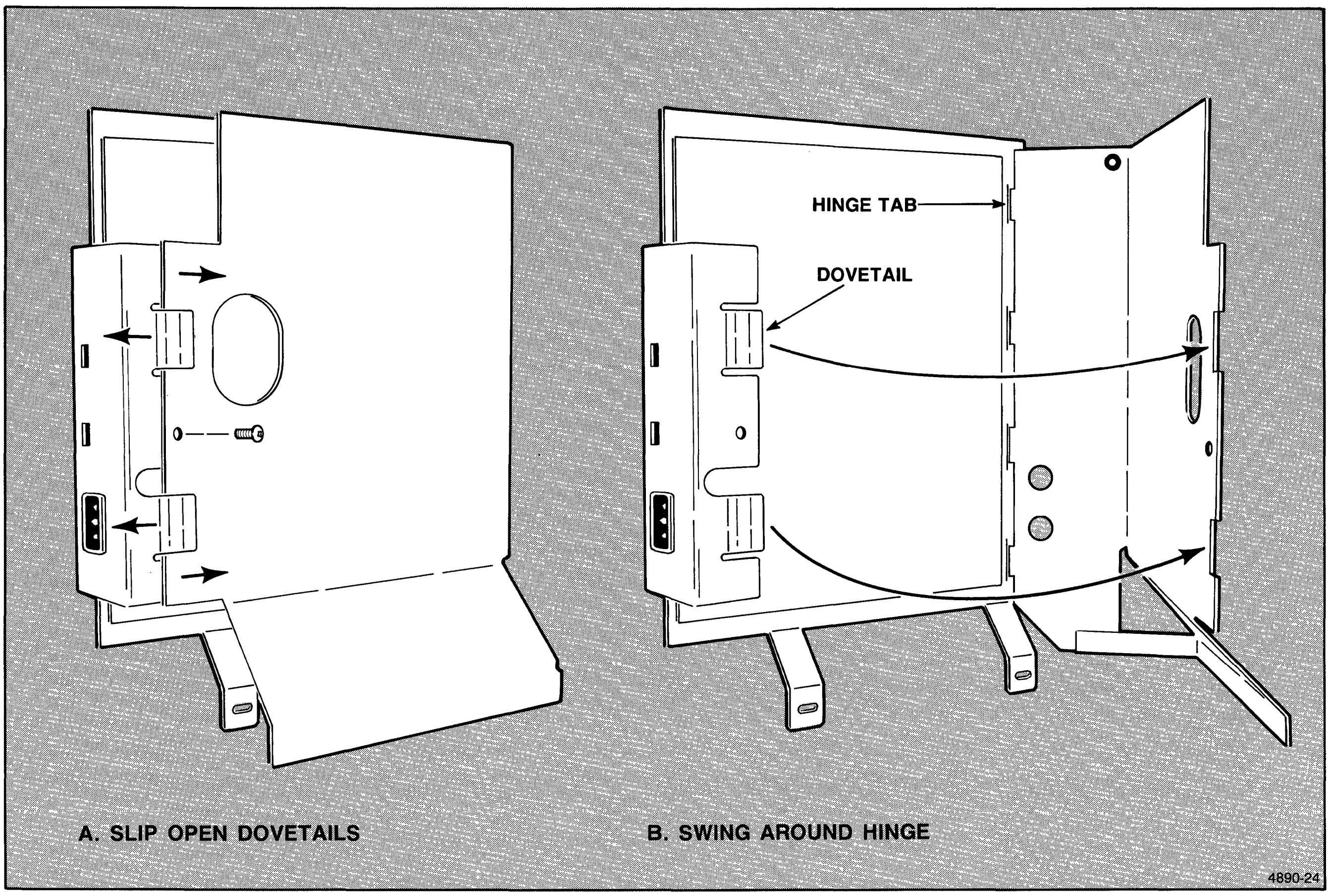


Figure 6-5. Opening the Power Supply Access Panel.

Replacing the Power Supply Fuse

A fire protection fuse is located at the bottom of the Power Supply Module board (just behind the ac power receptacle). See Figure 6-6.

If this fuse burns out, that indicates a serious overload problem. First, check all loads and the components serving those loads, and repair the overload condition. Then replace this fuse. Use only a 4A (250 V) slow blow fuse.

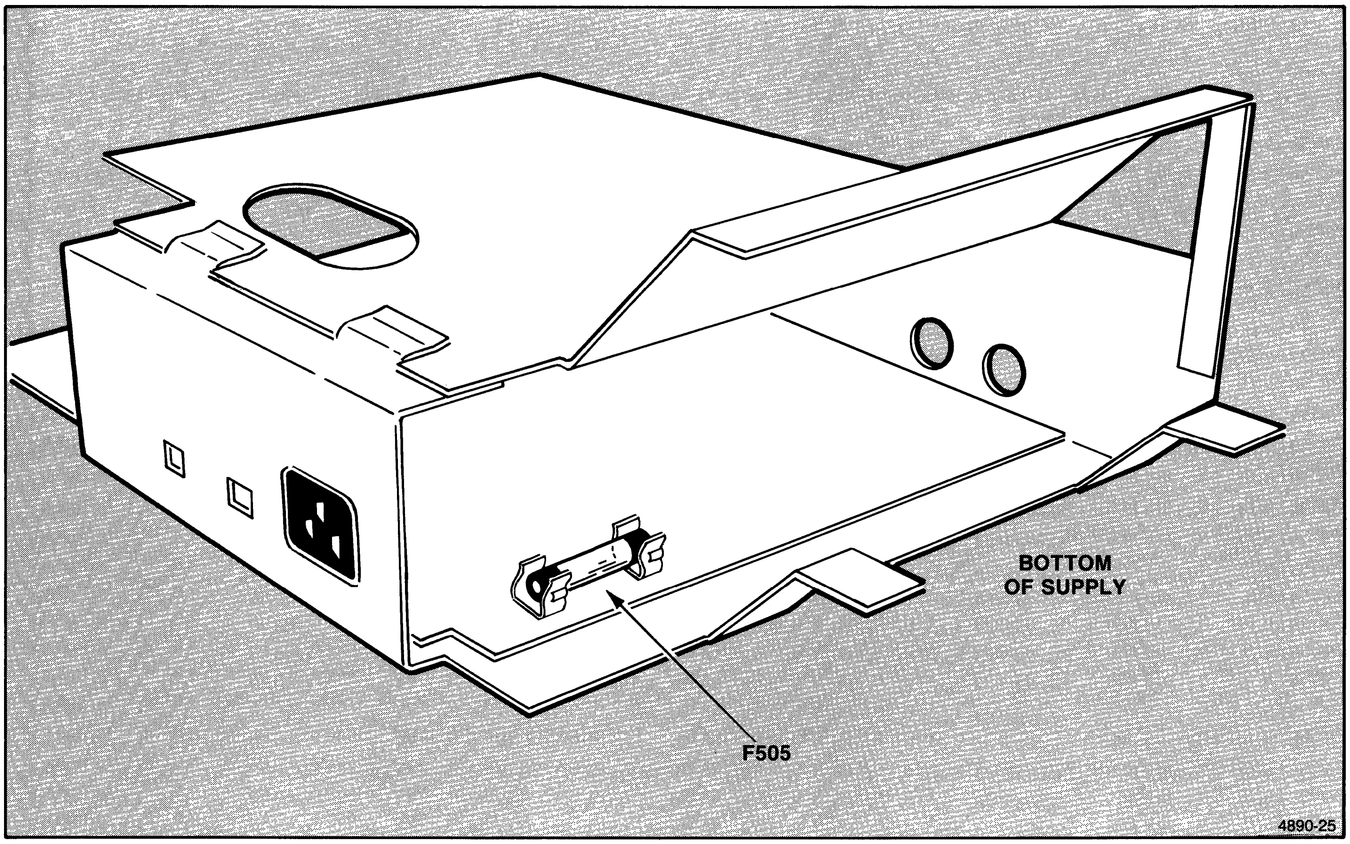


Figure 6-6. Power Supply Module Fuse Location.

Removing the Power Supply Circuit Board

The Power Supply board mounts to the power supply chassis with eight snap-on connectors and the ac power receptacle unit.

1. First, disconnect the circuit board's ground wire by unscrewing the nut that mounts it to the chassis.

2. Figure 6-7 shows how to disconnect the ac power receptacle from the chassis. First, using a scribe and hammer, tap the mandrel (pin) through each of the two rivets. Now, push out the rivets. The ac receptacle is free from the chassis.

   You can reuse these rivets by pushing each rivet through the chassis and receptacle holes, and then driving each mandrel in until it is flush with the top of the rivet head.

3. Remove the screw that fastens the ac power receptacle to the circuit board and the chassis. See Figure 6-6, again.

4. Locate the seven snap-on fasteners that mount the circuit board to the chassis.

5. One at a time, squeeze together the lock-ears on the chassis side of each fastener. Push the fasteners into their holes to keep the ears from popping out again.

6. Push the boss, on the ac power receptacle, through its hole in the chassis.

7. Then, push the seven fasteners through their holes in the chassis.

8. This releases the circuit board. Lift it out of the chassis.

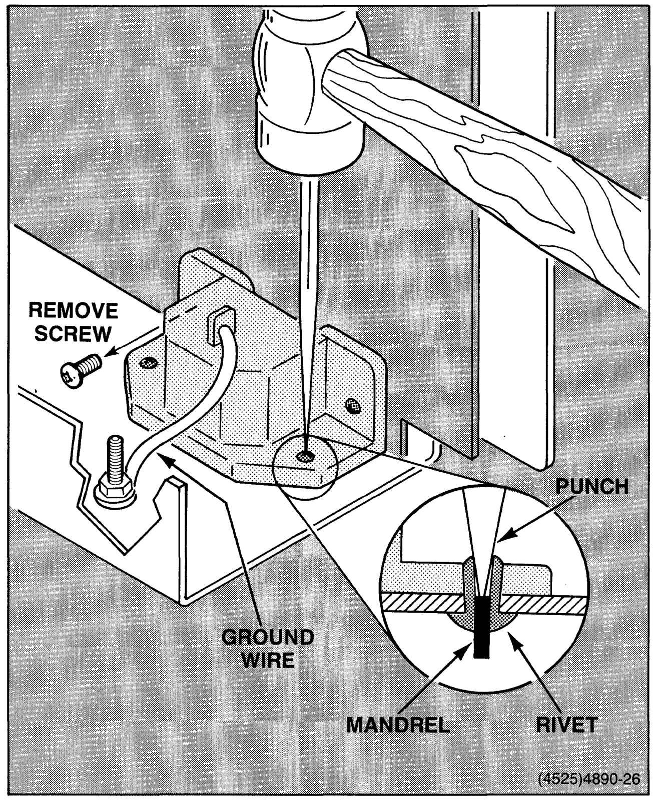


Figure 6-7. Removing Power Receptacle Rivets.

REMOVING THE GMA301 DISPLAY MODULE FROM THE TERMINAL

The GMA301-type Display Module mounts to the terminal with eight screws. One screw is located in each corner of the Display Module's base. Two screws in each side of the chassis (near the front of the CRT) fasten the terminal's front bezel to the Display Module. Figure 6-8 shows the locations of all eight screws.

WARNING

Lethal voltages are present at the High Voltage anode on the crt. Discharge this HV connection before performing the following procedure. Bodily contact with high voltages may cause shock, injury, or death.

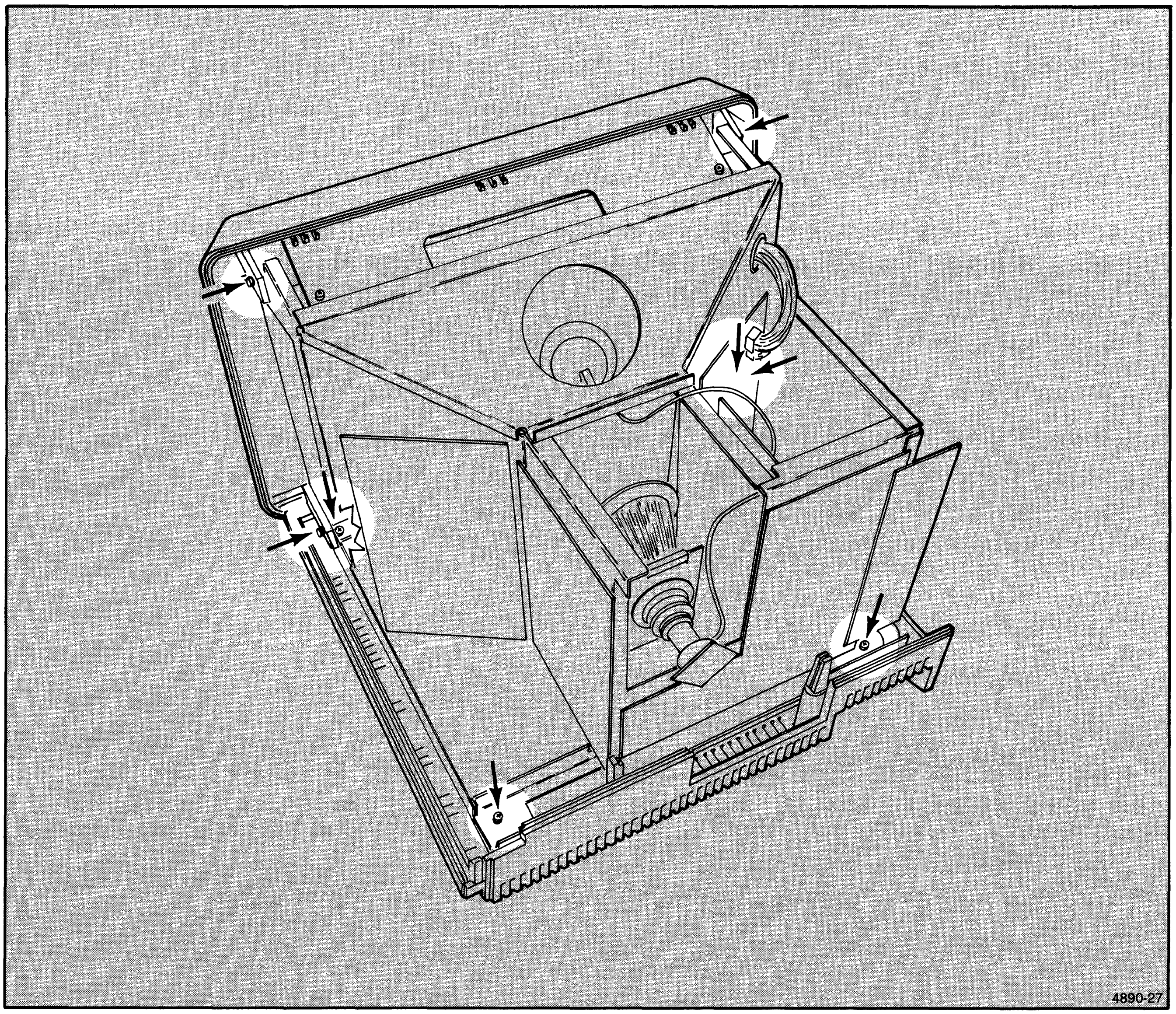


Figure 6-8. Mounting Screws for the Front Bezel and Display Module.

1. Discharge the high voltage anode button on the crt. Using an insulated screwdriver, slip the blade under the rubber anode-cover; then lay the screwdriver shaft against the grounded metal frame.

2. Unclamp the Terminal Control board's ground wire from the Display Module chassis.

3. Unplug the ribbon cable from connector J31 on the Display Control board.

4. Remove the Terminal Control board, RAM3 board, and Display Control board.

5. Remove the main front bezel that surrounds the crt and contains the BRIGHTNESS, POWER, and DEGAUSS controls. This bezel attaches with four screws (two in each side). See Figure 6-8 again.

NOTE

Disconnect the POWER and DEGAUSS control rods from their respective switches on the main Power Supply Module.

6. Remove the Digital Piggyback board and the Video Out connector-board. The Piggyback board mounts with four screws, and the connector-board attaches with only three nuts (one on each BNC connector).

7. Remove the BRIGHTNESS control from the back side of the bezel by spreading the retainer forks that slip over the top and bottom of this control. This releases the potentiometer from the back side of the bezel, while the knob remains attached to the front of the bezel.

8. If the Power Supply Module is still installed, remove it now using the procedure earlier in this section.

9. Unscrew the four Display Module base mounting screws; these screws thread into brass inserts in the base of the terminal.

10. Unplug any remaining Display Module connecting cables.

CAUTION

Exercise care when lifting the Display Module to avoid back injury.

11. Now, lift the Display Module out of the terminal.

REMOVING AND REINSTALLING THE DISPLAY CRT

The following crt removal procedure assumes the Display Module is installed in the terminal.

WARNING

Lethal voltages are present at the High Voltage anode on the crt. Discharge this HV connection before performing the following procedure. Bodily contact with high voltages may cause shock, injury, or death.

1. Discharge the High Voltage anode button on the crt; see preceding WARNING.

2. Unplug the High Voltage anode cable from its connection at the front of the crt.

3. Unclamp the Terminal Control board's ground wire from the Display Module chassis.

4. Unplug the ribbon cable from connector J31 on the Display Control board.

5. Remove the Terminal Control board, RAM3 board, and Display Control board.

6. Remove the main front bezel that surrounds the crt and contains the BRIGHTNESS, POWER, and DEGAUSS controls. This bezel attaches with four screws (two in each side). See Figure 6-8 again.

7. Remove the plastic mask that fits between the bezel and the crt.

8. Remove the EMI shield plate that lays on top of the front of the crt; it attaches with two screws, as shown in Figure 6-9.

9. Unplug the crt neck socket from the crt.

NOTE

Figure 6-13 and the "Socket Board Removal Procedure" (later in this section) provide more details.

A silicon gum may have been used to glue the socket to the crt; if so, use a knife to peel the gum away from the socket.

Pull the socket assembly to the right side so you can more easily work around the crt neck. If you need more freedom, unplug the wires from the socket assembly.

10. Unplug the deflection yoke cables from connector J52 on the Deflection board. Then pull this cable and connector through the pass-through hole in the chassis.

11. Unplug the convergence-coil wires from their connector (J60) on the Convergence board.

NOTE

The yoke assembly (including the Convergence Coil Set) is part of the crt, and must not be removed from the crt.

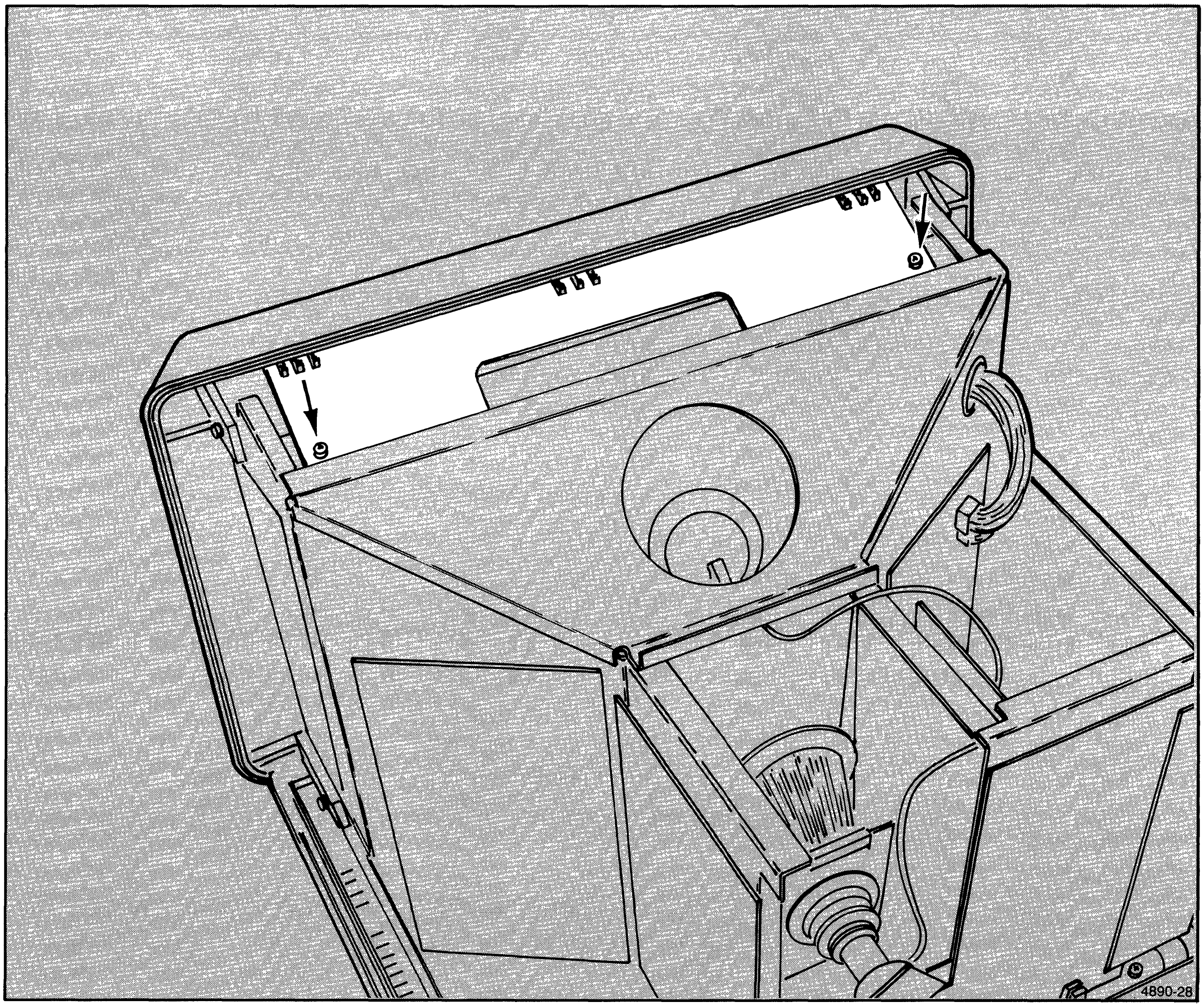


Figure 6-9. Removing the Top Shield Plate.

12. Unplug the degauss coil cable from its connector (J3) at the bottom of the circuit board in the Power Supply Module.

13. Remove the four nuts and washers that clamp the front corners of the crt to the Display Module chassis. Place the nuts, washers, and screws in a labeled container (to prevent misplacing them or confusing them with other similar, but different, screws). See Figure 6-10.

14. Place a soft pad on the bench-top and in front of the crt. (When removed, the crt will rest on this protective pad.)

WARNING

The crt may be damaged by careless handling when removing it from the terminal. Protect it from sharp, solid objects. If the crt cracks and explodes, serious personal injury is likely.

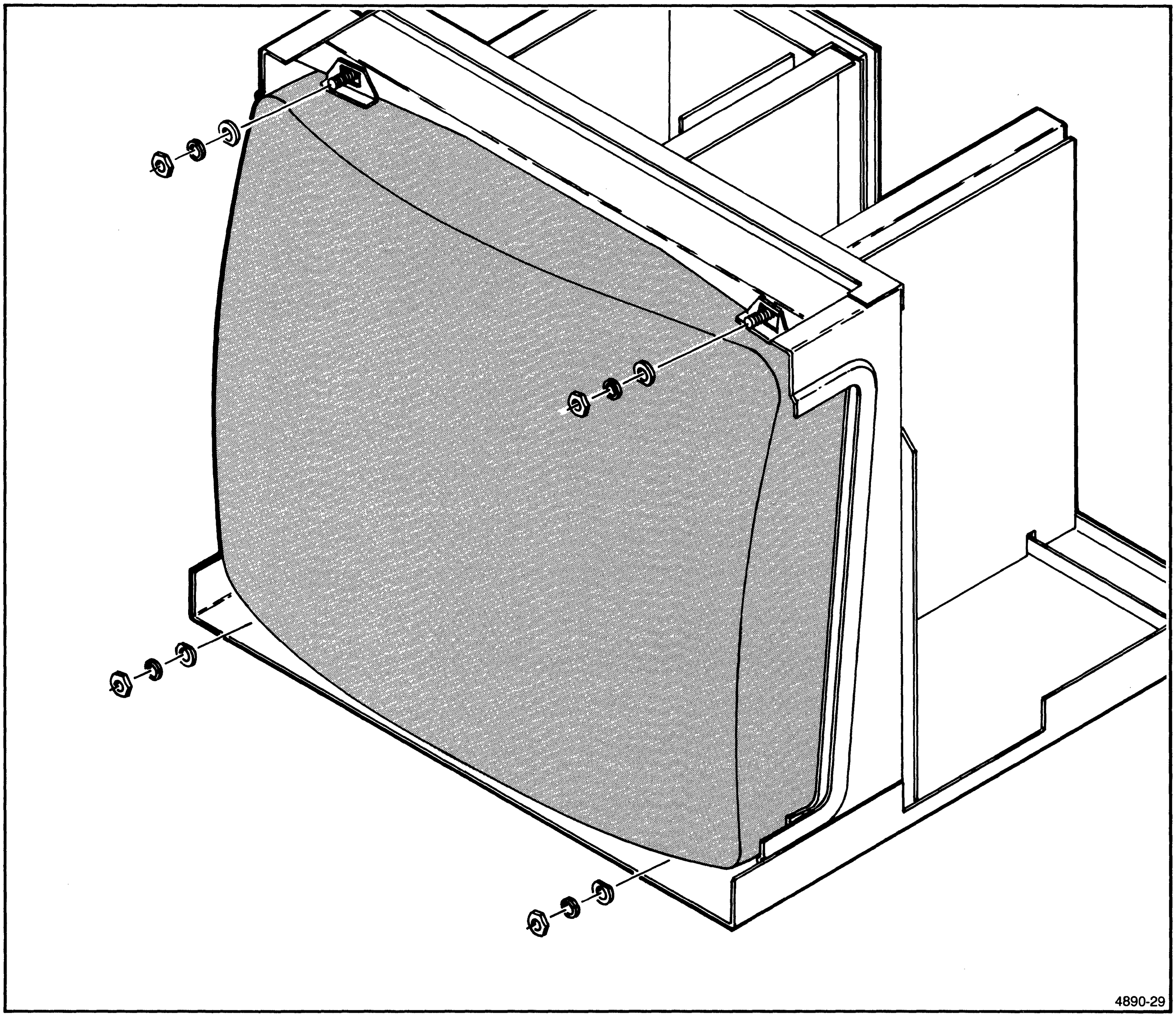


Figure 6-10. CRT Forward Mounting Nuts.

15. Rock the crt forward as shown in Figure 6-11. Then pull the crt out of the front of the Display Module, and lower it onto the protective pad.

To install the crt, follow the previous steps in reverse order.

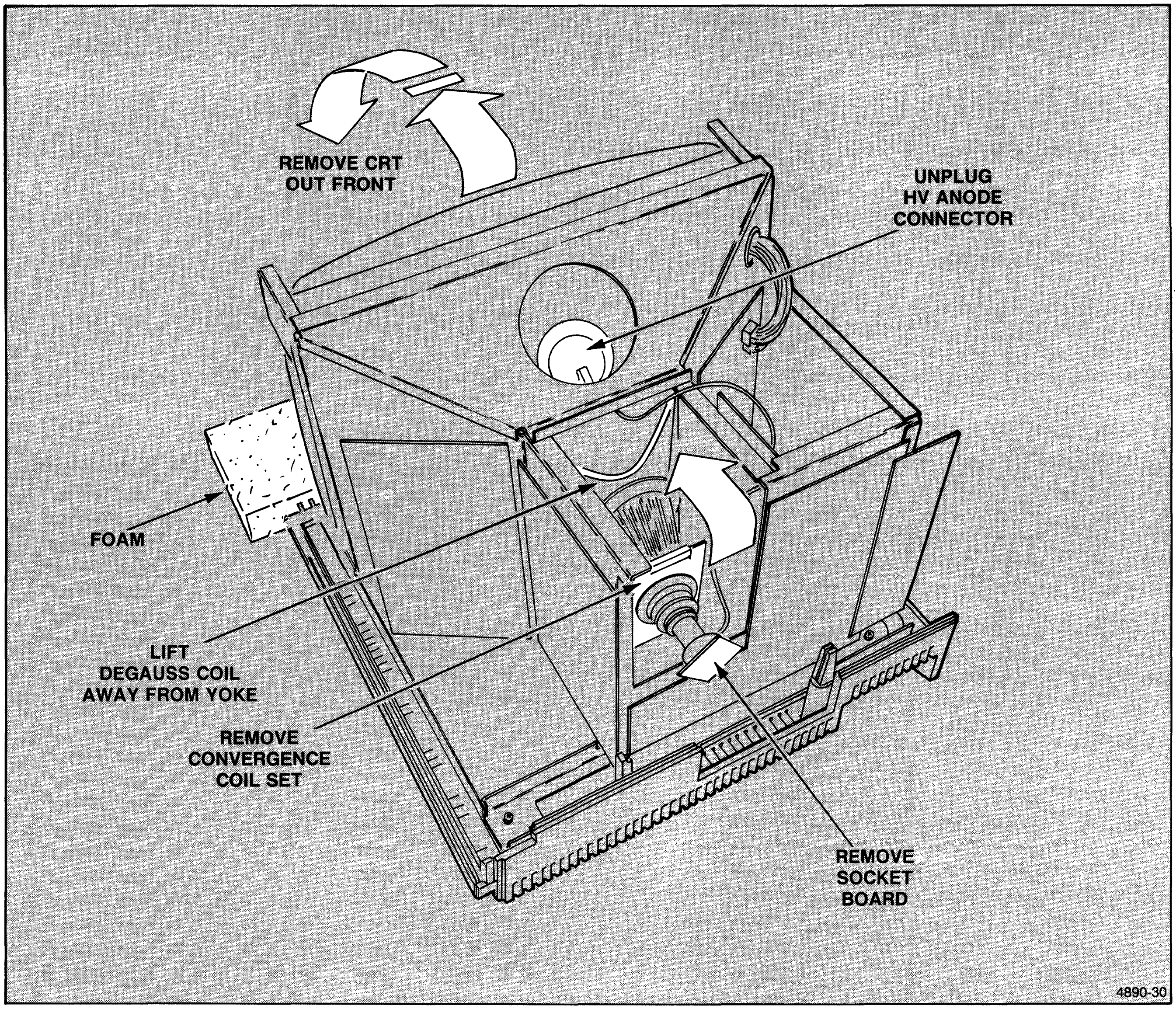


Figure 6-11. Removing the CRT.

REMOVING THE GMA301 DISPLAY MODULE CIRCUIT BOARDS AND ASSEMBLIES

The GMA301 Display Module consists of the following boards and assemblies; the numbers preceding each board name correspond to the circled numbers in Figure 6-12.

(1) Convergence board

(2) Deflection board

(3) Video (amplifier) board

(4) Socket board

(5) Digital Piggyback board

(6) High Voltage board

(7) Low Voltage board

(8) Convergence Coil set

NOTE

The crt Socket board is quite vulnerable to damage. Use caution when working around it.

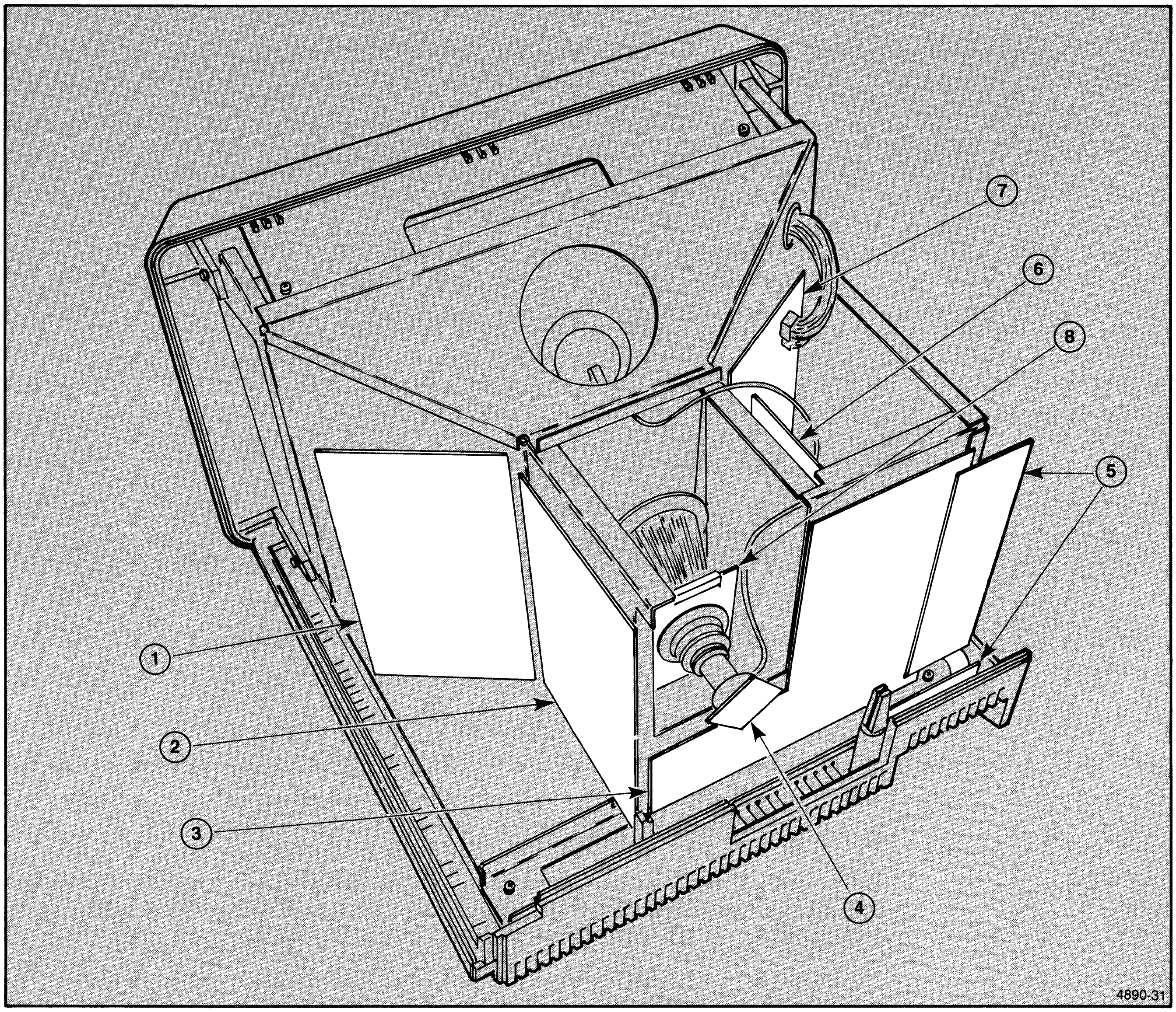


Figure 6-12. Display Module Boards and Assemblies.

Removing the Socket Board

The Socket board is mounted on the back end of the crt. Figure 6-13 shows the connectors mentioned in this procedure.

1. Unscrew the nut that fastens the ground wire (black) to the bottom corner of the Socket board.

2. The red cathode-voltage wire, from the divider on the HV board, passes through a hole in the chassis. At that point, the wire contains a large rubber-like connector. Pull apart this connector.

3. Unplug the connector from J23 on top of the HV board. (Its three wires go to the Socket board.) Pull the wires and connector through the pass-through hole in the chassis.

4. Unplug the four crt-grid wires at their connectors on the Video board. The connectors for these wires are labeled KR (J39), KG (J37), KB (J35), and G1 (J31). These wires (and part of the cathode wire) remain attached to the Socket board.

5. Gently pry off the Socket board. If silicon gum was used to secure the board to the crt, peel it off with a knife.

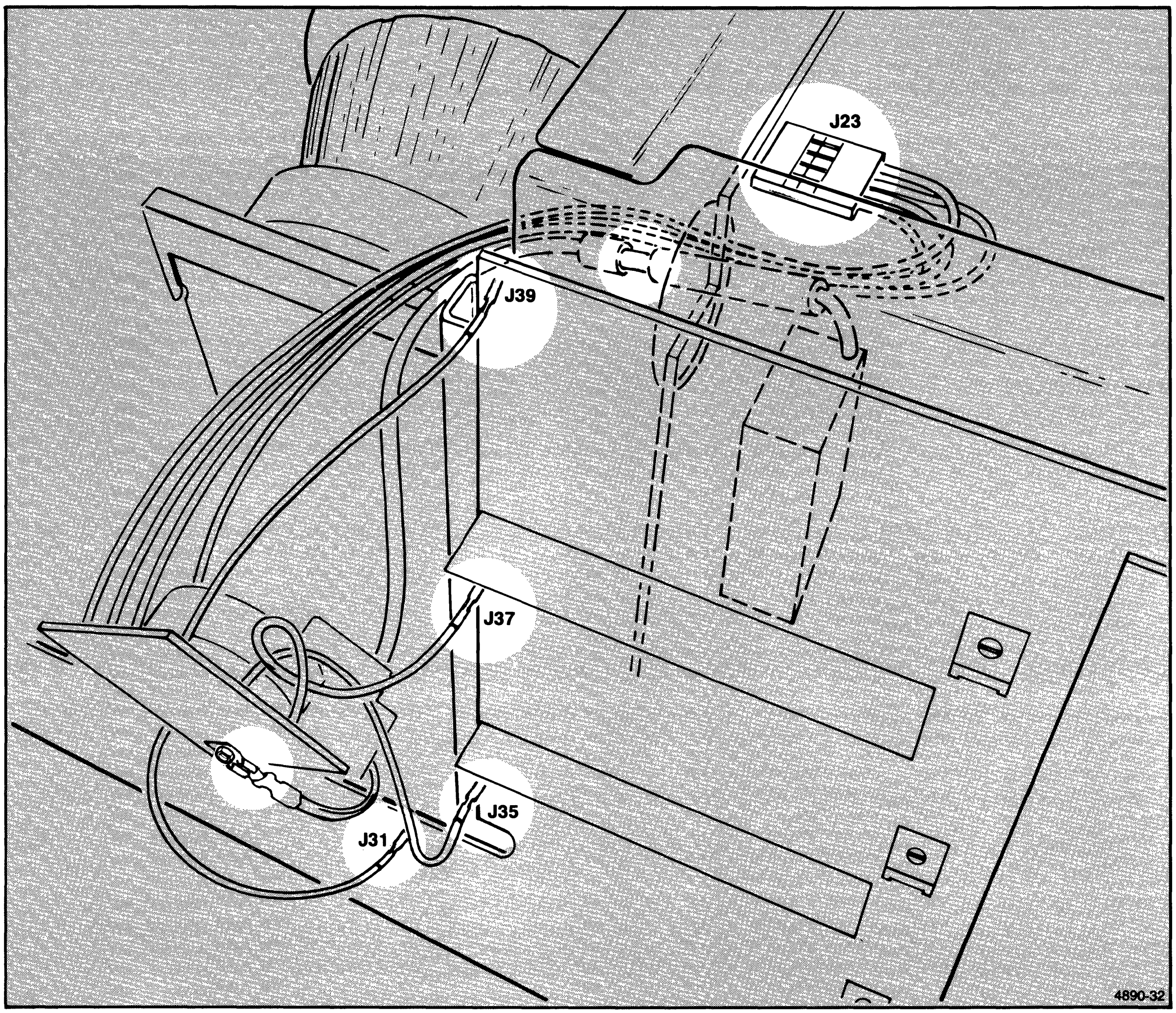


Figure 6-13. Connectors for Socket Board Wires.

Removing the Video Board and the Piggyback Board

This procedure describes how to replace the Video and Piggyback Boards assembly. See Figure 6-14.

1. Remove the threaded nuts and washers that mount the three BNC, VIDEO OUT, connectors to the rear panel. Save the nuts and washers.

NOTE

The VIDEO OUT connector panel is connected to the Piggyback board via a ribbon cable, and is considered part of the Piggyback board assembly.

2. Remove the three mounting screws in the Piggyback board. A hole in the base of the terminal provides access to the lower screw.
3. Remove the three screws that fasten the Video board and its heat sink to the chassis. These screws are recessed in the heat sink. Do NOT remove the flush-mounted screws just above them.
4. Pull the assembly to the right, unplugging it from the Deflection board (at the lower-left edge-connector).

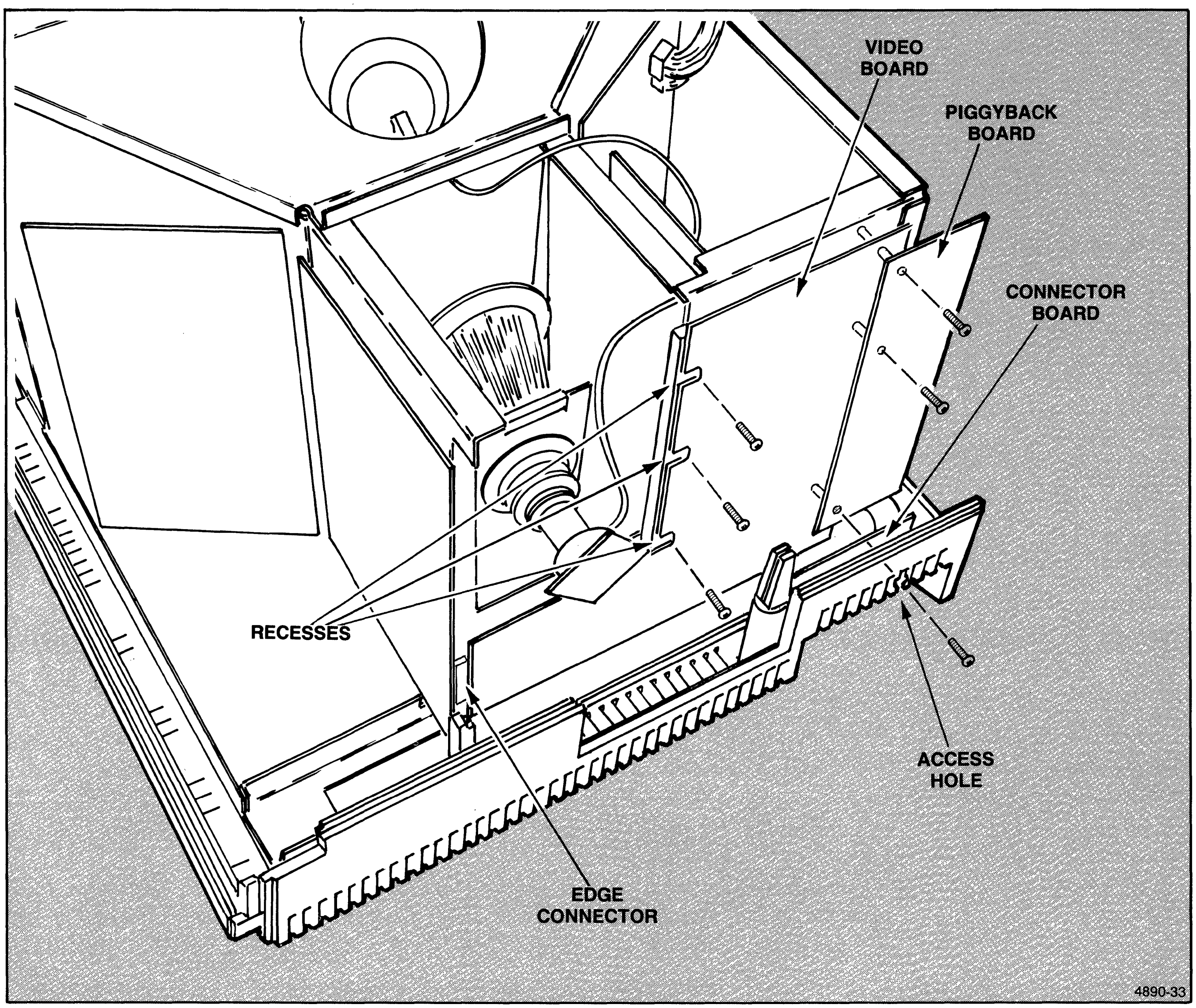


Figure 6-14. Removing the Video and Piggyback Boards.

Removing the Convergence Board

Remove the Power Supply Module; the procedure is earlier in this section. Then, refer to Figure 6-15 while doing the following procedure.

1. Unscrew the two screws from the heat sink on the left edge of the Convergence board.

2. Unplug the ribbon cable from connector J60 on the Convergence board.

3. Unplug the ribbon cable that connects J65 (on the Convergence board) to J51 (on the Deflection board). J65 is not a connector.

4. Pull the Convergence board away from the Display Module chassis (in the direction of the locator studs). The heat sink is part of the Convergence board assembly.

Removing the Deflection Board

Remove the Power Supply Module if it is still installed.

1. Unplug the four-conductor cable that comes from the deflection yoke and connects to J52 (on the back side of the Deflection board).

2. Unplug the ribbon cable from connector J51; it comes from J65 on the Convergence board.

3. Unscrew the two Convergence board mounting screws; one is in the middle of the left edge, and the other is in the top right corner. Two heat sinks remain attached to the board.

4. Pull the Deflection board assembly away from the Display Module chassis, so the Deflection-to-Video boards connector (J50) separates without stressing either board. This frees the Deflection board.

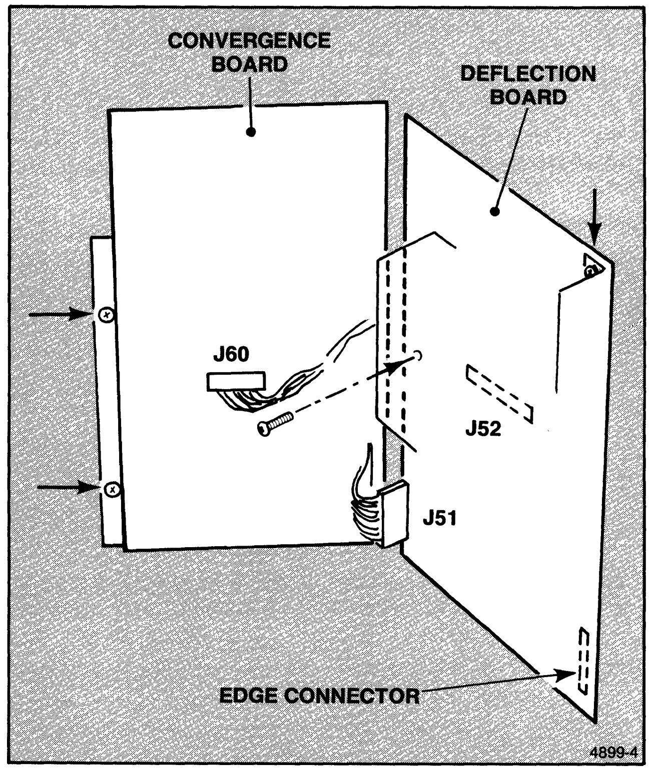


Figure 6-15. Convergence Board and Deflection Board Mounting Screws and Connectors.

Removing the High Voltage Board

To access the High Voltage (HV) board, you must remove the side panel that covers it. See "Side Panel Removal" procedure, at the end of this list of steps.

In this procedure, the circled numbers refer to the circled numbers in Figure 6-16.

WARNING

Lethal voltages are present on the HV anode cable. Discharge this connection before unplugging the cable.

1. Unplug the crt anode cable from its connection ((10)) on the top-front of the crt.
2. Unplug the crt cathode cable at its pass-through connector ((9)).
3. Unplug the ribbon cable from J23 ((8)) at the top of the HV board.
4. Unplug the ribbon cable from J20 ((11)) at the bottom right corner of the HV board.
4. Remove the screw that fastens a cable-clamp and bracket to the back of the Display Module chassis ((6)).
5. Remove the five screws ((1)...(5)) that mount the HV board to the Display Module chassis.
6. Pull the HV board to the right; this unplugs the HV-to-Video edge connector ((7)).

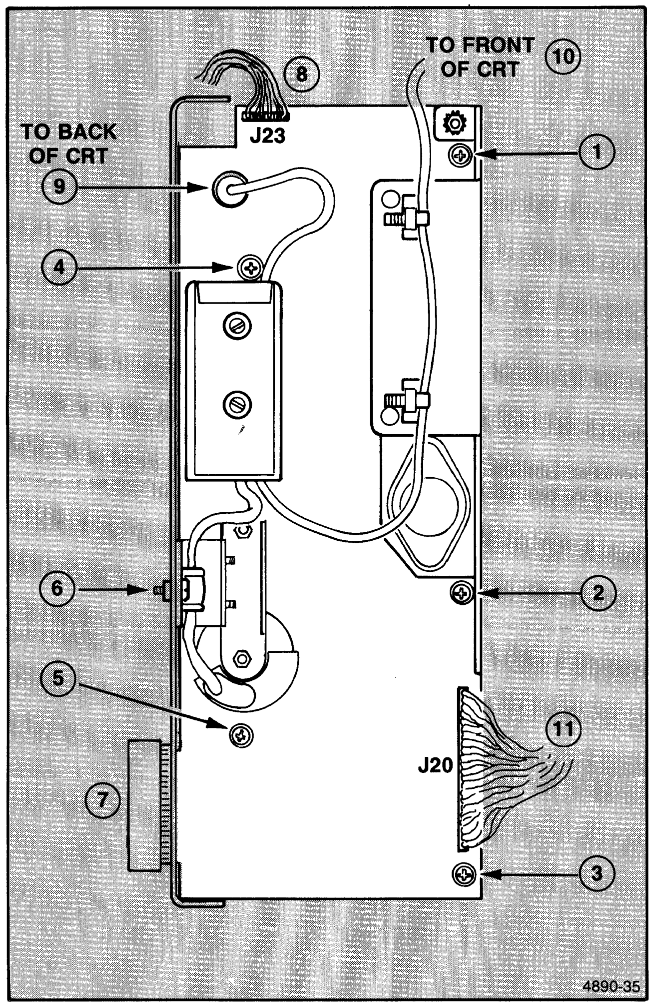


Figure 6-16. HV Board Screws and Connectors.

Side Panel Removal. See Figure 6-17.

1. Remove the two screws in the lower center of the side panel.
2. Remove the screws from each corner at the top of this panel.
3. Slide this panel back until the support pins (in its rear edge) slip out of their holes.

To remount this panel, first put the panel in place and insert the support pins into their holes. Then install the screw in the upper-right corner. Install the other corner screw, and then install the two remaining screws.

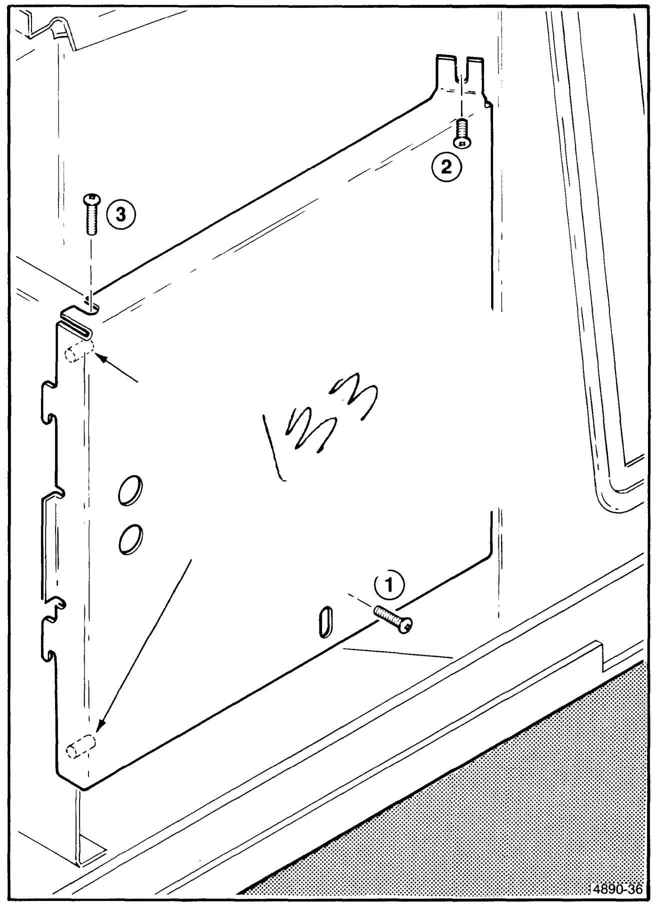


Figure 6-17. Side Panel Mounting Screws.

Removing the Low Voltage Board

To access the Low Voltage (LV) board, you must remove the side panel that covers this circuit board (see prior procedure, "Side Panel Removal"). Now, refer to Figure 6-18 while performing these steps.

1. Unplug J20 on the bottom of the HV board.
2. Label the connector J6 on the LV board; then unplug it. (Labeling the cable-end of this connector allows you to distinguish between J5 and J6 when you plug them back in.)
3. Unplug connectors J3, J4, and J5 (all at the top of the LV board).
4. Pull the LV board away from the chassis mounting plate. The board will slide free of its tension mounts.

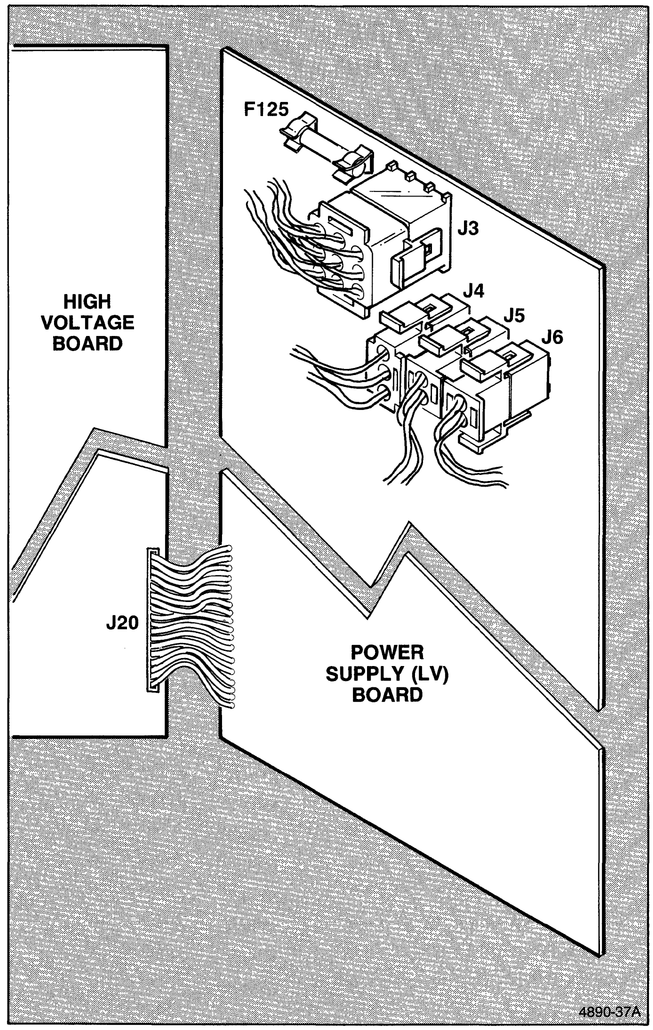


Figure 6-18. LV Board Connectors.

Removing the Convergence Coil Set

The convergence coils are mounted on two circuit boards that are fastened together and stradle the neck of the crt. If you need to remove this assembly, follow this procedure.

1. Unplug ribbon cable from J60 on the Convergence board.

2. Pull the cable and connector through the pass-through in the chassis.

3. Swing up the fastener-arm that hooks the two halves of the Coil board together (see Figure 6-19). Then let the halves open out away from the crt (the lower part of the assembly contains a hinge point).

4. Unplug the ground clip from the yoke-fastening screw; the screw is in front of the coil assembly (see Figure 6-19 again).

5. Unplug the Socket board from the neck of the crt.

6. Pull around the neck of the crt those wires that connect to one of the two coil boards. This puts all of the coil wires on one side of the neck of the crt.

7. The Coil Set assembly is now free of the Display Module. Pull it out from under the crt.

When replacing the Coil Set assembly, use care to not break the hook off of the fastener that joins the top halves of this assembly. Also, plug the Socket board back onto the crt, and reconnect the coil wires.

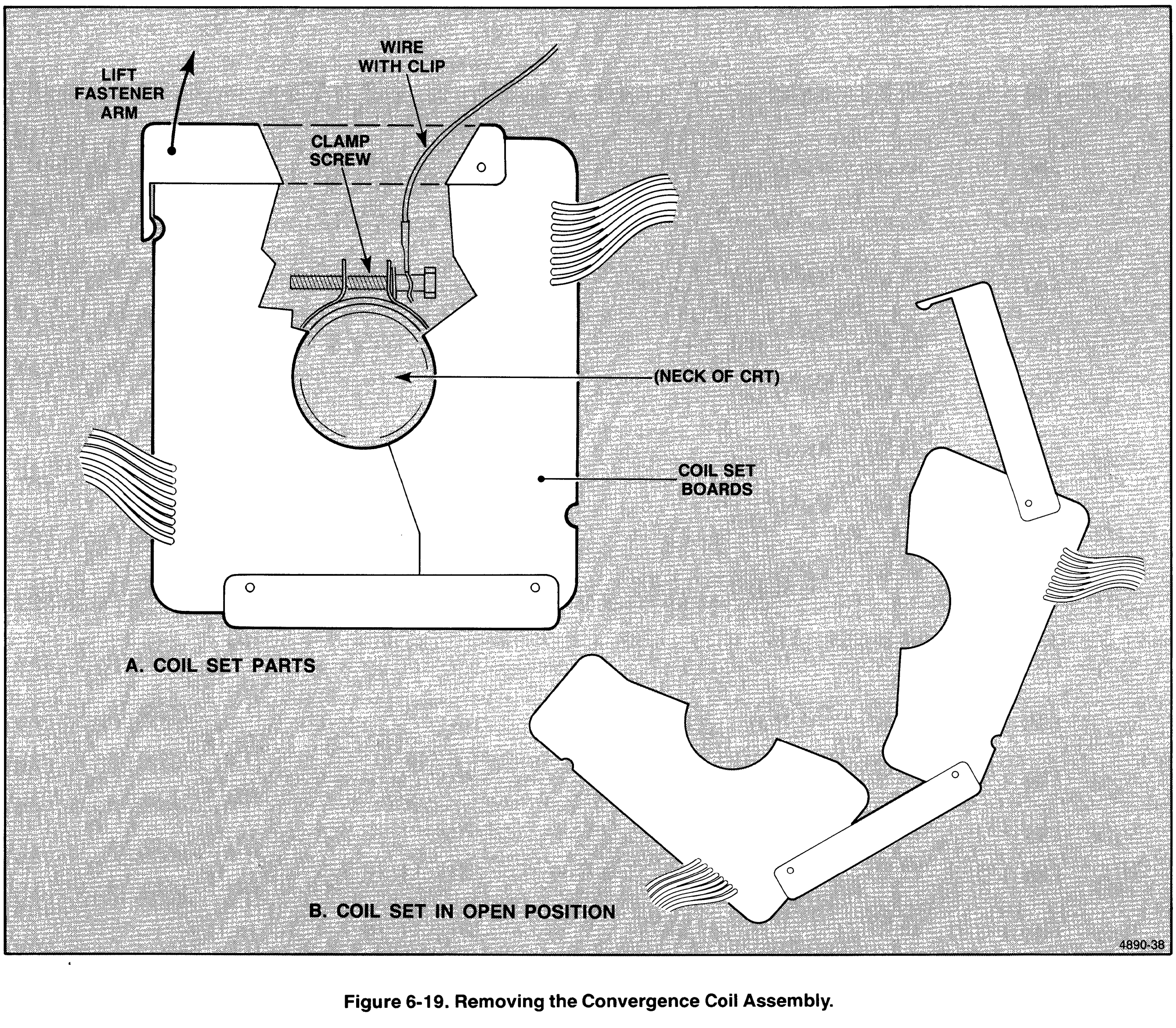


Figure 6-19. Removing the Convergence Coil Assembly.

REMOVING THE 119-2023-00 DISPLAY MODULE FROM THE TERMINAL

When removing this Display Module from the terminal, follow these steps (similar to the steps used to remove the GMA301 display):

1. Remove the logic boards: Terminal Control, Display Control, RAM3, and CX Interface (if present).

2. Remove Power Supply Module.

3. Remove the Video Interface board. This board is in a different location from the Digital Piggyback board. It is mounted to the terminal via two slip-fasteners on one end and three BNC connectors on the other end.

4. Remove the front bezel, attached by four screws.

5. Remove the Display Module:

   Unscrew the four screws (one in each corner of the bottom pan). Then lift the display out of the terminal.

REMOVING THE 119-2023-00 DISPLAY MODULE'S CIRCUIT BOARD ASSEMBLIES

This is a summary of the detailed procedure printed in the 119-2023-00 19" Display Module Service Manual.

This Display Module consists of the following replaceable subassemblies:

- Main circuit board (TNP-85811)
- Filter board (TNP-89503)
- Analog Interface board (TNP-81155)
- CRT-Yoke assembly
- Neck/Socket board (TNP-85811V)
- High Voltage brick

The mounting locations of boards are shown in Figure 1-3A near the beginning of this manual.

REMOVING THE CRT

WARNING

Hazardous voltage may be present on the High Voltage anode of the crt. Discharge this HV connection before performing the following procedure. Bodily contact with high voltage may cause shock, injury, or death.

1. Discharge the high voltage anode on the crt: Using an insulated screwdriver, slip the blade under the rubber anode-cover; then lay the screwdriver shaft against the grounded metal frame.

2. Unplug the HV cable from the crt.

3. Remove the terminal's logic boards: Terminal Control, Display Control, RAM3, and CX (if present). The power supply module does not need to be removed.

4. Remove the front bezel by unscrewing the four screws that mount it to the front of the Display Module. Refer back to Figure 6-8.

5. Use a knife to sever the silicon adhesive that holds the Socket board to the neck of the crt.

6. Unplug the Socket board from the neck of the crt. It remains attached to the other circuit boards via several wires.

7. To remove the crt, follow the same general procedure that starts on page 6-14. Refer to Figure 6-10 for the exact locations of the crt mounting nuts.

8. Gently rock the crt assembly out of the front of the terminal and onto its face.

Removing the HV brick:

CAUTION

The HV brick is part of the Main board assembly. If you need to remove the HV brick as a separate item, be sure to read the procedure.

9. Discharge the crt anode.

10. Disconnect the HV cable from the crt.

11. Unscrew the brick's four mounting screws. The brick remains connected to the Main board via a high-tension wire.

REMOVING THE MAIN CIRCUIT BOARD, SOCKET BOARD, AND THE VIDEO INTERFACE BOARD

Before attempting to remove the Display Module's boards, remove the terminal's logic boards (TCB, DCB, RAM3 and CX I/F). You do NOT need to remove the crt to remove the Display Module boards.

1. Use a knife to sever the silicon adhesive that holds the Socket board to the crt. Then, unplug the Socket board from the crt.

2. The Socket board is connected to the Main board via several wires. Generally, the Socket board is replaced with the Main board. However, if you must remove the Socket board separately, then unsolder these connecting wires.

3. The Main board is fastened to the chassis by four slotted mounting blocks (one on each side and in the back). Each of these blocks is attached to the chassis with one screw, accessible only through the bottom of the terminal.

   Set the terminal on its side, and unscrew only two of the four screws. Then, lift the Main board out of the display.

4. To remove the Analog Interface board, first unplug all wire connectors from the board. Using needlenose pliers, pinch the ends of the four plastic standoffs; then remove the board, shield and standoffs as a single unit.

REMOVING THE FILTER BOARD

To remove the AC input Filter board, first remove the logic boards from the terminal. Then, turn the terminal on its side. From the under-side of the Display Module, unscrew the Filter board's two mounting screws. Then unsolder the wires that connect this board to the Main circuit board. This releases the Filter board.

DISASSEMBLING THE KEYBOARD MODULE

The Keyboard Module is physically separate from the main terminal. It is only connected by a 5-conductor cord. This procedure describes the steps in unplugging the keyboard, and in disassembling it into its component parts. Steps 1 through 5 tell how to access the inside of the Keyboard Module. Steps 6 through 8 describe removal of the keyboard cable. And, steps 9 through 12 tell how to remove the keypad assembly.

1. Unplug the keyboard cable from its five-conductor connector on the terminal's rear panel.

2. Unscrew the four screws in the corners of the keyboard bottom panel. See Figure 6-20.

3. Flip the elevating bails outward, as in Figure 6-20.

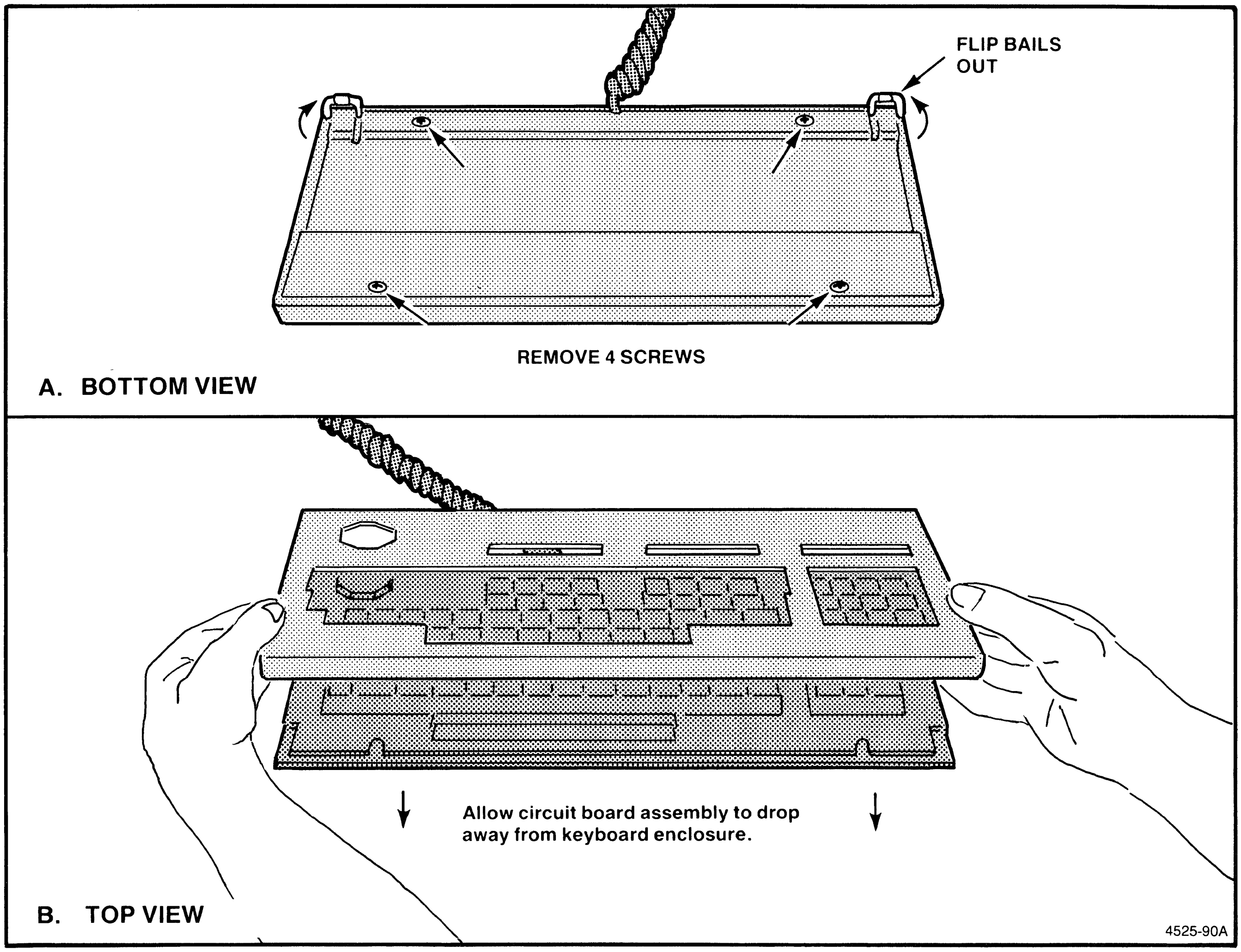


Figure 6-20. Separating the Keyboard Enclosure From the Keyboard and Bottom Panel.

4. Pull the circuit board and keypad assembly away from the underside of the keyboard enclosure.
5. Unscrew the two screws that attach the bottom panel to the circuit board and keypad assembly. These two screws act as a hinge. See Figure 6-21.
6. Unplug the keyboard-cable's ground wire from its spade-lug connector.
7. Unplug the five-pin keyboard-cable connector.
8. Remove the ¼-inch nut and lock washer in Figure 6-22, and remove the cable's strain relief strap.

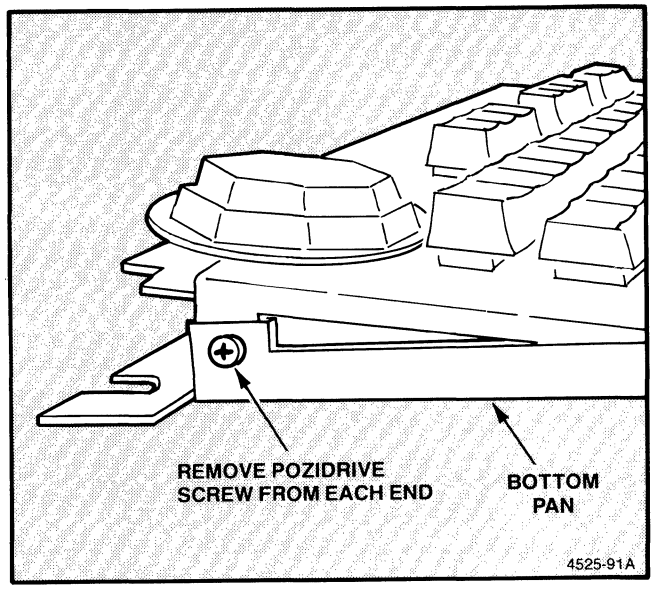


Figure 6-21. Removing the Keyboard Bottom Panel.

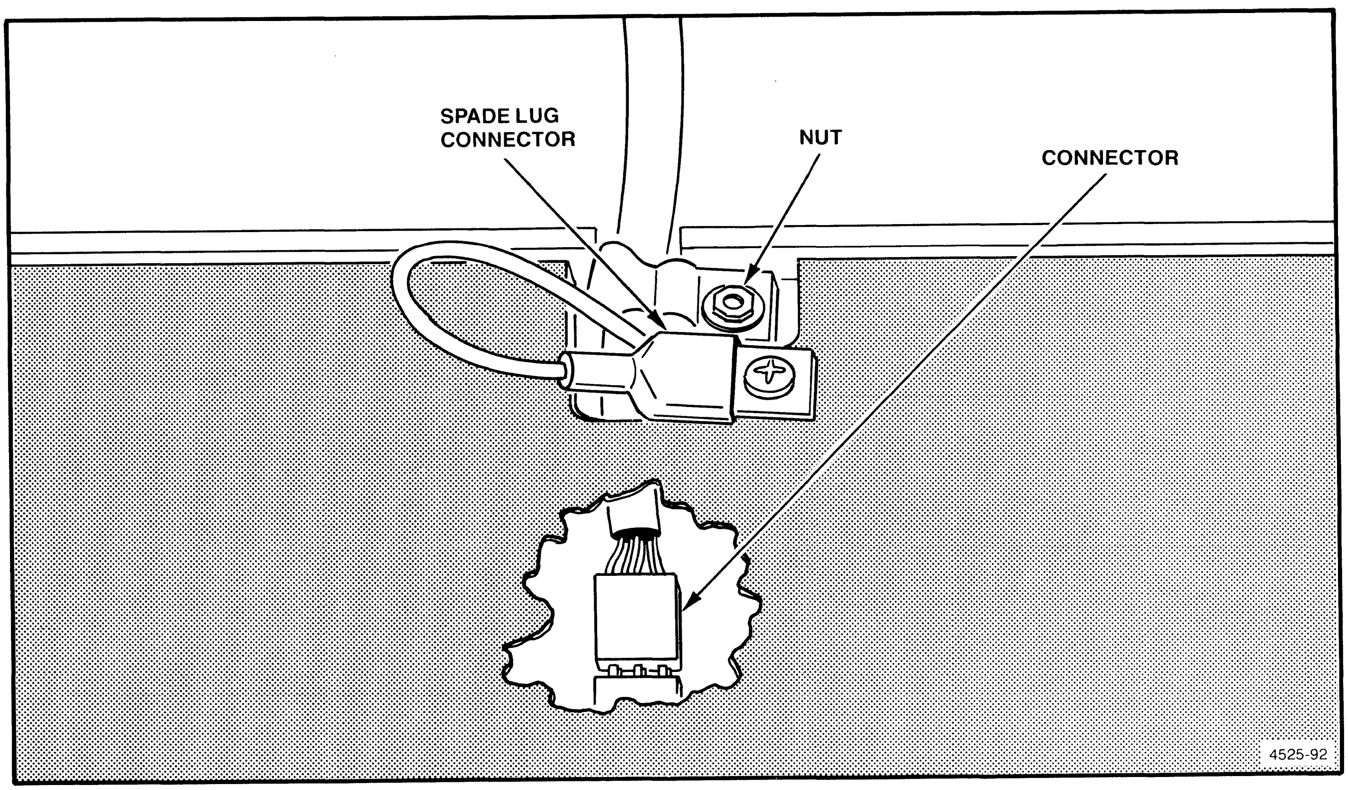


Figure 6-22. Disconnecting the Keyboard Cable.

9. Unscrew the 13 small Phillips screws from the Keyboard circuit board. See Figure 6-23.

10. Now, unscrew the three screws from the circuit board, also shown in Figure 6-23.

11. Unscrew one screw from the keypad's metal housing (located between the "Menu" and "F1" keys, on the opposite side of the keyboard).

12. Now separate the keypad assembly from the circuit board. The key switches are now accessible for cleaning or repair.

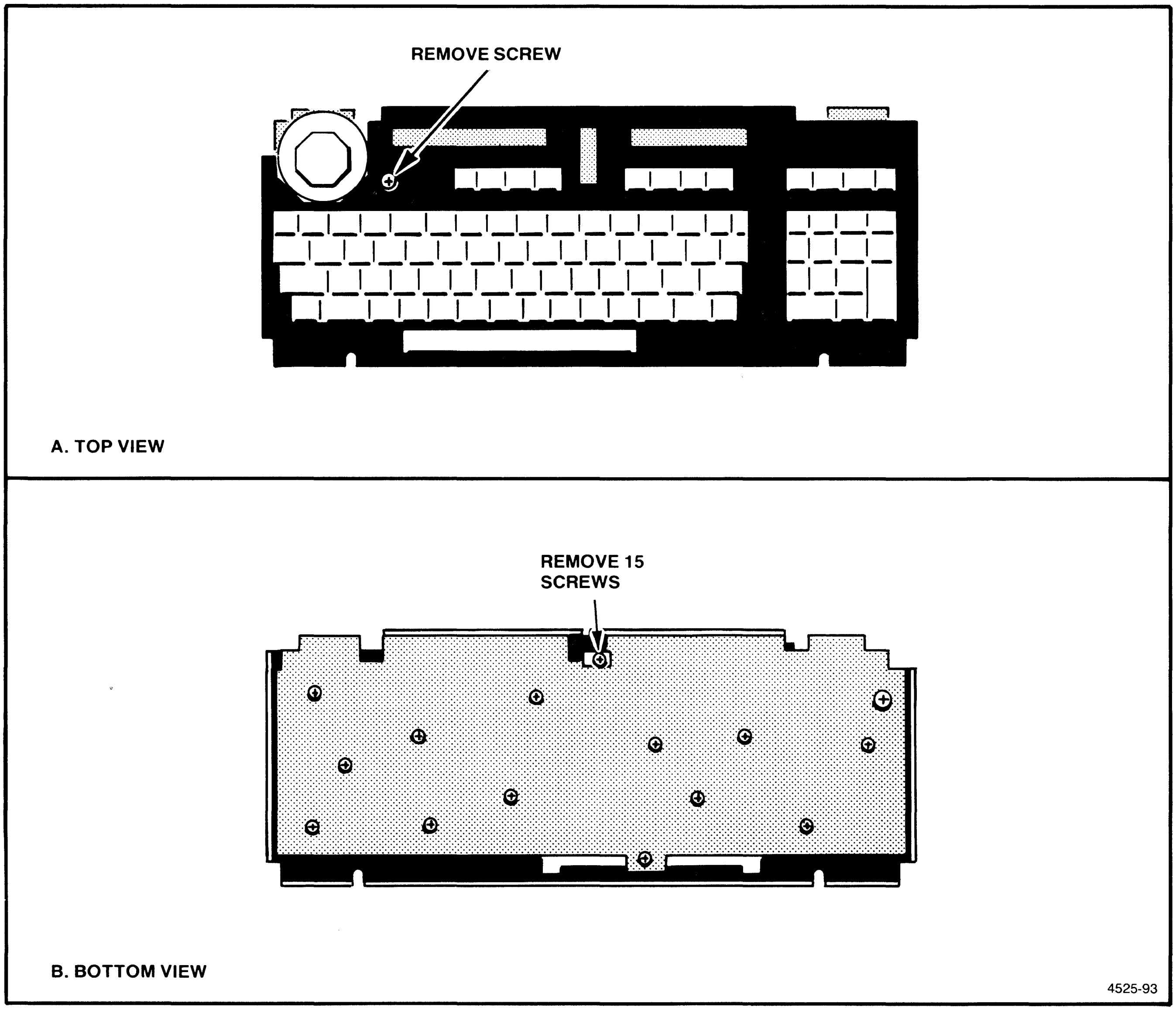


Figure 6-23. Keyboard Circuit Board Mounting Screws.

Replacing Keyboard Key Caps

You can remove a key cap by simply pulling straight up on the key. A gripping device, such as a rubber glove, can facilitate removing key caps from their switches. It is not necessary to remove the keyboard from the terminal to replace a keycap.

1. Position the key so that its label is pointing in the proper direction (not upside down or sideways). See Figure 6-24.
2. Now insert the fork (under the cap) into the receptacle in the key switch plunger. Be sure the spring is still in place (around the plunger). Push the keycap all the way onto the switch so that it rests level with the other keys when released.

NOTE

The BREAK key has a stronger spring than all the other keys. This feature prevents a touch-typist from accidentally exiting a program while typing.

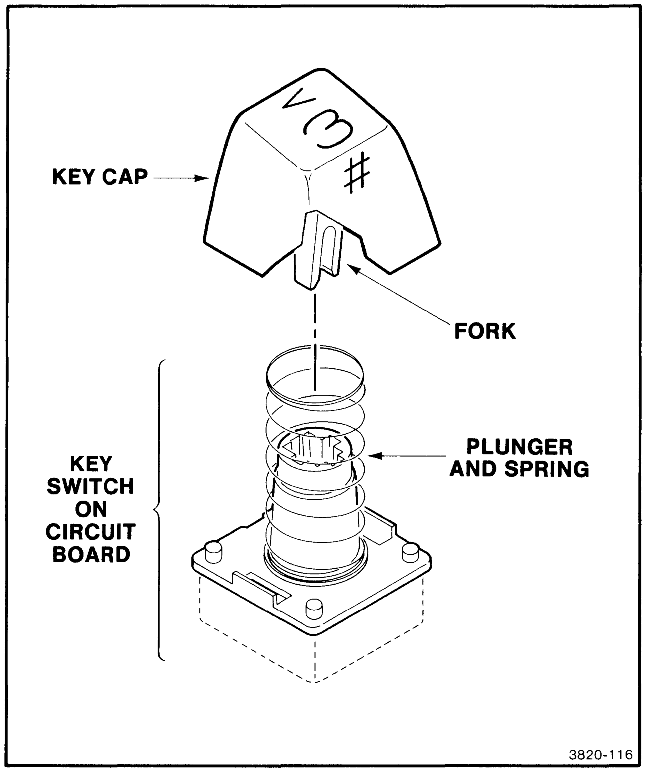


Figure 6-24. Installing Replacement Key Cap.

Replacing the Joydisk

The joydisk mounts on the keypad assembly with a pivot, screw, nut, and spring. The spring holds tension between the pivot point and the nut (that threads onto the screw). See Figure 6-25.

To remove the joydisk, unscrew the nut by hand. With the joydisk removed, you can clean or replace its capacitive pads.

When installing the Joydisk, place the disk so its screw goes into the hole in the keypad. Then place the spring over the screw, and thread the nut onto the screw (compressing the spring). Adjust the spring tension by setting the nut to a distance of .240 inch from the keypad bottom surface. See Figure 6-25 again.

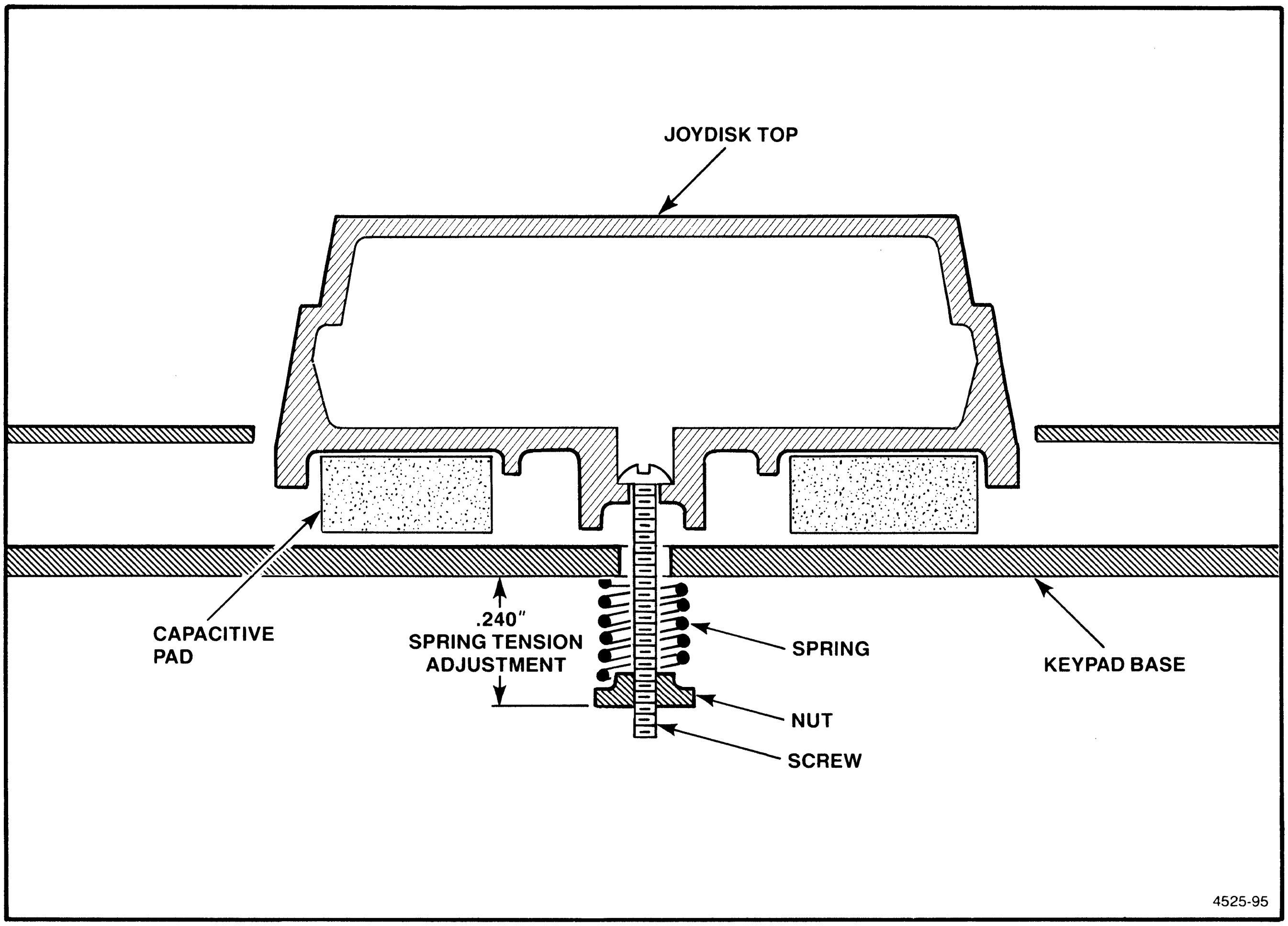


Figure 6-25. Installing the Joydisk and Adjusting the Spring Tension.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Fault isolation for the 4109 is best handled in the following manner. Carefully observe all symptoms of the problem and list them. Check the main user functions (Section 3) and note any problems. Then run Self Test and record the error message(s) displayed on the screen. (If the Display Module doesn't work, a crude message appears on the LEDs inside the back of the terminal.) After discovering which main module is malfunctioning, remove and repair, or replace it.

SELF TEST DIAGNOSTIC ROUTINE

Appendix C contains a complete description of the Self Test diagnostic program, and a list with explanations of all error messages. This program is designed such that the operator may run Self Test and report the findings to the local service center. This facilitates trouble shooting by narrowing the problem before the technician arrives.

The primary error reporting device is the display screen; all error messages are sent to the screen. If the display is faulty, no messages will appear while Self Test is running, but the bell will ring and LEDs may flash. This clue indicates a bad Display Module.

INITIAL/VISUAL CHECKS

Aside from Self Test, certain simple visual tests may help isolate a problem to the functional block level. The following basic suggestions help when trouble shooting the 4109.

Display Module Problems

The Display Module uses three-color, raster-scan technology, and is much like the display section of most color television receivers. Display problems may be grouped as follows:

- Blank screen – can mean
  - burned out filament in crt, or
  - loss of 25KV high voltage to crt, or
  - loss of low voltage to accelerating anodes of crt (from LV power supply module). If high voltage is low, check multiplier circuits.
- Low contrast – Check video amplifier stages and condition of crt.
- Dot of light – Check the horizontal and vertical deflection circuits. Lower the brightness to prevent crt phosphor damage.
- Only a horizontal line – Check the vertical deflection circuitry.
- Vertical line only (no deflection) – Check horizontal deflection circuits.
- Raster on screen but no information – Check the data path through the video amplifier sections.
- No color (only black and white) – Check the programming of the Color Map. (If white is pure, this means all three color guns are operational.)

These are customary checks when troubleshooting a color raster display.

The GMA301 Display Module contains three trouble-shooting lights. When lit, these LEDs verify that their circuit modules are functioning properly. Figure 6-26 shows the locations of these lights.

- LV light — confirms that all LV board outputs are present.
- HV light — says the HV board outputs are present.
- Deflection light — says the Deflection board is producing vertical scans.

The CX Interface board has a green LED, that flashes to indicate that it is functioning properly.

COMPONENT LEVEL REPAIR PROCEDURES

The use of Self Test and visual checks whould provide fault isolation to the board/module level. Normally the defective board/module is sent to a regional service center where component level repairs are performed with ease. If on-site component repairs are necessary, follow these checks.

- Check the power inputs to various chips on the board to verify that +5V or +12V is reaching all parts of the board. (First, verify that the power supply works.)
- Examine the board for obvious signs of excessive heat (especially on analog or discrete circuitry, such as the Display Module boards and power supply board).
- If the bell fails, examine/replace the small round transducer, located just above the processor (on the Terminal Control board).
- Replace the crt if one gun fails. See procedure earlier in this section.

NOTE

Certain components, such as High-Voltage supplies or high-efficiency circuits, may produce excessive and harmful radiation if replaced by non-Tektronix parts. Such components are identified in the electrical parts list (Section 9).

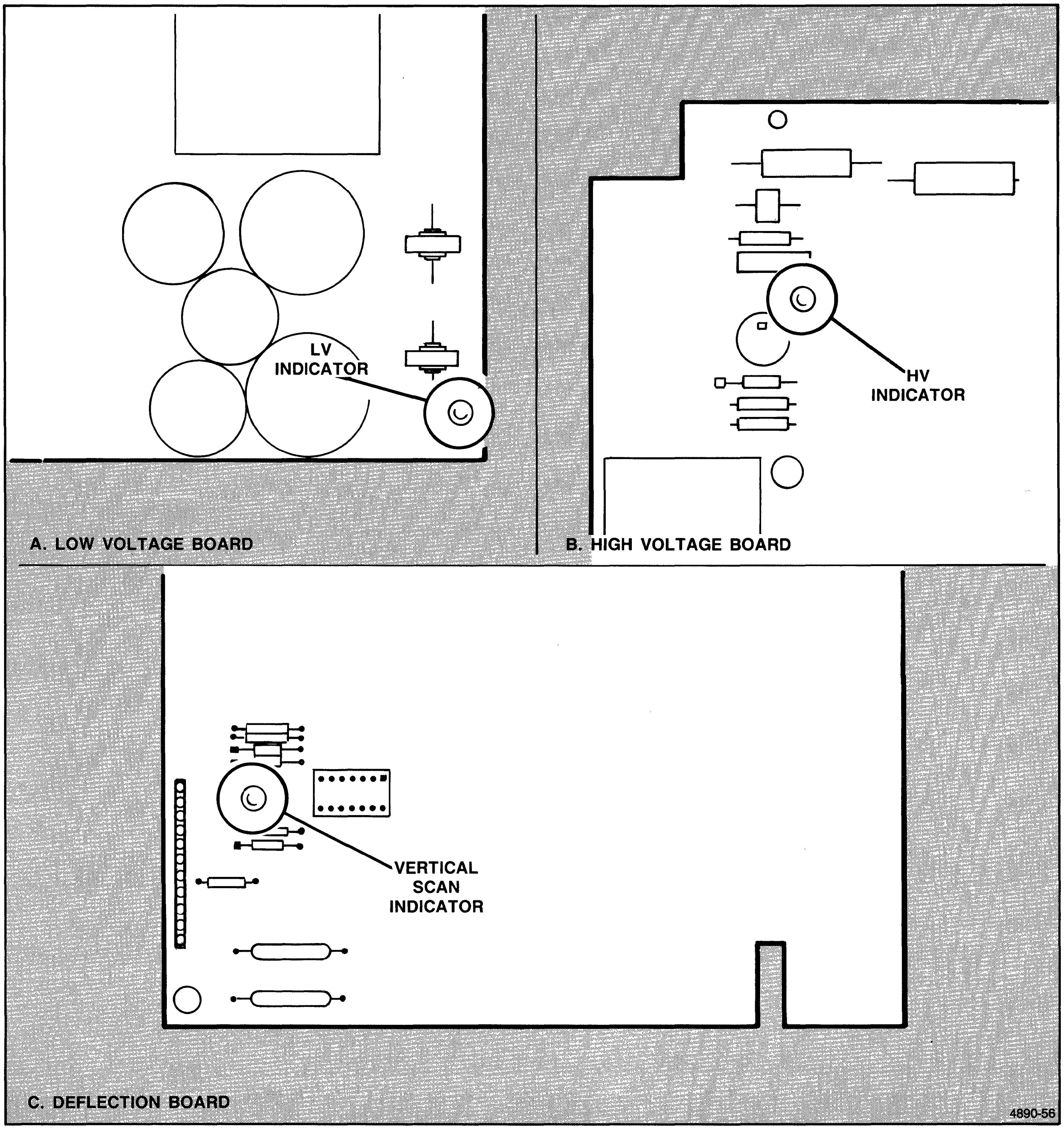


Figure 6-26. GMA301 Display Module Indicator Lights.

Section 7

OPTIONS

LIST OF OPTIONS

Table 7-1 lists the terminal options in numerical order. Option numbers beginning with an alpha designation are grouped at the end of the table.

Table 7-1

4109/CX OPTIONS

Option #	Description
Option 4A	United Kingdom keyboard option
Option 4B	French keyboard option
Option 4C	Swedish keyboard
Option 4F	Danish/Norwegian keyboard
Option 4G	German keyboard
Power Cord Options:	
Option A1	European Power Cable (220V)
Option A2	U.K. Power Cable (240V)
Option A3	Australian Power Cable (240V)
Option A4	North America Power Cable (240V)
Option A5	Swiss Power Cable (240V)

OPTIONS 4A-4F INSTALLATION PROCEDURES

Five optional keyboards are available for this terminal:

- Option 4A – United Kingdom Keyboard
- Option 4B – French Keyboard
- Option 4C – Swedish Keyboard
- Option 4F – Danish/Norwegian
- Option 4G – German

Changing a standard (North American) keyboard to one of the optional keyboards is accomplished by exchanging keyboard units.

First, unplug the cable of the standard keyboard from its connector on the back of the display unit.

Then, plug the cable from the optional keyboard into the same connector.

(No change in EEPROMs is required.)

Section 8

INSTALLATION

This section covers unpacking, installing, and checkout of the terminal. This section also provides repackaging instructions if reshipment of the terminal is necessary.

Installation consists of unpacking the terminal, checking for correct options and accessories, checking operating voltage and fuse selection, connecting the terminal to a host computer, applying power, running Self Test, and verifying communications between the host computer and the terminal.

The terminal is preassembled and requires no assembly for initial installation. The only options to the terminal are external, and do not require disassembly of the terminal. Installation of optional keyboards and the Adjustable Display Stand are described later in this section.

UNPACKING THE TERMINAL

You may want to refer to Figure 8-5 to see how the pieces are arranged inside the shipping carton. Then, follow this procedure:

WARNING

Lifting awkward or heavy objects can cause personal injury. When moving the shipping carton or the terminal, be sure to use recommended safe lifting methods (or have an assistant help) to avoid back injury.

1. Cut the strapping bands from the carton.
2. Slide the Outer Carton from over the foam pads and Pallet.
3. Remove the Keyboard Container box and the Accessory Box.
4. Pull the foam pieces from each side of the terminal.
5. Lift the terminal off of the Pallet and inspect for obvious damage.
6. RETAIN THE PACKING MATERIALS in case shipping damage requires repackaging for repair; see repackaging instructions at the end of this section.
7. Remove the accessories from the Accessory Box, and see that the enclosed packing list corresponds to included standard accessories and ordered optional accessories.

Standard accessories included with the terminal are:

- *4106/4107/4109 CDT Operators Manual* or *CX4100 Series CDT Operators Manual*
- Power cord (U.S., U.K., Australian, or European)
- Keyboard module with connecting cord (North American, U.K., French, Danish/Norwegian, Swedish, German, or Katakana).
- *4106/4107/4109/CX CDT Reference Guide*
- *4106/4107/4109/CX CDT Programmers Reference Manual*
- *CX4100 Series CDT Host Support Manual* (CX4109 only)
- Function Key Overlays

Optional accessories available include:

- *4109/CX CDT Service Manual*
- *Display Module for GMA301/4109, Service Manual*
- RS-232 Host Port cable
- RS-232 Loop-back connector
- Copier Port Loop-back connector
- Display screen alignment graticule

INSTALLATION PROCEDURE

Installation of the terminal does not require accessing any internal parts. Only qualified service technicians should open the terminal's cover; in such cases all cautions and warnings must be observed.

WARNING

Dangerous voltages exist within the terminal. Normal electrical precautions should be observed whenever working inside the terminal.

SITE SELECTION

The terminal is intended for use in normal office or research/design environments. Tektronix terminals are engineered to withstand semi-harsh operating environments; see Section 2 (Specification) for detailed operating limits.

The terminal will operate in a temperature environment between +10 °C and +40°C. The 4109/CX4109's maximum heat dissipation is 900 BTU/hour; this information may be used to calculate loading on the air-conditioning system (significant only when installing a large number of terminals).

Provide a power source that allows surge currents of 45 A (at nominal 120V line voltage).

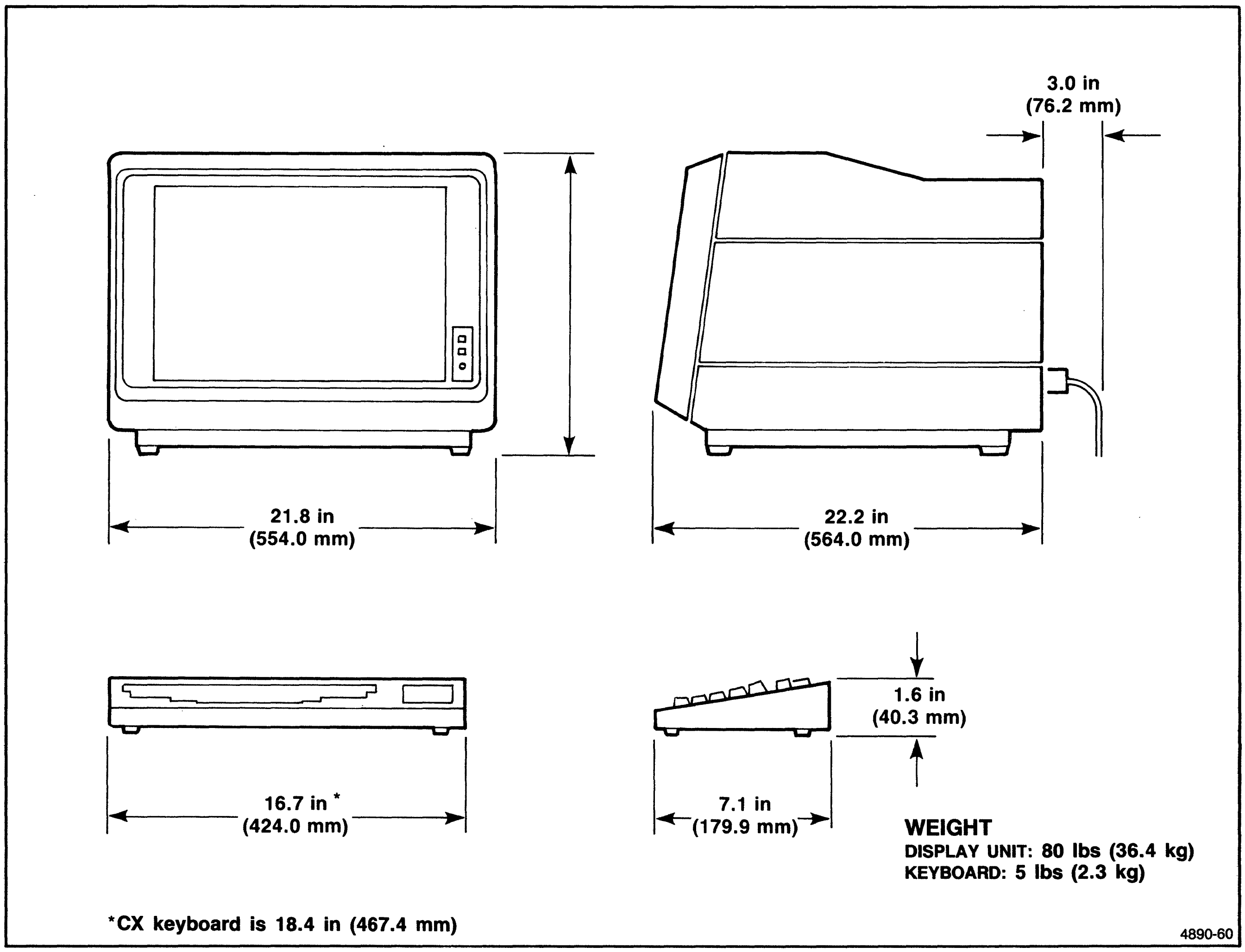


Figure 8-1. Overall Physical Dimensions.

Once the terminal is unpacked, place it on a stable desktop or the place it is to be used. Figure 8-1 shows the dimensions of the terminal. This figure may be used to determine how much space is needed for the terminal. Notice that the Adjustable Display Stand adds to these dimensions.

Allow at least 3 inches of clearance behind the terminal, to ensure adequate cooling. Also, the terminal should not be placed near other equipment containing large motors, fans, or other electromagnetic devices. Large magnetic fields will distort the display image.

CONNECTING THE KEYBOARD CABLE

The keyboard is a separate unit and passes data and power to/from the terminal through its coiled cable. This cable connects to the rear of the terminal. Align the connector keyslot and prongs; then insert the cord connector (male) into the jack (female) labeled KBD, on the terminal. See Figure 8-2.

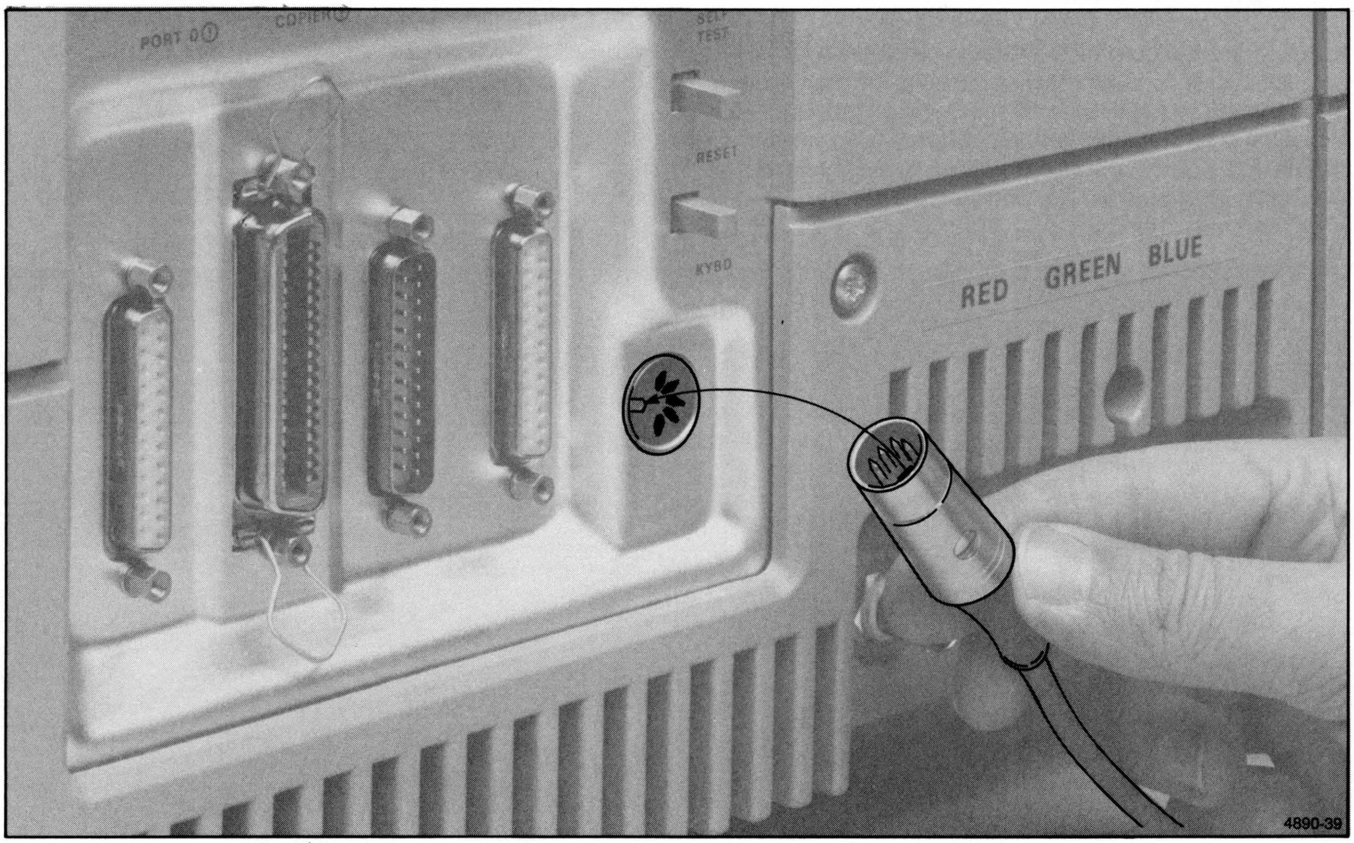


Figure 8-2. Rear Panel and Keyboard Cable Connector.

CONNECTING TO THE HOST COMPUTER

Connect the RS-232 cable to the COMPUTER connector on the rear of the terminal. Connect the other end of this cable to the modem or other computer connection. Access an active port to the host system.

If you are using a CX terminal on an IBM system, connect the Control Unit's coax cable to the COMM connector on the back of the terminal.

CONNECTING TO PERIPHERALS

Before connecting any peripheral device to the terminal, read the installation instructions and setup information in that peripheral's operators manual. Some peripherals make use of the programmable keys on the terminal to execute certain operations in the peripheral (such as copying part of the display). Become familiar with such information.

Connect those devices that use an RS-232C interface to the terminal's peripheral ports labeled, PORT 0 and PORT 1 (on the rear panel). See Figure 8-3. Such peripherals include TEKTRONIX 4660-series plotters, and the TEKTRONIX 4957 graphics tablet.

1. Plug the RS-232 cable into PORT 0 (or PORT 1).

2. Screw the plug-fasteners into each end of the RS-232 connector.

The TEKTRONIX 4690-series copiers/printers use a Centronics-type interface. Connect this type of peripheral device to the terminal's connector labeled: COPIER. This connector has two bails; slip them over the plug, securing it to the terminal. See Figure 8-4.

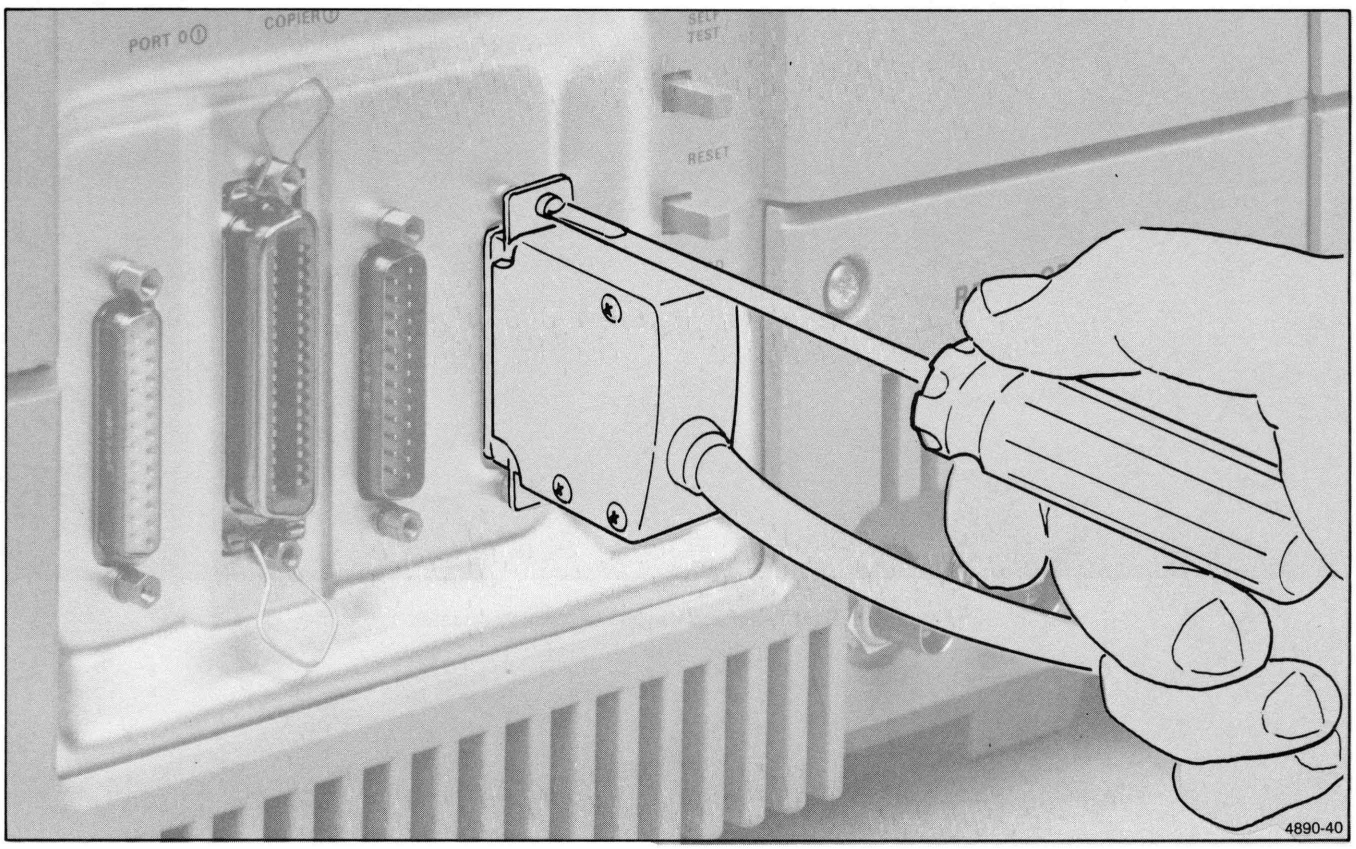


Figure 8-3. Connecting an RS-232 Cable to Peripheral Port 1.

APPLYING POWER

Before applying power, check the settings of the voltage selector switches. See that both voltage selector switches (on the rear panel) match the nominal voltage level of the AC power outlet that will supply the terminal.

Power is applied to the terminal by plugging the female end of the power cord into the AC power socket on the back panel. Then plug the male end of the same cord into the AC power outlet. Now, turn on the terminal by pressing the power button located near the lower right corner of the display screen. After the power is turned on, a cursor should appear in the upper left corner of the display screen.

After power is turned off, wait 5 seconds before turning power on again. This allows time for capacitors to discharge so the terminal will reset properly on power up.

RUNNING SELF TEST

The terminal is now connected to the computer and has power applied. However, you should run the Self Test program before logging onto the computer. This will verify that the terminal is functioning properly. Refer to Appendix C for explanations of any error messages that may appear on the screen. When Self Test is finished and all circuitry proves good, the cursor will blink in the upper left corner of the screen. It is ready for operation.

USING THE TERMINAL

Now you may log onto the host computer and use the 4109 or CX4109 as a terminal. Section 3, Operating Information, provides a complete explanation of how to use the terminal, once it is operational. You should use several system commands to satisfy yourself that the terminal performs as expected.

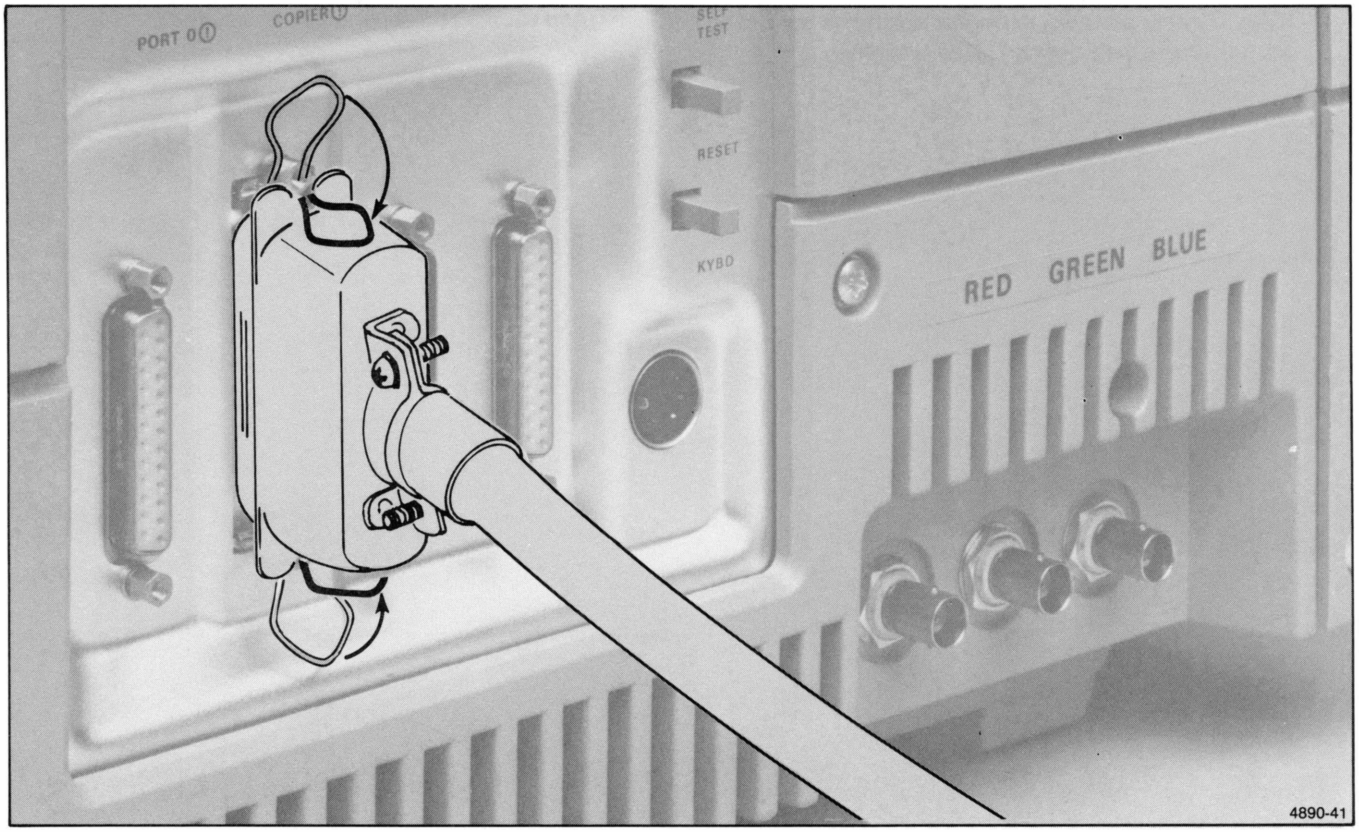


Figure 8-4. Connecting the Centronics-type Plug into COPIER Connector.

REPACKAGING THE TERMINAL

In the event that the terminal needs to be shipped, for servicing or to be used in a different location, follow this repackaging procedure. The following steps relate to Figure 8-5.

1. Set the Pallet (E) on the floor or on a table.
2. Place the Tray (D) in the cutout on the Pallet.
3. Set the terminal on the Tray.
4. Cover the right and left sides of the terminal with the foam Side Pads (B) and (G).
5. Place all manuals, cords, and other needed accessories in the Accessory Box (C). Ship only the items that are needed at the destination. Then set this box between the cutouts in the front of the two Side Pads.
6. Place the Keyboard Module in the Keyboard Container (I). The keys face up and the spacebar is toward the lid hinge. The cord passes through a notch and rests in a pocket across the front end of the container.
7. Place the Keyboard Container between the cutouts in the top-rear portion of the Side Pads.
8. Set up the Outer Carton (A) so the top flaps are up. Then turn the carton so the right and left bottom flaps are on the same sides as the cutaway sections under the Pallet.
9. Slip the carton over the foam Side Pads. Slide the carton down so it covers the Pallet.
10. Fold the bottom flaps up into the cutouts on each side of the Pallet.
11. Fold the top flaps closed and seal with packing tape.
12. Wrap the assembled carton with two Strapping Bands (F); first position the bands between the runners on the bottom of the Pallet, then wrap the bands up over the top of the Carton and fasten the ends together.
13. Label the carton with: model number, serial number, and source and destination as required.

This completes the procedure.

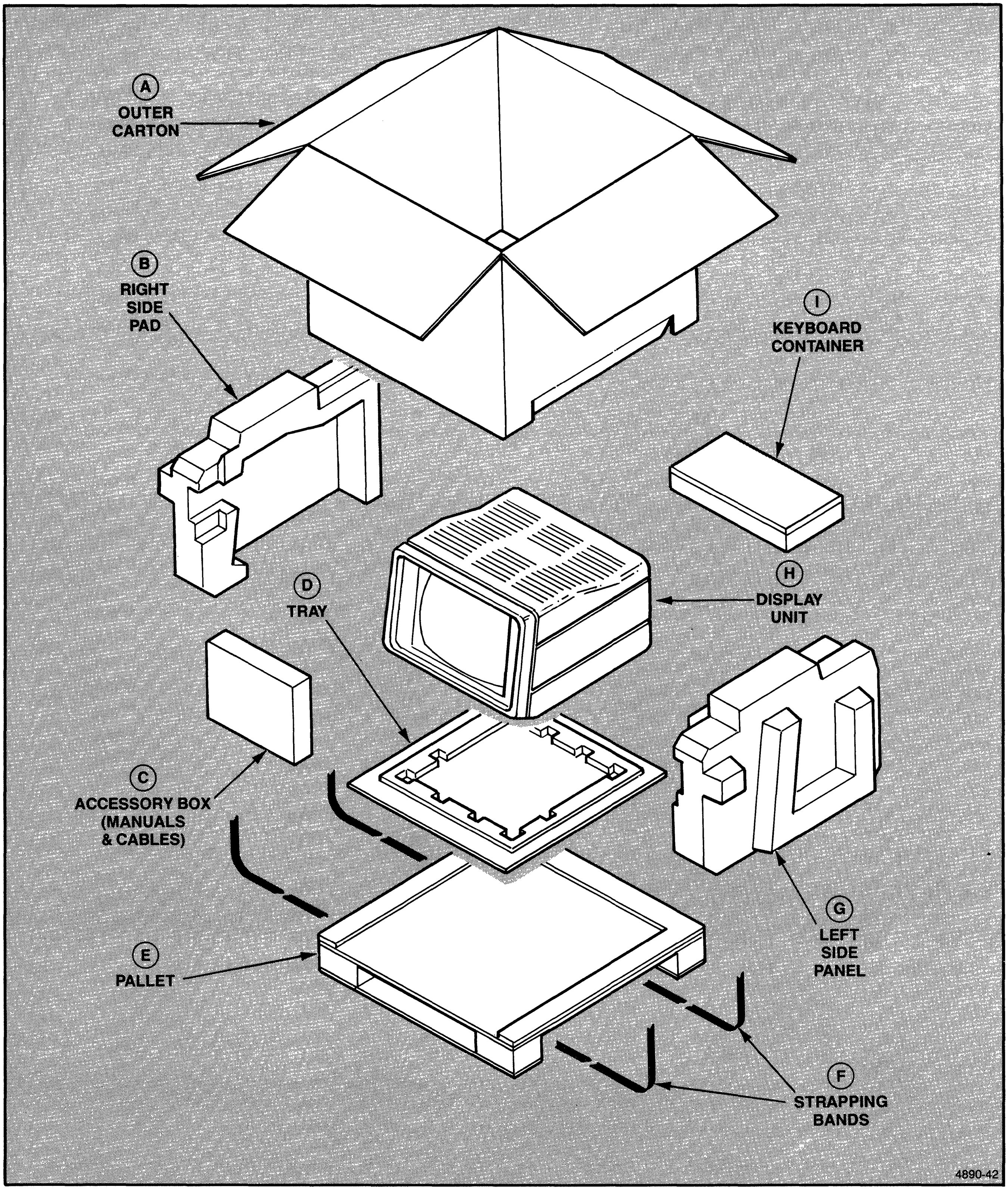


Figure 8-5. Repackaging Diagram.

Section 9
REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.

A23R1234 — component number: A23 (Assembly number) R1234 (Circuit number)

Read: Resistor 1234 of Assembly 23

Example b.

A23A2R1234 — component number: A23 (Assembly number) A2 (Subassembly number) R1234 (Circuit number)

Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00213	NYTRONICS COMPONENTS GROUP INC SUBSIDIARY OF NYTRONICS INC	ORANGE ST	DARLINGTON SC 29532
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
01537	MOTOROLA COMMUNICATIONS AND ELECTRONICS INC	2553 N EDGINGTON ST	FRANKLIN PARK IL 60131
02113	COILCRAFT INC	1102 SILVER LAKE RD	CARY IL 60013
02660	BUNKER RAMO CORP AMPHENOL NORTH AMERICA DIV	2801 S 25TH AVE	BROADVIEW IL 60153
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
05828	GENERAL INSTRUMENT CORP GOVERNMENT SYSTEMS DIV	600 W JOHN ST	HICKSVILLE NY 11802
07088	KELVIN ELECTRIC CO	5907 NOBLE AVE	VAN NUYS CA 91411
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP SEMICONDUCTOR DIV	464 ELLIS ST	MOUNTAIN VIEW CA 94042
07716	TRW INC TRW ELECTRONICS COMPONENTS TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
11236	CTS OF BERNE INC	406 PARR ROAD	BERNE IN 46711
12300	POTTER AND BRUMFIELD DIV AMF CANADA LTD	52 ROYAL RD P O BOX 698	GUELPH ONT CAN
12969	UNITRODE CORP	580 PLEASANT ST	WATERTOWN MA 02172
13511	AMPHENOL CADRE DIV BUNKER RAMO CORP		LOS GATOS CA
13606	SPRAGUE ELECTRIC CO TRANSISTOR DIVISION	PEMBROKE RD	CONCORD NH 03301
14193	CAL-R INC	1601 OLYMPIC BLVD	SANTA MONICA CA 90404
14433	ITT SEMICONDUCTORS DIV		WEST PALM BEACH FL
14552	MICRO/SEMICONDUCTOR CORP	2830 S FAIRVIEW ST	SANTA ANA CA 92704
14752	ELECTRO CUBE INC	1710 S DEL MAR AVE	SAN GABRIEL CA 91776
14936	GENERAL INSTRUMENT CORP DISCRETE SEMI CONDUCTOR DIV	600 W JOHN ST	HICKSVILLE NY 11802
15238	ITT SEMICONDUCTORS A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP	500 BROADWAY P O BOX 168	LAWRENCE MA 01841
15454	AMETEK INC RODAN DIV	2905 BLUE STAR ST	ANAHEIM CA 92806
15513	DATA DISPLAY PRODUCTS	303 N OAK ST	LOS ANGELES CA 90302
18324	SIGNETICS CORP	811 E ARQUES	SUNNYVALE CA 94086
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
20932	KYOCERA INC	11620 SORRENTO VALLEY RD	SAN DIEGO CA 92121
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
22753	UID SWITCHES INC DIV OF ILLINOIS TOOL WORKS INC	6615 W IRVING PARK RD	CHICAGO IL 60634
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
24972	AEG-TELEFUNKEN CORP	RT 22 ORR DR P O BOX 3800	SUMMERVILLE NJ 08876
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051
27264	MOLEX INC CORPORATE HQ	2222 WELLINGTON COURT	LISLE IL 60532
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE MN 55343
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
33095	SPECTRUM CONTROL INC	8061 AVONIA RD	FAIRVIEW PA 16415
34335	ADVANCED MICRO DEVICES	901 THOMPSON PL	SUNNYVALE CA 94086

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
34371	HARRIS SEMICONDUCTOR DIV OF HARRIS CORP	P O BOX 883	MELBOURNE FL 32901
34649	INTEL CORP	3065 BOWERS AVE	SANTA CLARA CA 95051
34899	FAIR-RITE PRODUCTS CORP	1 COMMERCIAL ROW	WALLKILL NY 12589
50364	MONOLITHIC MEMORIES INC	1165 E ARQUES AVE	SUNNYVALE CA 94086
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	640 PAGE MILL RD	PALO ALTO CA 94304
51181	KEYTRONICS INC	707 NORTH ST	ENDICOTT NY 13760
51642	CENTRE ENGINEERING INC	2820 E COLLEGE AVE	STATE COLLEGE PA 16801
52833	KEY TRONIC CORP OCR DIV	SPOKANE INDUSTRIAL PK P O BOX 14687	SPOKANE WA 99214
53848	SMC MICROSYSTEMS CORP	35 MARCUS BLVD	HAUPPAUGE NY 11787
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY	SECAUCUS NJ 07094
55112	WESTLAKE CAPACITORS INC	5334 STERLING CENTER DRIVE	WESTLAKE VILLAGE CA 91361
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
56289	SPRAGUE ELECTRIC CO	87 MARSHALL ST	NORTH ADAMS MA 01247
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
58361	GENERAL INSTRUMENT CORP OPTOELECTRONICS DIV	3400 HILLVIEW AVE	PALO ALTO CA 94304
59660	TUSONIX INC	2155 N FORBES BLVD	TUCSON, ARIZONA 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO TX 79915
60705	CERA-MITE CORPORATION	1327 6TH AVE	GRAFTON WI 53024
61271	FUJITSU MICRO ELECTRONICS INC	3320 SCOTT BLVD	SANTA CLARA CA 95051
62786	HITACHI AMERICA LTD	1800 BERING DRIVE	SAN JOSE CA 95122
71468	ITT CANNON ELECTRIC	10550 TALBERT PO BOX 8040	FOUNTAIN VALLEY CA 92728-8040
75042	TRW INC TRW ELECTRONIC COMPONENTS IRC FIXED RESISTORS PHILADELPHIA DIV	401 N BROAD ST	PHILADELPHIA PA 19108
75915	LITTELFUSE INC	800 E NORTHWEST HWY	DES PLAINES IL 60016
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
81312	WINCHESTER ELECTRONICS DIVISION LITTON SYSTEMS INC	MAIN STREET AND HILLSIDE AVENUE	OAKVILLE CT 06779
82389	SWITCHCRAFT INC SUB OF RAYTHEON CO	5555 N ELSTRON AVE	CHICAGO IL 60630
91637	DALE ELECTRONICS INC	P O BOX 609	COLUMBUS NE 68601
94617	BETTER COIL AND TRANSFORMER CORP	2001 W UNION	GOODLAND IN 47948
96733	SAN FERNANDO ELECTRIC MFG CO	1501 FIRST ST	SAN FERNANDO CA 91341
TK0213	TOPTRON CORP	TOKYO	JAPAN
TK0510	PANASONIC COMPANY DIV OF MATSUSHITA ELECTRIC CORP	ONE PANASONIC WAY	SECAUCUS NJ 07094
TK0515	RIFA WORLD PRODUCTS INC	19678 8TH STREET EAST P O BOX 517	SONOMA CA 95476
TK1345	ZMAN AND ASSOCIATES	7633 S 180TH	KENT WA 98032
TK1481	INTECH MICROCIRCUIT DIV	2270 MARTIN AVE	SANTA CLARA CA 95050
TK1483	TEKA PRODUCTS INC	45 SALEM ST	PROVIDENCE RI 02907
TK1601	PULSE ENGINEERING INC	1680 THE ALAMEDA	SAN JOSE CA 95126
TK1645	RIFA AB	S-16381	STOCKHOLM SWEDEN
TK1815	NOBLE - USA ELECTRONIC COMPONENTS GROUP	151 STANLEY ST	ELKGROVE VILLAGE IL 60007

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A	020-1407-00	B010100	B010996	COMPONENT KIT:V8 FIRMWARE (4109A)	80009	020-1407-00
A	020-1407-02	B010997		COMPONENT KIT:V8.2 (4109A)	80009	020-1407-02
A	020-1407-00	B010100	B010188	COMPONENT KIT:V8 FIRMWARE (CX4109A)	80009	020-1407-00
A	020-1407-02	B010189		COMPONENT KIT:V8.2 (CX4109A)	80009	020-1407-02
A1	670-8234-01	B010100	B010329	CIRCUIT BD ASSY:TERMINAL CONTROL (4109 ONLY)	80009	670-8234-01
A1	670-8234-16	B010330	B011278	CIRCUIT BD ASSY:TERMINAL CONTROL (4109 ONLY)	80009	670-8234-16
A1	670-8234-20	B011279	B011299	CIRCUIT BD ASSY:TERMINAL CONTROL (4109 ONLY)	80009	670-8234-20
A1	670-8776-00	B011300	B022670	CIRCUIT BD ASSY:TERMINAL CONTROL (4109 ONLY)	80009	670-8776-00
A1	670-8814-40	B022671		CIRCUIT BD ASSY:TERMINAL CONTROL (4109 ONLY)	80009	670-8814-40
A1	670-8814-00	B010100	B010153	CIRCUIT BD ASSY:TERMINAL CONTROL (CX4109 ONLY)	80009	670-8814-00
A1	670-8814-40	B010154		CIRCUIT BD ASSY:TERMINAL CONTROL (CX4109 ONLY)	80009	670-8814-40
A1	670-8814-40	B010100	B032182	CIRCUIT BD ASSY:TERMINAL CONTROL (4109A ONLY)	80009	670-8814-40
A1	670-8814-41	B032183		CIRCUIT BD ASSY:TERMINAL CONTROL (4109A ONLY)	80009	670-8814-41
A1	670-8814-40	B010100	B020245	CIRCUIT BD ASSY:TERMINAL CONTROL (CX4109A ONLY)	80009	670-8814-40
A1	670-8814-41	B020246		CIRCUIT BD ASSY:TERMINAL CONTROL (CX4109A ONLY)	80009	670-8814-41
A1C20	285-1257-00	670-8234-01	670-8234-20	CAP,FXD,PLASTIC:0.0056UF,10%,200V (4109 ONLY)	13606	192P56292M480
A1C25	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C25	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C25	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C26	290-0745-00	B010100	B020340	CAP,FXD,ELCTLT:22UF,+50-10%,25V (4109 ONLY)	54473	ECE-A25V22L
A1C26	290-0745-02	B020341		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (4109 ONLY)	55680	ULA1E220TEA
A1C26	290-0745-00	B010100	B020222	CAP,FXD,ELCTLT:22UF,+50-10%,25V (CX4109 ONLY)	54473	ECE-A25V22L
A1C26	290-0745-02	B020223		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (CX4109 ONLY)	55680	ULA1E220TEA
A1C30	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C30	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C30	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C31	290-0804-00	B010100	B020340	CAP,FXD,ELCTLT:10UF,+50-10%,25V (4109 ONLY)	55680	ULB1E100TAAANA
A1C31	290-0804-02	B020341		CAP,FXD,ELCTLT:10UF,20%,25V (4109 ONLY)	55680	ULB1E100TAAANA
A1C31	290-0804-00	B010100	B020222	CAP,FXD,ELCTLT:10UF,+50-10%,25V (CX4109 ONLY)	55680	ULB1E100TAAANA
A1C31	290-0804-02	B020223		CAP,FXD,ELCTLT:10UF,20%,25V (CX4109 ONLY)	55680	ULB1E100TAAANA
A1C35	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A1C40	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C40	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL	04222	MA105E104ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(4109 ONLY)		
A1C40	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C50	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C50	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C50	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C60	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C60	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C60	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C70	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C70	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C70	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C80	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C80	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C80	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C90	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C90	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C90	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C125	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C125	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C125	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C126	283-0005-00	670-8234-20		CAP,FXD,CER DI:0.01UF,+100-0%,250V (4109 ONLY)	04222	SR303E103ZAA
A1C130	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C130	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C130	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C135	283-0144-00	670-8234-00	670-8234-20	CAP,FXD,CER DI:33PF,2%,500V (4109 ONLY)	59660	801-547P2G330G
A1C135	281-0819-00	670-8776-00		CAP,FXD,CER DI:33 PF,5%,50V (4109 ONLY)	04222	GC105A330J
A1C135	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (CX4109 ONLY)	04222	GC105A330J
A1C140	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C140	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C140	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C145	290-0745-00	B010100	B020340	CAP,FXD,ELCTLT:22UF,+50-10%,25V (4109 ONLY)	54473	ECE-A25V22L
A1C145	290-0745-02	B020341		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (4109 ONLY)	55680	ULA1E220TEA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1C145	290-0745-00	B010100	B020222	CAP,FXD,ELCTLT:22UF,+50-10%,25V (CX4109 ONLY)	54473	ECE-A25V22L
A1C145	290-0745-02	B020223		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (CX4109 ONLY)	55680	ULA1E220TEA
A1C150	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C150	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C150	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C160	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C160	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C160	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C170	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C170	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C170	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C180	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C180	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C180	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C190	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C190	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C190	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C235	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C235	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C235	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C240	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C240	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C240	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C245	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C245	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C245	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C250	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C250	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C250	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C255	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C255	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C255	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL	04222	MA105E104ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(CX4109 ONLY)		
A1C260	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C260	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C260	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C265	290-0745-00	B010100	B020340	CAP,FXD,ELCTLT:22UF,+50-10%,25V (4109 ONLY)	54473	ECE-A25V22L
A1C265	290-0745-02	B020341		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (4109 ONLY)	55680	ULA1E220TEA
A1C265	290-0745-00	B010100	B020222	CAP,FXD,ELCTLT:22UF,+50-10%,25V (CX4109 ONLY)	54473	ECE-A25V22L
A1C265	290-0745-02	B020223		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (CX4109 ONLY)	55680	ULA1E220TEA
A1C270	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C270	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C270	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C275	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C275	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C275	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C280	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C280	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C280	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C285	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C285	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C285	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C290	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C290	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C290	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C335	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C335	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C335	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C340	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C340	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C340	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C345	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C345	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C345	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1C375	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C375	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C375	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C380	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C380	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C380	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C425	290-0745-00	B010100	B020340	CAP,FXD,ELCTLT:22UF,+50-10%,25V (4109 ONLY)	54473	ECE-A25V22L
A1C425	290-0745-02	B020341		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (4109 ONLY)	55680	ULA1E220TEA
A1C425	290-0745-00	B010100	B020222	CAP,FXD,ELCTLT:22UF,+50-10%,25V (CX4109 ONLY)	54473	ECE-A25V22L
A1C425	290-0745-02	B020223		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (CX4109 ONLY)	55680	ULA1E220TEA
A1C435	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C435	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C435	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C437	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C437	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C437	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C440	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C440	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C440	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C445	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C445	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C445	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C495	290-0745-00	B010100	B020340	CAP,FXD,ELCTLT:22UF,+50-10%,25V (4109 ONLY)	54473	ECE-A25V22L
A1C495	290-0745-02	B020341		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (4109 ONLY)	55680	ULA1E220TEA
A1C495	290-0745-00	B010100	B020222	CAP,FXD,ELCTLT:22UF,+50-10%,25V (CX4109 ONLY)	54473	ECE-A25V22L
A1C495	290-0745-02	B020223		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (CX4109 ONLY)	55680	ULA1E220TEA
A1C496	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C496	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C496	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C497	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C497	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C535	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(4109 ONLY)		
A1C535	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C535	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C540	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C540	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C540	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C545	283-0423-00	B010100	B011343	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A1C545	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C545	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C591	283-0156-00	670-8234-00	670-8234-20	CAP,FXD,CER DI:0.001 UF,+80-20%,200V (4109 ONLY)	05397	C315C102Z2R5CA
A1C591	281-0770-00	670-8776-00		CAP,FXD,CER DI:1000PF,20%,100V (4109 ONLY)	04222	MA101C102MAA
A1C591	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V (CX4109 ONLY)	04222	MA101C102MAA
A1C592	283-0156-00	670-8234-00	670-8234-20	CAP,FXD,CER DI:0.001 UF,+80-20%,200V (4109 ONLY)	05397	C315C102Z2R5CA
A1C592	281-0770-00	670-8776-00		CAP,FXD,CER DI:1000PF,20%,100V (4109 ONLY)	04222	MA101C102MAA
A1C592	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V (CX4109 ONLY)	04222	MA101C102MAA
A1C594	283-0167-00	B010100	B011343	CAP,FXD,CER DI:0.1UF,10%,100V (4109 ONLY)	04222	3430-100C-104K
A1C594	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C594	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C597	283-0156-00	670-8234-00	670-8234-20	CAP,FXD,CER DI:0.001 UF,+80-20%,200V (4109 ONLY)	05397	C315C102Z2R5CA
A1C597	281-0770-00	670-8776-00		CAP,FXD,CER DI:1000PF,20%,100V (4109 ONLY)	04222	MA101C102MAA
A1C597	281-0720-00			CAP,FXD,CER DI:1750PF,+80-20%,250V (CX4109 ONLY)	33095	51-707-002
A1C598	283-0167-00	B010100	B011343	CAP,FXD,CER DI:0.1UF,10%,100V (4109 ONLY)	04222	3430-100C-104K
A1C598	281-0913-00	B011344		CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A1C598	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A1C599	290-0745-00	B010100	B020340	CAP,FXD,ELCTLT:22UF,+50-10%,25V (4109 ONLY)	54473	ECE-A25V22L
A1C599	290-0745-02	B020341		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (4109 ONLY)	55680	ULA1E220TEA
A1C599	290-0745-00	B010100	B020222	CAP,FXD,ELCTLT:22UF,+50-10%,25V (CX4109 ONLY)	54473	ECE-A25V22L
A1C599	290-0745-02	B020223		CAP,FXD,ELCTLT:22UF,+50-10%,25V,ALUMINUM (CX4109 ONLY)	55680	ULA1E220TEA
A1CR20	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR31	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR33	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR395	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR396	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR397	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR481	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1CR482	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR486	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR491	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR525	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR526	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR527	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR528	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR596	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR597	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1DS273	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX	58361	Q6878/MV5074C
A1DS275	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX	58361	Q6878/MV5074C
A1DS280	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX	58361	Q6878/MV5074C
A1J13	131-2964-00			CONN,RCPT,ELEC:FEMALE,3 X 32,RTANG	81312	096S-6043-0731-0
A1J21	131-2898-00			CONN,RCPT,ELEC:PCB MOUNT,36 CONTACT	02660	57-40360-22-398
A1J22	131-0813-00			CONN,RCPT,ELEC:CKT BD MT,25 CONT,MALE	13511	777-DB-25P-T
A1J25	131-1741-00			CONN,RCPT,ELEC:PCB MOUNT,5 CONTACT	82389	57NC5F
A1J28	131-2964-00			CONN,RCPT,ELEC:FEMALE,3 X 32,RTANG	81312	096S-6043-0731-0
A1L597	108-0474-00			COIL,RF:FIXED,2UH	80009	108-0474-00
A1L599	108-0474-00			COIL,RF:FIXED,2UH	80009	108-0474-00
A1LS20	119-1427-00	B010100	B017404	XDCR,AUDIO:6V,30MA,1-4.2KHZ (4109 ONLY)	TK1066	QMB-06 (SEALED)
A1LS20	119-1427-01	B017405		XDCR,AUDIO:1-4.2KHZ,30MA,6V (4109 ONLY)	TK1066	QMB-06
A1LS20	119-1427-00	B010100	B010153	XDCR,AUDIO:6V,30MA,1-4.2KHZ (CX4109 ONLY)	TK1066	QMB-06 (SEALED)
A1LS20	119-1427-01	B010154		XDCR,AUDIO:1-4.2KHZ,30MA,6V (CX4109 ONLY)	TK1066	QMB-06
A1P11	131-2908-00			CONN,RCPT,ELEC:CKT BD,1 X 10,0.156 SPACING	27264	09-62-3102
A1P20	131-0971-00			CONN,RCPT,ELEC:CKT BD MT,25 CONTACT,FEMALE	71468	DB25-SH
A1P23	131-0971-00			CONN,RCPT,ELEC:CKT BD MT,25 CONTACT,FEMALE	71468	DB25-SH
A1Q38	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A1Q39	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A1Q135	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A1R19	315-0472-00	670-8776-00		RES,FXD,FILM:4.7K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E04K7
A1R19	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E04K7
A1R20	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R21	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R33	321-0217-00			RES,FXD,FILM:1.78K OHM,1%,0.125W,TC=T0	19701	5043D1K780F
A1R34	321-0227-00			RES,FXD,FILM:2.26K OHM,1%,0.125W,TC=T0	01121	RNK2261F
A1R37	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A1R38	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A1R39	315-0122-00			RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A1R130	315-0122-00			RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A1R131	315-0221-00			RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
A1R134	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A1R135	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A1R137	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A1R150	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R240	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R251	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R252	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R253	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R282	315-0472-00	670-8776-00		RES,FXD,FILM:4.7K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E04K7
A1R285	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R286	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R287	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1R295	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R350	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E04K7
A1R350	315-0471-00	670-8814-41		RES,FXD,FILM:470 OHM,5%,0.25W (4109A/CX ONLY)	57668	NTR25J-E470E
A1R351	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
A1R355	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R356	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R357	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R358	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R359	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R360	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R361	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R362	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R363	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R364	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R370	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E04K7
A1R371	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R395	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R396	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R397	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R398	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
A1R399	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
A1R426	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R427	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R435	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R436	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R437	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R438	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A1R445	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R446	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R447	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R448	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R449	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R450	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R473	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R474	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R475	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R480	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
A1R483	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R484	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
A1R485	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R490	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R491	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A1R591	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
A1S490	260-2111-00			SWITCH,PUSH:SPDT,MOMENTARY (4109 ONLY)	59821	2LL199NB021085
A1S493	260-2111-00			SWITCH,PUSH:SPDT,MOMENTARY (4109 ONLY)	59821	2LL199NB021085
A1U25	156-1065-01			MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A1U30	156-1735-00	670-8234-00	670-8234-20	MICROCKT,DGTL:NMOS,2048 X 8 EEPROM (4109 ONLY)	34649	D2817-3
A1U30	156-2140-00	670-8776-00		MICROCKT,DGTL:NMOS,2048 X 8 EPROM (4109/CX ONLY)	34649	2817A-4
A1U36	156-1631-00			MICROCKT,LINEAR:ADJUSTABLE SHUNT REGULATOR	01295	TL431C-LP
A1U40	156-1734-00	670-8814-40	670-8814-40	MICROCKT,DGTL:8192 X 8 PSUEDO STATIC RAM (4109A/CX ONLY)	34649	D2186A-30
A1U40	156-2066-00	670-8814-41		MICROCKT,DGTL:CMOS,8192 X 8,SCRN	62786	HM6264P-12

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(4109A/CX ONLY)		
A1U50	156-1734-00	670-8814-40	670-8814-40	MICROCKT,DGTL:8192 X 8 PSUEDO STATIC RAM (4109A/CX ONLY)	34649	D2186A-30
A1U50	156-2066-00	670-8814-41		MICROCKT,DGTL:CMOS,8192 X 8,SCRN (4109A/CX ONLY)	62786	HM6264P-12
A1U60	160-2379-01	670-8234-00	670-8234-20	MICROCKT,DGTL:16384 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2379-01
A1U60	160-3283-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3283-00
A1U60	160-3283-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3283-02
A1U70	160-2377-01	670-8234-00	670-8234-20	MICROCKT,DGTL:16384 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2377-01
A1U70	160-2377-03	670-8776-00	670-8776-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109 ONLY)	80009	160-2377-03
A1U70	160-2377-05	670-8814-00	670-8814-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-2377-05
A1U70	160-2377-07	670-8814-40		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109/CX ONLY) (ORDER 020-1408-00 FOR FIRMWARE SET)	80009	160-2377-07
A1U70	160-3281-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3281-00
A1U70	160-3281-02	020-1470-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3281-02
A1U80	160-2375-01	670-8234-00	670-8234-20	MICROCKT,DGTL:32768 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2375-01
A1U80	160-2375-03	670-8776-00	670-8776-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109 ONLY)	80009	160-2375-03
A1U80	160-2375-05	670-8814-00	670-8814-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-2375-05
A1U80	160-2375-07	670-8814-40		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109/CX ONLY) (ORDER 020-1408-00 FOR FIRMWARE SET)	80009	160-2375-07
A1U80	160-3279-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3279-00
A1U80	160-3279-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3279-02
A1U90	160-2373-01	670-8234-00	670-8234-20	MICROCKT,DGTL:32768 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2373-01
A1U90	160-2373-03	670-8776-00	670-8776-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109 ONLY)	80009	160-2373-03
A1U90	160-2373-05	670-8814-00	670-8814-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-2373-05
A1U90	160-2373-07	670-8814-40		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109/CX ONLY) (ORDER 020-1408-00 FOR FIRMWARE SET)	80009	160-2373-07
A1U90	160-3277-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3277-00
A1U90	160-3277-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3277-02
A1U125	156-1841-00	B010100	B010974	MICROCKT,DGTL:16 BIT MICROPROCESSOR (4109A ONLY)	34335	R80186
A1U125	156-1841-02	B010975		MICROCKT,DGTL:NMOS,MICROPROCESSOR,8MHZ (4109A ONLY)	34649	A80186
A1U125	156-1841-00	B010100	B010189	MICROCKT,DGTL:16 BIT MICROPROCESSOR (CX4109A ONLY)	34335	R80186

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1U125	156-1841-02	B010190		MICROCKT,DGTL:NMOS,MICROPROCESSOR,8MHZ (CX4109A ONLY)	34649	A80186
A1U135	156-0323-02			MICROCKT,DGTL:HEX INVERTER,BURN-IN	18324	N74S04(NB OR FB)
A1U140	156-1734-00	670-8814-40	670-8814-40	MICROCKT,DGTL:8192 X 8 PSUEDO STATIC RAM (4109A/CX ONLY)	34649	D2186A-30
A1U140	156-2066-00	670-8814-41		MICROCKT,DGTL:CMOS,819? X 8,SCRN (4109A/CX ONLY)	62786	HM6264P-12
A1U150	156-1734-00	670-8814-40	670-8814-40	MICROCKT,DGTL:8192 X 8 PSUEDO STATIC RAM (4109A/CX ONLY)	34649	D2186A-30
A1U150	156-2066-00	670-8814-41		MICROCKT,DGTL:CMOS,8192 X 8,SCRN (4109A/CX ONLY)	62786	HM6264P-12
A1U160	160-2380-01	670-8234-00	670-8234-20	MICROCKT,DGTL:16384 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2380-01
A1U160	160-3284-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3284-00
A1U160	160-3284-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3284-02
A1U170	160-2378-01	670-8234-00	670-8234-20	MICROCKT,DGTL:16384 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2378-01
A1U170	160-2378-03	670-8776-00	670-8776-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109 ONLY)	80009	160-2378-03
A1U170	160-2378-05	670-8814-00	670-8814-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-2378-05
A1U170	160-2378-07	670-8814-40		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109/CX ONLY) (ORDER 020-1408-00 FOR FIRMWARE SET)	80009	160-2378-07
A1U170	160-3282-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3282-00
A1U170	160-3282-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3282-02
A1U180	160-2376-01	670-8234-00	670-8234-20	MICROCKT,DGTL:32768 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2376-01
A1U180	160-2376-03	670-8776-00	670-8776-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109 ONLY)	80009	160-2376-03
A1U180	160-2376-05	670-8814-00	670-8814-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-2376-05
A1U180	160-2376-07	670-8814-40		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109/CX ONLY) (ORDER 020-1408-00 FOR FIRMWARE SET)	80009	160-2376-07
A1U180	160-3280-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3280-00
A1U180	160-3280-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE SET)	80009	160-3280-02
A1U190	160-2374-01	670-8234-00	670-8234-20	MICROCKT,DGTL:32768 X 8 EPROM,PROGRAMMED (4109 ONLY)	80009	160-2374-01
A1U190	160-2374-03	670-8776-00	670-8776-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109 ONLY) (4109A/CX ONLY)	80009	160-2374-03
A1U190	160-3278-00	020-1407-00	020-1407-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (ORDER 020-1407-00 FOR FIRMWARE SET)	80009	160-3278-00
A1U190	160-2374-05	670-8814-00	670-8814-00	MICROCKT,DGTL:32768 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-2374-05
A1U190	160-2374-07	670-8814-40		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109/CX ONLY) (ORDER 020-1408-00 FOR FIRMWARE SET)	80009	160-2374-07
A1U190	160-3278-02	020-1407-02		MICROCKT,DGTL:32768 X 8 EPROM,PRGM (4109A/CX ONLY) (ORDER 020-1407-02 FOR FIRMWARE KIT)	80009	160-3278-02

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1U235	156-1258-01			MICROCKT,DGTL:DUAL J-K NEG-EDGE-TRIG FF	01295	SN74LS112(NP3)
A1U240	156-1065-01			MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A1U245	156-1065-01			MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A1U250	156-0180-04			MICROCKT,DGTL:QUAD 2 INP NAND GATE,	18324	N74S00(NB OR FB)
A1U255	156-1724-00			MICROCKT,DGTL:QUAD 2 INPUT OR GATE	04713	MC74F32ND
A1U260	156-1855-00			MICROCKT,DGTL:STTL,BUS INTERFACE LATCHES	34335	AM29841DC
A1U265	156-1570-01			MICROCKT,DGTL:PRDM PRPHL INTFC	34335	AM8255A-5 P/D CB
A1U275	156-0467-02			MICROCKT,DGTL:QUAD 2-INP NAND BFR W/OC OUT	01295	SN74LS38NP3
A1U280	156-0388-03			MICROCKT,DGTL:DUAL D FLIP-FLOP	01295	SN74LS74ANP3
A1U285	156-0878-01			MICROCKT,DGTL:QUAD LINE RCVR	04713	MC1489LDS
A1U290	156-1737-00			MICROCKT,DGTL:DUAL ASYNC RECEIVER/XMTR	18324	SCN2681AC1N40
A1U335	156-0321-02			MICROCKT,DGTL:TRIPLE 3 INP NAND GATE	18324	N74S10(NB OR FB)
A1U340	160-1953-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-1953-00
A1U345	156-0462-02			MICROCKT,DGTL:HEX INVERTER	01295	SN7414NP3
A1U375	156-1080-01			MICROCKT,DGTL:HEX BUFFERS W/OC HV OUT,SCRN	01295	SN7407NP3
A1U380	156-0462-02			MICROCKT,DGTL:HEX INVERTER	01295	SN7414NP3
A1U385	156-0878-01			MICROCKT,DGTL:QUAD LINE RCVR	04713	MC1489LDS
A1U435	156-1724-00			MICROCKT,DGTL:QUAD 2 INPUT OR GATE	04713	MC74F32ND
A1U437	156-1737-00			MICROCKT,DGTL:DUAL ASYNC RECEIVER/XMTR	18324	SCN2681AC1N40
A1U440	156-0878-01			MICROCKT,DGTL:QUAD LINE RCVR	04713	MC1489LDS
A1U445	156-0878-01			MICROCKT,DGTL:QUAD LINE RCVR	04713	MC1489LDS
A1U495	156-0879-01			MICROCKT,DGTL:QUAD LINE DRIVER	04713	MC1488LD
A1U535	156-1722-00			MICROCKT,DGTL:HEX INVERTER	04713	MC74F04ND
A1U540	156-0879-01			MICROCKT,DGTL:QUAD LINE DRIVER	04713	MC1488LD
A1U545	156-0879-01			MICROCKT,DGTL:QUAD LINE DRIVER	04713	MC1488LD
A1VR490	152-0279-00			SEMICOND DVC,DI:ZEN,SI,5.1V,5%,0.4W,DO-7	14552	TD3810989
A1Y485	119-1591-00	B010100	B022888	OSC,XTAL CLOCK:14.7456MHZ,0.01% (4109 ONLY)	08111	M1200-14.7456M
A1Y485	119-1994-00	B022889		OSC,XTAL CLOCK:14.7456MHZ,0.01% W/ENABLE (4109 ONLY)	08111	A1824-14.7456MHZ
A1Y485	119-1591-00	B010100	B020209	OSC,XTAL CLOCK:14.7456MHZ,0.01% (CX4109 ONLY)	08111	M1200-14.7456M
A1Y485	119-1994-00	B020210		OSC,XTAL CLOCK:14.7456MHZ,0.01% W/ENABLE (CX4109 ONLY)	08111	A1824-14.7456MHZ
A2	670-7196-00	B010100	B010184	CIRCUIT BD ASSY:RAM THREE (4109/CX ONLY)	80009	670-7196-00
A2	670-7196-15	B010185		CIRCUIT BD ASSY:RAM THREE (4109/CX ONLY)	80009	670-7196-15
A2	670-7196-15	B010100	B010100	CIRCUIT BD ASSY:RAM THREE (4109A/CX ONLY)	80009	670-7196-15
A2	670-7196-16	B010101		CIRCUIT BD ASSY:RAM THREE (4109A/CX ONLY)	80009	670-7196-16
A2C225	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C225	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C225	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C315	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C315	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C315	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C341	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C341	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C341	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A2C511	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C511	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C511	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C515	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C515	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C515	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C521	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C521	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C521	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C525	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C525	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C525	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C531	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C531	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C531	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C535	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C535	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C535	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C541	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C541	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C541	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C545	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C545	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C545	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C711	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C711	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C711	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C715	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C715	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C715	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C721	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A2C721	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C721	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C725	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C725	283-0423-00	670-/196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C725	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C731	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C731	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C731	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C735	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C735	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C735	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2C741	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C741	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C741	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (410A/CX ONLY)	96733	W513BZ224M
A2C745	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109/CX ONLY)	04222	MD015E224ZAA
A2C745	283-0423-00	670-7196-15	670-7196-15	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109A/CX ONLY)	04222	MD015E224ZAA
A2C745	281-0925-00	670-7196-16		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL (4109A/CX ONLY)	96733	W513BZ224M
A2J49	131-2964-00			CONN,RCPT,ELEC:FEMALE,3 X 32,RTANG	81312	096S-6043-0731-0
A2P48	131-2866-00	B010100	B012210	CONN,RCPT,ELEC:MALE,RTANG,3 X 32,0.1 SP (4109 ONLY)	81312	96P-6033-0731-0
A2P48	131-2866-01	B012211		CONN,RCPT,ELEC:MALE,3 X 32,RTANG (4109 ONLY)	80009	131-2866-01
A2P48	131-2866-00	B010100	B010183	CONN,RCPT,ELEC:MALE,RTANG,3 X 32,0.1 SP (CX4109 ONLY)	81312	96P-6033-0731-0
A2P48	131-2866-01	B010184		CONN,RCPT,ELEC:MALE,3 X 32,RTANG (CX4109 ONLY)	80009	131-2866-01
A2R221	315-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A2R222	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A2R223	315-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A2R224	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A2U221	160-2397-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	27014	PAL16L8A-2 JN/JC
A2U311	156-1065-01			MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A2U321	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A2U325	156-1697-00			MICROCKT,DGTL:STTL,64K DRAM CONTROLLER	80009	156-1697-00
A2U335	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A2U345	156-1065-01			MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A2U411	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U415	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U421	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U425	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U431	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U435	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U441	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U445	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A2U511	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U515	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U521	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U525	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U531	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U535	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U541	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U545	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U611	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U615	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U621	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U625	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U631	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U635	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U641	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U645	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U711	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U715	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U721	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U725	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U731	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U735	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U741	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A2U745	156-1876-00			MICROCKT,DGTL:NMOS,65536 X 1 BIT DYN RAM	04713	MCM6665-AP-15
A3	670-8233-00	B010100	B010154	CIRCUIT BD ASSY:DISPLAY CONTROL (4109 ONLY)	80009	670-8233-00
A3	670-8233-03	B010155	B010184	CIRCUIT BD ASSY:DISPLAY CONTROL (4109 ONLY)	80009	670-8233-03
A3	670-8233-15	B010185	B011429	CIRCUIT BD ASSY:DISPLAY CONTROL (4109 ONLY)	80009	670-8233-15
A3	670-8233-16	B011430	B022670	CIRCUIT BD ASSY:DISPLAY CONTROL (4109 ONLY)	80009	670-8233-16
A3	670-8233-17	B022671		CIRCUIT BD ASSY:DISPLAY CONTROL (4109 ONLY)	80009	670-8233-17
A3	670-8233-17	B010100	B010989	CIRCUIT BD ASSY:DISPLAY CONTROL (4109A ONLY)	80009	670-8233-17
A3	670-8815-00	B010990	B032265	CIRCUIT BD ASSY:DISPLAY CONTROL (4109A ONLY)	80009	670-8815-00
A3	670-8815-01	B032266		CIRCUIT BD ASSY:DISPLAY CONTROL (CX4109 ONLY)	80009	670-8815-01
A3	670-8815-00	B010100	B020251	CIRCUIT BD ASSY:DISPLAY CONTROL (CX4109 ONLY)	80009	670-8815-00
A3	670-8815-01	B020252		CIRCUIT BD ASSY:DISPLAY CONTROL (CX4109 ONLY)	80009	670-8815-01
A3C1	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
A3C115	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C115	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C125	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C125	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C131	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C131	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C147	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C147	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3C161	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C161	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C171	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C171	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C185	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C185	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C201	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C201	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C207	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C207	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C215	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C215	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C221	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C221	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C227	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C227	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C231	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C231	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C247	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C247	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C261	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C261	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C271	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C271	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C285	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C285	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C301	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C301	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C307	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C307	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C327	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3C327	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C347	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C347	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C361	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C361	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C371	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C371	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C401	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C401	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C407	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C407	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C415	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C415	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C425	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C425	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C431	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C431	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C447	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C447	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C461	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C461	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C471	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C471	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C501	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C501	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C507	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C507	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C513	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
A3C525	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C525	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C531	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C531	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3C533	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C533	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C547	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C547	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C601	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C601	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C607	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C607	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C615	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C615	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C635	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
A3C647	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C647	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C655	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C655	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C657	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C657	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C661	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C661	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C671	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C671	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C681	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C681	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C701	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C701	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C707	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C707	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C715	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C715	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C720	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
A3C725	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C725	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3C731	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C731	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C735	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C735	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C737	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C737	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C801	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C801	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C805	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C805	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C807	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C807	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C811	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C811	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C815	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C815	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C825	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C825	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C831	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C831	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C857	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C857	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C871	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C871	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3C881	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A3C881	281-0913-00			CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A3DS87	150-1029-00			LT EMITTING DIO:GREEN,565NM,35MA	58361	Q6480/MV5274C
A3J31	131-3092-00			CONN,RCPT,ELEC:HEADER,2 X 10,VERTICAL,W/	22526	65863-067
A3J37	131-3154-00			CONN,RCPT,ELEC:CKT BD,RTANG,2 X 20,MALE	00779	102333-9
A3P35	131-2963-00			CONN,RCPT,ELEC:MALE,3 X 32,0.1 CTR	81312	94P032110105-589
A3P39	131-2963-00			CONN,RCPT,ELEC:MALE,3 X 32,0.1 CTR	81312	94P032110105-589
A3R162	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R163	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R167	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R168	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R172	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3R173	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R218	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R231	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R258	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R259	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R362	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R363	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R364	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R421	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R431	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R531	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R533	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R554	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R576	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R577	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R751	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R765	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R886	315-0331-00	670-8233-00	670-8233-15	RES,FXD,FILM:330 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E330E
A3R886	315-0391-00	670-8233-16		RES,FXD,FILM:390 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E390E
A3R886	315-0391-00			RES,FXD,FILM:390 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E390E
A3R887	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3U101	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U105	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U107	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U111	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U115	160-2382-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2382-00
A3U121	156-1933-00			MICROCKT,DGTL:16 BIT SHIFT REGISTER,SCRN	07263	74F676PCQR/DCQR
A3U125	156-1761-00			MICROCKT,DGTL:16:1 MUX,SCRN	50364	74LS450NSHRP
A3U127	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U131	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U135	156-0469-02			MICROCKT,DGTL:3/8 LINE DCDR	01295	SN74LS138NP3
A3U137	156-1935-00			MICROCKT,DGTL:SYNC PRESETTABLE BINARY CNTR	04713	MC74F163ND/JD
A3U141	156-1702-00			MICROCKT,DGTL:STTL,10 BIT REGISTER	34335	AM29821DCB
A3U147	160-2386-00	670-8233-00	670-8233-15	MICROCKT,DGTL:ARRAY LOGIC,PRGM (4109 ONLY)	80009	160-2386-00
A3U147	160-2386-00	670-8233-16		MICROCKT,DGTL:ARRAY LOGIC,PRGM (4109 ONLY)	80009	160-2386-00
A3U147	160-2386-01			MICROCKT,DGTL:ARRAY LOGIC,PRGM (CX4109 ONLY)	80009	160-2386-01
A3U155	160-2385-00	670-8233-00	670-8233-00	MICROCKT,DGTL:ARRAY LOGIC,PRGM (4109 ONLY)	80009	160-2385-00
A3U155	160-2385-01	670-8233-03		MICROCKT,DGTL:ARRAY LOGIC,PRGM (4109 ONLY)	80009	160-2385-01
A3U161	156-1743-00			MICROCKT,DGTL:ASTTL,QUAD 2-INPUT NOR GATE	18324	74F02 NB OR FB
A3U165	156-1722-00			MICROCKT,DGTL:HEX INVERTER	04713	MC74F04ND
A3U167	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A3U171	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A3U175	156-1080-01			MICROCKT,DGTL:HEX BUFFERS W/OC HV OUT,SCRN	01295	SN7407NP3
A3U181	160-2393-00	670-8815-00	670-8815-00	MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2393-00
A3U181	160-2393-01	670-8815-01		MICROCKT,DGTL:HEX 20 INPUT RGTR AND/OR PRGM	80009	160-2393-01
A3U185	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U187	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
A3U201	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U205	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U207	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U211	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3U215	160-2383-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2383-00
A3U217	156-1957-00			MICROCKT,DGTL:DUAL 4 INPUT NAND GATE	04713	74F20 NDS OR JDS
A3U221	156-0530-02			MICROCKT,DGTL:QUAD 2-INP MUX	01295	SN74LS157NP3
A3U225	160-2392-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2392-00
A3U231	156-1702-00			MICROCKT,DGTL:STTL,10 BIT REGISTER	34335	AM29821DCB
A3U235	156-1935-00			MICROCKT,DGTL:SYNC PRESETTABLE BINARY CNTR	04713	MC74F163ND/JD
A3U237	156-1935-00			MICROCKT,DGTL:SYNC PRESETTABLE BINARY CNTR	04713	MC74F163ND/JD
A3U241	156-1702-00			MICROCKT,DGTL:STTL,10 BIT REGISTER	34335	AM29821DCB
A3U247	160-2384-00	670-8233-00	670-8233-17	MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2384-00
A3U247	160-2384-01	670-8815-00		MICROCKT,DGTL:ARRAY LOGIC,STTL,SCRN,PRGM	80009	160-2384-01
A3U251	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U255	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U257	156-1611-00			MICROCKT,DGTL:DUAL D TYPE EDGE-TRIGGERED FF	80009	156-1611-00
A3U261	156-1934-00			MICROCKT,DGTL:64 BIT RANDOM ACCESS MEMORY	07263	74F189
A3U265	156-1934-00			MICROCKT,DGTL:64 BIT RANDOM ACCESS MEMORY	07263	74F189
A3U267	156-1934-00			MICROCKT,DGTL:64 BIT RANDOM ACCESS MEMORY	07263	74F189
A3U271	156-1934-00			MICROCKT,DGTL:64 BIT RANDOM ACCESS MEMORY	07263	74F189
A3U275	156-1934-00			MICROCKT,DGTL:64 BIT RANDOM ACCESS MEMORY	07263	74F189
A3U281	156-1934-00			MICROCKT,DGTL:64 BIT RANDOM ACCESS MEMORY	07263	74F189
A3U285	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U287	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
A3U301	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U305	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U307	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U311	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U335	156-1273-01			MICROCKT,DGTL:8-BIT EQUAL TO COMPTR,SCRN	34335	25LS2521 PCB2
A3U337	156-1935-00			MICROCKT,DGTL:SYNC PRESETTABLE BINARY CNTR	04713	MC74F163ND/JD
A3U347	160-2394-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	27014	PAL16R8AJN/JC
A3U351	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U355	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U357	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U361	156-1743-00			MICROCKT,DGTL:ASTTL,QUAD 2-INPUT NOR GATE	18324	74F02 NB OR FB
A3U365	156-1722-00			MICROCKT,DGTL:HEX INVERTER	04713	MC74F04ND
A3U367	156-0914-02			MICROCKT,DGTL:OCT ST BFR W/3 STATE OUT	01295	SN74LS240NP3
A3U371	156-0914-02			MICROCKT,DGTL:OCT ST BFR W/3 STATE OUT	01295	SN74LS240NP3
A3U375	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U381	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A3U385	156-1736-00			MICROCKT,DGTL:HIGH PRFM BUS INTFC RGTR	34335	AM29824PCB
A3U387	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
A3U401	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U405	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U407	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U411	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U415	160-2387-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2387-00
A3U421	156-1933-00			MICROCKT,DGTL:16 BIT SHIFT REGISTER,SCRN	07263	74F676PCQR/DCQR
A3U425	156-1761-00			MICROCKT,DGTL:16:1 MUX,SCRN	50364	74LS450NSHRP
A3U427	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U431	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U435	156-0530-02			MICROCKT,DGTL:QUAD 2-INP MUX	01295	SN74LS157NP3
A3U437	156-1273-01			MICROCKT,DGTL:8-BIT EQUAL TO COMPTR,SCRN	34335	25LS2521 PCB2
A3U441	156-1702-00			MICROCKT,DGTL:STTL,10 BIT REGISTER	34335	AM29821DCB
A3U447	156-1723-00			MICROCKT,DGTL:QUAD 2 INPUT & GATE	04713	MC74F08 ND OR JD
A3U451	156-1744-00			MICROCKT,DGTL:ASTTL,OCTAL BUFFER/LINE DRIVE R	07263	74F240PCQR
A3U455	156-1744-00			MICROCKT,DGTL:ASTTL,OCTAL BUFFER/LINE DRIVE R	07263	74F240PCQR
A3U457	156-1704-00			MICROCKT,DGTL:ASTTL,OCTAL D TYPE FF	07263	74F374PCQR
A3U461	156-1722-00			MICROCKT,DGTL:HEX INVERTER	04713	MC74F04ND

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3U465	156-1963-00			MICROCKT,DGTL:NONINVERTING REGISTER	34335	AM29823DCB
A3U467	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U471	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U475	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U487	156-1723-00			MICROCKT,DGTL:QUAD 2 INPUT & GATE	04713	MC74F08 ND OR JD
A3U501	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U505	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U507	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U511	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U515	156-1740-00			MICROCKT,DGTL:OCTAL DYN MEM DRVR W/3 STATE	34335	AM2966DCB
A3U521	156-1933-00			MICROCKT,DGTL:16 BIT SHIFT REGISTER,SCRN	07263	74F676PCQR/DCQR
A3U525	156-1761-00			MICROCKT,DGTL:16:1 MUX,SCRN	50364	74LS450NSHRP
A3U527	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U531	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U533	156-1800-00			MICROCKT,DGTL:ASTTL,QUAD 2 INP EXCL OR GATE	18324	N74F86(NB OR JB)
A3U535	156-0469-02			MICROCKT,DGTL:3/8 LINE DCDR	01295	SN74LS138NP3
A3U537	160-2395-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2395-00
A3U541	156-1702-00			MICROCKT,DGTL:STTL,10 BIT REGISTER	34335	AM29821DCB
A3U547	156-1724-00			MICROCKT,DGTL:QUAD 2 INPUT OR GATE	04713	MC74F32ND
A3U585	156-1909-00			MICROCKT,DGTL:QUAD 2 INP MULTIPLEXER	04713	74F157 ND OR JD
A3U587	156-2001-00			MICROCKT,DGTL:TTL,QUAD 2-INPUT MULTIPLEXER	04713	MC74F257
A3U591	156-1736-00			MICROCKT,DGTL:HIGH PRFM BUS INTFC RGTR	34335	AM29824PCB
A3U601	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U605	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U607	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U611	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U615	156-0530-02			MICROCKT,DGTL:QUAD 2-INP MUX	01295	SN74LS157NP3
A3U637	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U641	156-0530-02			MICROCKT,DGTL:QUAD 2-INP MUX	01295	SN74LS157NP3
A3U647	156-1744-00			MICROCKT,DGTL:ASTTL,OCTAL BUFFER/LINE DRIVE R	07263	74F240PCQR
A3U651	160-2389-00	670-8233-00	670-8233-17	MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2389-00
A3U651	160-2389-01	670-8815-00		MICROCKT,DGTL:ARRAY LOGIC,STTL,SCRN,PRGM	80009	160-2389-01
A3U655	156-1702-00			MICROCKT,DGTL:STTL,10 BIT REGISTER	34335	AM29821DCB
A3U657	156-1963-00			MICROCKT,DGTL:NONINVERTING REGISTER	34335	AM29823DCB
A3U661	156-1963-00			MICROCKT,DGTL:NONINVERTING REGISTER	34335	AM29823DCB
A3U665	156-1944-00			MICROCKT,DGTL:SINGLE ROW BUFFER,SCRN	53848	CRT9006HS
A3U675	156-2012-00			MICROCKT,DGTL:NMOS,2048 X 8 SRAM,SCREENED	80009	156-2012-00
A3U681	156-2012-00			MICROCKT,DGTL:NMOS,2048 X 8 SRAM,SCREENED	80009	156-2012-00
A3U685	156-1909-00			MICROCKT,DGTL:QUAD 2 INP MULTIPLEXER	04713	74F157 ND OR JD
A3U687	156-2001-00			MICROCKT,DGTL:TTL,QUAD 2-INPUT MULTIPLEXER	04713	MC74F257
A3U701	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U705	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U707	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U711	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U715	156-1936-00			MICROCKT,DGTL:QUAD 2-INP 4-BIT RGTR,SCRN	07263	74F399PC
A3U717	156-0530-02			MICROCKT,DGTL:QUAD 2-INP MUX	01295	SN74LS157NP3
A3U721	160-2390-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2390-00
A3U727	160-2396-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2396-00
A3U731	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U735	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U741	156-1704-00			MICROCKT,DGTL:ASTTL,OCTAL D TYPE FF	07263	74F374PCQR
A3U747	156-1961-00			MICROCKT,DGTL:BIDIRECTIONAL UNIV SHF RGTR	07263	74F194P
A3U785	156-1909-00			MICROCKT,DGTL:QUAD 2 INP MULTIPLEXER	04713	74F157 ND OR JD
A3U787	156-1763-00			MICROCKT,DGTL:CRT VIDEO PROCESSOR & CONT	53848	CRT9007CDBI
A3U801	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U805	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U807	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3U811	156-1859-00			MICROCKT,DGTL:MOS,DYNAMIC RAM,SCRN	01295	TMS4416-15
A3U815	156-1936-00			MICROCKT,DGTL:QUAD 2-INP 4-BIT RGTR,SCRN	07263	74F399PC
A3U821	156-1933-00			MICROCKT,DGTL:16 BIT SHIFT REGISTER,SCRN	07263	74F676PCQR/DCQR
A3U825	156-1761-00			MICROCKT,DGTL:16:1 MUX,SCRN	50364	74LS450NSHRP
A3U827	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U831	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A3U835	156-1724-00			MICROCKT,DGTL:QUAD 2 INPUT OR GATE	04713	MC74F32ND
A3U837	156-1839-00			MICROCKT,DGTL:OCTAL BIDIRECTIONAL I/O PORT	34335	AM2952DCB
A3U841	156-1722-00			MICROCKT,DGTL:HEX INVERTER	04713	MC74F04ND
A3U847	156-1961-00			MICROCKT,DGTL:BIDIRECTIONAL UNIV SHF RGTR	07263	74F194P
A3U851	156-1744-00			MICROCKT,DGTL:ASTTL,OCTAL BUFFER/LINE DRIVE R	07263	74F240PCQR
A3U855	160-2381-00	670-8233-00	670-8233-16	MICROCKT,DGTL:4096 X 8 EPROM,PRGM (4109 ONLY)	80009	160-2381-00
A3U855	160-3087-00	670-8233-17		MICROCKT,DGTL:4096 X 8 EPROM,PRGM (4109 ONLY)	80009	160-3087-00
A3U855	160-3087-00			MICROCKT,DGTL:4096 X 8 EPROM,PRGM (CX4109 ONLY)	80009	160-3087-00
A3U857	160-2391-00			MICROCKT,DGTL:ARRAY LOGIC,PRGM	80009	160-2391-00
A3U861	156-1963-00			MICROCKT,DGTL:NONINVERTING REGISTER	34335	AM29823DCB
A3U865	156-1944-00			MICROCKT,DGTL:SINGLE ROW BUFFER,SCRN	53848	CRT9006HS
A3U875	156-2012-00			MICROCKT,DGTL:NMOS,2048 X 8 SRAM,SCREENED	80009	156-2012-00
A3U881	156-2012-00			MICROCKT,DGTL:NMOS,2048 X 8 SRAM,SCREENED	80009	156-2012-00
A3U885	156-0323-02			MICROCKT,DGTL:HEX INVERTER,BURN-IN	18324	N74S04(NB OR FB)
A3Y157	119-1721-00	B010100	B022888	OSC,XTAL CLOCK:25.2MHZ,0.01% (4109 ONLY)	08111	M1200-25.2M
A3Y157	119-1993-00	B022889		OSC,XTAL CLOCK:25.2MHZ,0.01% W/ENABLE (4109 ONLY)	08111	A1824-25.2MHZ
A3Y157	119-1721-00	B010100	B020209	OSC,XTAL CLOCK:25.2MHZ,0.01% (CX4109 ONLY)	08111	M1200-25.2M
A3Y157	119-1993-00	B020210		OSC,XTAL CLOCK:25.2MHZ,0.01% W/ENABLE (CX4109 ONLY)	08111	A1824-25.2MHZ
A4	670-8151-00	B010100	B010329	CIRCUIT BD ASSY:DIGITAL PIGGYBACK (4109 ONLY)	80009	670-8151-00
A4	670-8151-15	B010330	B012022	CIRCUIT BD ASSY:DIGITAL PIGGYBACK (4109 ONLY)	80009	670-8151-15
A4	670-8151-16	B012023	B019999	CIRCUIT BD ASSY:DIGITAL PIGGYBACK (4109 ONLY)	80009	670-8151-16
A4	670-8151-15	B010100	B010120	CIRCUIT BD ASSY:DIGITAL PIGGYBACK (CX4109 ONLY)	80009	670-8151-15
A4	670-8151-16	B010121	B019999	CIRCUIT BD ASSY:DIGITAL PIGGYBACK (CX4109 ONLY)	80009	670-8151-16
A4	670-9045-00	B020000	B023234	CIRCUIT BD ASSY:VIDEO INTERFACE (4109 ONLY)	80009	670-9045-00
A4	670-9045-01	B023235		CIRCUIT BD ASSY:VIDEO INTERFACE (4109 ONLY)	80009	670-9045-01
A4	670-9045-00	B020000	B020242	CIRCUIT BD ASSY:VIDEO INTERFACE (CX4109 ONLY)	80009	670-9045-00
A4	670-9045-01	B020243		CIRCUIT BD ASSY:VIDEO INTERFACE (CX4109 ONLY)	80009	670-9045-01
A4	670-9045-01	B010100	B011480	CIRCUIT BD ASSY:VIDEO INTERFACE (4109A ONLY)	80009	670-9045-01
A4	670-9045-02	B011481	B011525	CIRCUIT BD ASSY:VIDEO INTFC (4109A ONLY)	80009	670-9045-02
A4	670-9045-03	B011526	B021911	CIRCUIT BD ASSY:VIDEO INTERFACE (4109A ONLY)	80009	670-9045-03
A4	670-9045-04	B021912		CIRCUIT BD ASSY:VIDEO INTERFACE (4109A ONLY)	80009	670-9045-04
A4	670-9045-01	B010100	B010211	CIRCUIT BD ASSY:VIDEO INTERFACE (CX4109A ONLY)	80009	670-9045-01
A4	670-9045-02	B010212	B010215	CIRCUIT BD ASSY:VIDEO INTFC (CX4109A ONLY)	80009	670-9045-02

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A4	670-9045-03	B010216	B020235	CIRCUIT BD ASSY:VIDEO INTERFACE (CX4109A ONLY)	80009	670-9045-03
A4	670-9045-04	B020236		CIRCUIT BD ASSY:VIDEO INTERFACE (CX4109A ONLY)	80009	670-9045-04
A4C11	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C11	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C11	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C13	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C13	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C13	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C108	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C109	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C110	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C127	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C128	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C129	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C131	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C131	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C131	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C133	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C133	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C133	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C141	290-0759-00	670-9045-00	670-9045-01	CAP,FXD,ELCTLT:290UF,+75-10%,15V	56289	500D150
A4C141	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C151	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C152	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C161	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C161	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C161	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C161	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C162	281-0913-00	670-9045-02		CAP,FXD,CER DI:0.1UF,50V,AXIAL	04222	MA105E104ZAA
A4C163	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C163	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C163	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C170	290-1086-00	670-9045-00	670-9045-01	CAP,FXD,ELCTLT:22UF,+/-20%,16V	29309	TYPEMDI22UF16V
A4C171	281-0925-00	670-9045-00		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C172	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C191	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C191	290-1086-00	670-9045-02		CAP,FXD,ELCTLT:22UF,+/-20%,16V	29309	TYPEMDI22UF16V
A4C192	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C195	290-0759-00	670-9045-02		CAP,FXD,ELCTLT:290UF,+75-10%,15V	56289	500D150
A4C210	281-0925-00	670-9045-00	670-9045-01	CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C220	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(4109 ONLY)		
A4C220	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C220	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C221	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C221	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C221	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C221	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C223	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C223	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C223	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C225	290-0187-00	670-8151-00	670-8151-16	CAP,FXD,ELCTLT:4.7UF,20%,35V	05397	T110B475M035AS
A4C227	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C227	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C227	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C231	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C261	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C261	283-0423-00	B010100	B011757	CAP,FXD,CER DI:0.22UF,+80-20%,50V (4109 ONLY)	04222	MD015E224ZAA
A4C261	281-0913-00	B011758	B019999	CAP,FXD,CER DI:0.1UF,50V,AXIAL (4109 ONLY)	04222	MA105E104ZAA
A4C261	281-0913-00	670-8151-15	670-8151-16	CAP,FXD,CER DI:0.1UF,50V,AXIAL (CX4109 ONLY)	04222	MA105E104ZAA
A4C322	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4C325	281-0925-00	670-9045-02		CAP,FXD,CER DI:0.22UF,20%,50V,AXIAL	96733	W513BZ224M
A4CR142	152-0066-00	670-9045-02		SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A4CR211	152-0066-00	670-9045-00	670-9045-01	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A4CR221	152-0066-00	670-8151-00	670-8151-16	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A4J51	131-3192-00	670-8151-00	670-8151-16	CONN,RCPT,ELEC:BNC,FEM,PC MOUNT	00779	227673-1
A4J51	131-3378-00	670-9045-00		CONN,RCPT,ELEC:BNC,CKT BD,RTANG,GOLD CONT	00779	227677-1
A4J52	131-3192-00	670-8145-00	670-8151-16	CONN,RCPT,ELEC:BNC,FEM,PC MOUNT	00779	227673-1
A4J52	131-3378-00	670-9045-00		CONN,RCPT,ELEC:BNC,CKT BD,RTANG,GOLD CONT	00779	227677-1
A4J53	131-3378-00	670-9045-00		CONN,RCPT,ELEC:BNC,CKT BD,RTANG,GOLD CONT	00779	227677-1
A4J55	131-3192-00	670-8151-00	670-8151-16	CONN,RCPT,ELEC:BNC,FEM,PC MOUNT	00779	227673-1
A4J55	131-3380-00	670-9045-00		CONN,RCPT,ELEC:HEADER,1 X 4,0.156 CTR	00779	643990-1
A4J56	131-1857-00	670-9045-00		TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	TK1483	082-3643-SS10
A4J57	131-3154-00			CONN,RCPT,ELEC:CKT BD,RTANG,2 X 20,MALE	00779	102333-9
A4L167	276-0752-00	670-9045-02		CORE,EM:FERRITE	34899	2743001111
A4L168	276-0752-00	670-9045-02		CORE,EM:FERRITE	34899	2743001111
A4L169	276-0752-00	670-9045-02		CORE,EM:FERRITE	34899	2743001111
A4P53	131-2601-00	670-8151-00	670-8151-16	CONN,RCPT,ELEC:CIRCUIT BD,1X10 CONTACT	22526	65780-010
A4P54	131-2676-00	670-8151-00	670-8151-16	CONN,RCPT,ELEC:CKT BD,1 X 3,0.1 SPACING	22526	65780-003
A4P56	131-2676-00	670-8151-00	670-8151-16	CONN,RCPT,ELEC:CKT BD,1 X 3,0.1 SPACING	22526	65780-003
A4P58	131-2676-00	670-8151-00	670-8151-16	CONN,RCPT,ELEC:CKT BD,1 X 3,0.1 SPACING	22526	65780-003
A4R10	321-0105-00	670-8151-00	670-8151-16	RES,FXD,FILM:121 OHM 1%,0.125W,TC=\0	07716	CEAD121R0F
A4R11	311-1238-00	670-8151-00	670-8151-16	RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386X-DY6-502
A4R13	321-0105-00	670-8151-00	670-8151-16	RES,FXD,FILM:121 OHM 1%,0.125W,TC=\0	07716	CEAD121R0F
A4R15	303-0151-00	670-8151-00	670-8151-16	RES,FXD,CMPSN:150 OHM,5%,1W	24546	FP1 150 OHM 5%
A4R17	321-0082-00	670-8151-00	670-8151-16	RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R111	311-1238-00	670-8151-00	670-8151-16	RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386X-DY6-502

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A4R113	315-0511-00	670-8151-00	670-8151-16	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R115	315-0511-00	670-8151-00	670-8151-16	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R117	315-0621-00	670-8151-00	670-8151-15	RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
A4R121	321-0082-00	670-9045-02		RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R122	303-0121-00	670-9045-02		RES,FXD,CMPSN:120 OHM,5%,1W	01121	GB1215
A4R123	321-0082-00	670-9045-02		RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R124	303-0121-00	670-9045-02		RES,FXD,CMPSN:120 OHM,5%,1W	01121	GB1215
A4R125	321-0082-00	670-9045-02		RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R126	303-0121-00	670-9045-02		RES,FXD,CMPSN:120 OHM,5%,1W	01121	GB1215
A4R131	321-0105-00	670-8151-00	670-8151-16	RES,FXD,FILM:121 OHM 1%,0.125W,TC=\0	07716	CEAD121R0F
A4R131	315-0472-00	670-9045-00	670-9045-01	RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A4R133	321-0105-00	670-8151-00	670-8151-16	RES,FXD,FILM:121 OHM 1%,0.125W,TC=\0	07716	CEAD121R0F
A4R135	303-0151-00	670-8151-00	670-8151-16	RES,FXD,CMPSN:150 OHM,5%,1W	24546	FP1 150 OHM 5%
A4R137	321-0082-00	670-8151-00	670-8151-16	RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R141	315-0331-00	670-8151-00	670-8151-16	RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
A4R141	307-0658-00	670-9045-02		RES NTWK,FXD,FI:14,220 OHM,14,330 OHM,2%	01121	316E221331
A4R154	303-0121-00	670-9045-00	670-9045-01	RES,FXD,CMPSN:120 OHM,5%,1W	01121	GB1215
A4R155	321-0082-00	670-9045-00	670-9045-01	RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R161	321-0105-00	670-8151-00	670-8151-16	RES,FXD,FILM:121 OHM 1%,0.125W,TC=\0	07716	CEAD121R0F
A4R163	321-0105-00	670-8151-00	670-8151-16	RES,FXD,FILM:121 OHM 1%,0.125W,TC=\0	07716	CEAD121R0F
A4R163	311-1224-00	670-9045-02		RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501
A4R164	321-0612-00	670-9045-02		RES,FXD,FILM:500 OHM,1%,0.125W,TC=T0	07716	CEAD500R0F
A4R165	303-0151-00	670-8151-00	670-8151-16	RES,FXD,CMPSN:150 OHM,5%,1W	24546	FP1 150 OHM 5%
A4R167	321-0082-00	670-8151-00	670-8151-16	RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R171	315-0472-00	670-9045-02		RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A4R174	303-0121-00	670-9045-00	670-9045-01	RES,FXD,CMPSN:120 OHM,5%,1W	01121	GB1215
A4R175	321-0082-00	670-9045-00	670-9045-01	RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R194	303-0121-00	670-9045-00	670-9045-01	RES,FXD,CMPSN:120 OHM,5%,1W	01121	GB1215
A4R195	321-0082-00	670-9045-00	670-9045-01	RES,FXD,FILM:69.8 OHM,1%,0.125W,TC=T0	91637	CMF55116G69R80F
A4R211	311-1238-00	670-8151-00	670-8151-16	RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386X-DY6-502
A4R211	307-0658-00	670-9045-00	670-9045-01	RES NTWK,FXD,FI:14,220 OHM,14,330 OHM,2%	01121	316E221331
A4R221	307-0658-00	670-8151-00	670-8151-16	RES NTWK,FXD,FI:14,220 OHM,14,330 OHM,2%	01121	316E221331
A4R227	315-0511-00	670-8151-00	670-8151-16	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R233	315-0330-00	670-8151-00	670-8151-16	RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A4R251	315-0330-00	670-9045-02		RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A4R252	315-0330-00	670-9045-00	670-9045-00	RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A4R252	315-0221-00	670-9045-01	670-9045-01	RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
A4R252	315-0330-00	670-9045-02		RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A4R271	315-0330-00	670-9045-02		RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A4R287	311-1227-00	670-9045-00	670-9045-01	RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386F-T04-502
A4R288	311-1227-00	670-9045-00	670-9045-01	RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386F-T04-502
A4R289	311-1227-00	670-9045-00	670-9045-01	RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386F-T04-502
A4R291	321-0117-00	670-9045-00	670-9045-01	RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
A4R292	315-0511-00	670-9045-00	670-9045-01	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R293	321-0117-00	670-9045-00	670-9045-01	RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
A4R294	315-0511-00	670-9045-00	670-9045-01	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R295	321-0117-00	670-9045-00	670-9045-01	RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
A4R296	315-0511-00	670-9045-00	670-9045-01	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R391	321-0089-00	670-9045-02		RES,FXD,FILM:82.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G82R50F
A4R392	321-0178-00	670-9045-02		RES,FXD,FILM:698 OHM,1%,0.125W,TC=T0	07716	CEAD698R0F
A4R393	321-0089-00	670-9045-02		RES,FXD,FILM:82.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G82R50F
A4R394	321-0178-00	670-9045-02		RES,FXD,FILM:698 OHM,1%,0.125W,TC=T0	07716	CEAD698R0F
A4R395	321-0089-00	670-9045-02		RES,FXD,FILM:82.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G82R50F
A4R396	321-0178-00	670-9045-02		RES,FXD,FILM:698 OHM,1%,0.125W,TC=T0	07716	CEAD698R0F
A4U11	156-1984-00	670-8151-00	670-8151-16	MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U67	276-0752-00	670-9045-02		CORE,EM:FERRITE	34899	2743001111
A4U68	276-0752-00	670-9045-02		CORE,EM:FERRITE	34899	2743001111
A4U69	276-0752-00	670-9045-02		CORE,EM:FERRITE	34899	2743001111

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A4U111	156-1972-00	670-9045-00	670-9045-01	MICROCKT,DGTL:3-4 BIT D/A CONVERTER	TK1481	TBA
A4U131	156-1984-00	670-8151-00	670-8151-16	MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U131	156-0914-02	670-9045-00	670-9045-01	MICROCKT,DGTL:OCT ST BFR W/3 STATE OUT	01295	SN74LS240NP3
A4U151	156-1984-00	670-9045-00	670-9045-01	MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U151	156-2701-00	670-9045-02		MICROCKT,LINEAR:CMOS,TRIPLE,4 BIT D/A CONV	80009	156-2701-00
A4U161	156-1984-00	670-8151-00	670-8151-16	MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U171	156-1984-00	670-9045-00	670-9045-01	MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U171	156-0914-02	670-9045-02		MICROCKT,DGTL:OCT ST BFR W/3 STATE OUT	01295	SN74LS240NP3
A4U191	156-1984-00	670-9045-00	670-9045-01	MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U221	156-1972-00	670-8151-00	670-8151-16	MICROCKT,DGTL:3-4 BIT D/A CONVERTER	TK1481	TBA
A4U221	156-1984-00	670-9045-02		MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U231	156-1984-00	670-9045-02		MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A4U261	156-0323-02	670-8151-00	670-8151-16	MICROCKT,DGTL:HEX INVERTER,BURN-IN	18324	N74S04(NB OR FB)
A4U321	156-1984-00	670-9045-02		MICROCKT,LINEAR:VIDEO BUFFER	34371	HA-5033
A5	119-1592-01	B010100	B022884	KEYBOARD ASSY: (4109 STANDARD ONLY)	52833	ORDER BY DESCR
A5	119-1592-02	B022885		KEYBOARD ASSY: (4109 STANDARD ONLY)	80009	119-1592-02
A5	119-1619-01	B010100	B022940	KEYBOARD ASSY:UNITED KINGDOM (4109 OPTION 4A ONLY)	80009	119-1619-01
A5	119-1619-02	B022941		KEYBOARD ASSY:UNITED KINGDOM OPT 4A (4109 OPTION 4A ONLY)	80009	119-1619-02
A5	119-1618-01			KEYBOARD ASSY:FRENCH (4109 OPTION 4B ONLY)	80009	119-1618-01
A5	119-1621-01	B010100	B022781	KEYBOARD ASSY:SWEDISH (4109 OPTION 4C ONLY)	80009	119-1621-01
A5	119-1621-02	B022782		KEYBOARD ASSY:SWEDISH OPT 4C (4109 OPTION 4C ONLY)	80009	119-1621-02
A5	119-1620-01	B010100	B022300	KEYBOARD ASSY:DANISH/NORWEGIAN (4109 OPTION 4F ONLY)	80009	119-1620-01
A5	119-1620-02	B022301		KEYBOARD ASSY:DANISH/NORWEGIAN OPT 4F (4109 OPTION 4F ONLY)	80009	119-1620-02
A5	119-1622-01	B010100	B022902	KEYBOARD ASSY:GERMAN (4109 OPTION 4G ONLY)	80009	119-1622-01
A5	119-1622-02	B022903		KEYBOARD ASSY:GERMAN OPT 4G (4109 OPTION 4G ONLY)	80009	119-1622-02
A5	119-1678-01			KEYBOARD ASSY:KATAKANA (4109 OPTION 4K ONLY)	80009	119-1678-01
A5	119-1860-00			KEYBOARD ASSY:NORTH AMERICAN (CX4109 STANDARD ONLY)	52833	ORDER BY DESCR
A5	119-1861-00			KEYBOARD ASSY:UNITED KINGDOM (CX4109 OPTION 4A ONLY)	80009	119-1861-00
A5	119-1862-00			KEYBOARD ASSY:FRENCH (CX4109 OPTION 4B ONLY)	80009	119-1862-00
A5	119-1863-00			KEYBOARD ASSY:SWEDISH (CX4109 OPTION 4C ONLY)	80009	119-1863-00
A5	119-1864-00			KEYBOARD ASSY:DANISH NORWEGIAN (CX4109 OPTION 4F ONLY)	80009	119-1864-00
A5	119-1865-00			KEYBOARD ASSY:GERMAN (CX4109 OPTION 4G ONLY)	80009	119-1865-00
A5A1	118-2975-01	119-1592-01	119-1592-01	KEYBOARD ASSY:W/O ENCLOSURE (4109 STANDARD ONLY)	51181	65-02518-08A
A5A1	118-2975-02	119-1592-02		KEYBOARD ASSY:W/O ENCLOSURE (4109 STANDARD ONLY)	80009	118-2975-02
A5A1	118-3276-01	119-1619-01	119-1619-01	KEYBOARD ASSY:W/O ENCLOSURE,UNITED KINGDOM (4109 OPTION 4A ONLY)	51181	65-02518-10A
A5A1	118-3276-02	119-1619-02		KEYBOARD ASSY:W/O ENCLOSURE,UNITED KINGDOM (4109 OPTION 4A ONLY)	80009	118-3276-02
A5A1	118-3278-01	119-1621-01	119-1621-01	KEYBOARD ASSY:W/O ENCLOSURE,SWEDISH (4109 OPTION 4C ONLY)	51181	65-02518-12A
A5A1	118-3278-02	119-1621-02		KEYBOARD ASSY:W/O ENCLOSURE,SWEDISH (4109 OPTION 4C ONLY)	80009	118-3278-02
A5A1	118-3280-01			KEYBOARD ASSY:W/O ENCLOSURE,FRENCH (4109 OPTION 4B ONLY)	51181	65-02518-09B

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A5A1	118-3277-01	119-1620-01	119-1620-01	KEYBOARD ASSY:W/O ENCL,DANISH/NORWEGIAN (4109 OPTION 4F ONLY)	51181	65-02518-11A
A5A1	118-3277-02	119-1620-02		KEYBOARD ASSY:W/O ENCL DANISH/NORWEGIAN (4109 OPTION 4F ONLY)	80009	118-3277-02
A5A1	118-3281-01	119-1622-01	119-1622-01	KEYBOARD ASSY:W/O ENCLOSURE,GERMAN (4109 OPTION 4G ONLY)	51181	65-02518-15A
A5A1	118-3281-02	119-1622-02		KEYBOARD ASSY:W/O ENCLOSURE,GERMAN (4109 OPTION 4G ONLY)	80009	118-3281-02
A5A1	118-3279-01			KEYBOARD ASSY:W/O ENCLOSURE,KATAKANA (4109 OPTION 4K ONLY)	51181	65-02518-14A
A5A1	118-3866-00			KEYBOARD ASSY:W/O ENCLOSURE NORTH AMERICAN (CX4109 STANDARD ONLY)	51181	65-02866-001
A5A1	118-3867-00			KEYBOARD ASSY:W/O ENCLOSURE UK (CX4109 OPTION 4A ONLY)	51181	66-02866-002
A5A1	118-3868-00			KEYBOARD ASSY:W/O ENCLOSURE FRENCH (CX4109 OPTION 4B ONLY)	51181	66-02866-003
A5A1	118-3869-00			KEYBOARD ASSY:W/O ENCLOSURE SWEDISH (CX4109 OPTION 4C ONLY)	51181	66-02866-004
A5A1	118-3870-00			KEYBOARD ASSY:W/O ENCL,DANISH/NORWEGIAN (CX4109 OPTION 4F ONLY)	51181	66-02866-005
A5A1	118-3871-00			KEYBOARD ASSY:W/O ENCLOSURE GERMAN (CX4109 OPTION 4G ONLY)	51181	66-02866-006
A5A1C1	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (4109 ONLY)	04222	GC105A330J
A5A1C1	290-0535-00			CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM (CX4109 ONLY)	56289	196D336X0010KA1
A5A1C2	118-3189-00			CAP,FXD,ELCTLT:10UF,10V (4109 ONLY)	51181	32-00106-010
A5A1C2	281-0761-00			CAP,FXD,CER DI:27PF,5%,100V (CX4109 ONLY)	04222	MA101A270JAA
A5A1C3	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (4109 ONLY)	04222	GC105A330J
A5A1C3	281-0761-00			CAP,FXD,CER DI:27PF,5%,100V (CX4109 ONLY)	04222	MA101A270JAA
A5A1C4	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A5A1C5	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A5A1C6	290-0284-00			CAP,FXD,ELCTLT:4.7UF,10%,35V (4109 ONLY)	05397	T110B475K035AS
A5A1C6	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (CX4109 ONLY)	04222	GC105A330J
A5A1C7	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (CX4109 ONLY)	04222	GC105A330J
A5A1C8	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A5A1C9	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (4109 ONLY)	04222	GC105A330J
A5A1C9	290-0284-00			CAP,FXD,ELCTLT:4.7UF,10%,35V (CX4109 ONLY)	05397	T110B475K035AS
A5A1C10	290-0535-00			CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM (4109 ONLY)	56289	196D336X0010KA1
A5A1C10	118-3189-00			CAP,FXD,ELCTLT:10UF,10V (CX4109 ONLY)	51181	32-00106-010
A5A1C11	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A5A1C13	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (CX4109 ONLY)	04222	GC105A330J
A5A1C14	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (CX4109 ONLY)	04222	GC105A330J
A5A1C16	283-0159-00			CAP,FXD,CER DI:18PF,5%,50V (CX4109 ONLY)	04222	SR155A180JAA
A5A1C19	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V (CX4109 ONLY)	04222	GC105A330J
A5A1C20	283-0239-00			CAP,FXD,CER DI:0.022UF,10%,50V (CX4109 ONLY)	04222	3439-050C-223K
A5A1C21	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(CX4109 ONLY)		
A5A1CR1	118-3003-00			SEMICOND DVC,DI: (CX4109 ONLY)	51181	21-04148-000
A5A1CR2	118-3003-00			SEMICOND DVC,DI:	51181	21-04148-000
A5A1CR3	118-3003-00			SEMICOND DVC,DI:	51181	21-04148-000
A5A1CR4	118-3003-00			SEMICOND DVC,DI:	51181	21-04148-000
A5A1CR5	118-3003-00			SEMICOND DVC,DI: (CX4109 ONLY)	51181	21-04148-000
A5A1CR6	118-3003-00			SEMICOND DVC,DI: (CX4109 ONLY)	51181	21-04148-000
A5A1CR9	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX (4109 ONLY)	58361	Q6878/MV5074C
A5A1CR9	118-4028-00			LT EMITTING DIO:GREEN (CX4109 ONLY)	51181	21-A0024-002
A5A1J1	118-3001-00			CONN,RCPT,ELEC:RTANG,6 PIN	51181	39-00757-000
A5A1LS1	118-4035-00			SPEAKER:ALARM (CX4109 ONLY)	51181	48-00125-002
A5A1Q1	151-0301-00			TRANSISTOR:PNP,SI,TO-18 (CX4109 ONLY)	04713	ST898
A5A1R1	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E470E
A5A1R1	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E03K3
A5A1R2	315-0121-00			RES,FXD,FILM:120 OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX120R0J
A5A1R3	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E33K0
A5A1R4	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E03K3
A5A1R6	315-0121-00			RES,FXD,FILM:120 OHM,5%,0.25W (4109 ONLY)	19701	5043CX120R0J
A5A1R6	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E470E
A5A1R7	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E03K3
A5A1R8	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
A5A1R9	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E180E
A5A1R9	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E270E
A5A1R10	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E330E
A5A1R10	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E03K3
A5A1R11	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E270E
A5A1R11	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E330E
A5A1R12	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E180E
A5A1R13	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E06K8
A5A1R14	322-0184-00			RES,FXD,FILM:806 OHM,1%,0.25W,TC=T0 (CX4109 ONLY)	75042	CEBT0-8060F
A5A1R15	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E02K7
A5A1R16	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX15K00J
A5A1R17	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX10RR00J
A5A1R19	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX10K00J

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A5A1R20	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E470E
A5A1RX1	307-0741-00			RES NTWK,FXD,FI:7,3.3K OHM,2%,0.19W EACH (CX4109 ONLY)	11236	750-81-R3.3K
A5A1RX2	307-0741-00			RES NTWK,FXD,FI:7,3.3K OHM,2%,0.19W EACH (CX4109 ONLY)	11236	750-81-R3.3K
A5A1S1	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S2	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S3	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S4	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S5	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S6	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S7	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S8	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S9	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S10	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S11	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S12	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S13	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S14	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S15	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S16	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE (4109 ONLY)	80009	260-2176-00
A5A1S16	118-3018-00			SWITCH: (CX4109 LEFT SWITCH ONLY)	51181	61-04031-002
A5A1S16	118-3029-00			SWITCH: (CX4109 RIGHT SWITCH ONLY)	51181	61-04031-001
A5A1S17	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S18	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S19	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S20	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S21	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S22	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S23	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S24	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S25	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S26	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S27	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S28	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S29	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S30	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S31	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S32	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S33	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S34	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S35	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S36	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S37	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S38	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S39	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S40	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S41	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S42	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S43	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S44	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S45	118-3018-00			SWITCH: (4109 LEFT SWITCH ONLY)	51181	61-04031-002
A5A1S45	118-3029-00			SWITCH: (4109 RIGHT SWITCH ONLY)	51181	61-04031-001

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A5A1S45	260-2177-00			SW,CAPACITIVE:30MM,LOW PROFILE W/LED (CX4109 ONLY)	80009	260-2177-00
A5A1S46	260-2177-00			SW,CAPACITIVE:30MM,LOW PROFILE W/LED (4109 ONLY)	80009	260-2177-00
A5A1S46	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S47	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S48	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S49	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S50	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S51	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S52	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S53	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S54	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S55	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S56	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S57	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S58	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S59	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S60	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S61	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S62	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S63	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S64	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S65	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S66	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S67	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S68	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S69	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S70	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S71	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S72	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S73	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S73	118-3029-00			SWITCH: (4109 RIGHT SWITCH ONLY)	51181	61-04031-001
A5A1S73	118-3018-00			SWITCH: (4109 LEFT SWITCH ONLY)	51181	61-04031-002
A5A1S74	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S75	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S76	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S77	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S78	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S78	260-2177-00			SW,CAPACITIVE:30MM,LOW PROFILE W/LED (OPTION 4K 4109 ONLY)	80009	260-2177-00
A5A1S79	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S80	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S81	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S82	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S83	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S84	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE (4109 ONLY)	80009	260-2176-00
A5A1S84	118-3018-00			SWITCH: (CX4109 LEFT SWITCH ONLY)	51181	61-04031-002
A5A1S84	118-3029-00			SWITCH: (CX4109 RIGHT SWITCH ONLY)	51181	61-04031-001
A5A1S85	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S86	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S87	260-2176-00			SW,CAPACITIVE:30MM,LOW PROFILE	80009	260-2176-00
A5A1S88	118-3018-00			SWITCH:	51181	61-04031-002

Component No.	Tektronix Part No.	Serial/Assembly No. Effective Dscont	Name & Description	Mfr. Code	Mfr. Part No.
			(CX4109 LEFT SWITCH ONLY)		
A5A1S88	118-3029-00		SWITCH: (CX4109 RIGHT SWITCH ONLY)	51181	61-04031-001
A5A1S93	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S94	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S95	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S96	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S97	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S98	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S99	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S100	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S101	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S102	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S103	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1S104	260-2176-00		SW,CAPACITIVE:30MM,LOW PROFILE (CX4109 ONLY)	80009	260-2176-00
A5A1U1	118-0941-00		MICROCKT,LINEAR:KYBD DETECTOR,CAPACITIVE (4109 ONLY)	51181	22-00908-016
A5A1U1	118-4101-00		MICROCKT,DGTL:CUSTOM PROGRAM (CX4109 ONLY)	51181	20-08051-711
A5A1U2	118-0973-00		MICROCKT,DGTL:TTL,X-LINE DRIVER (4109 ONLY)	51181	22-00950-016
A5A1U2	156-0469-02		MICROCKT,DGTL:3/8 LINE DCDR (CX4109 ONLY)	01295	SN74LS138NP3
A5A1U3	118-3024-00		MICROCKT,DGTL:CUSTOM KEYTRONICS (4109 ONLY)	51181	20-08048-473
A5A1U3	156-0469-02		MICROCKT,DGTL:3/8 LINE DCDR (CX4109 ONLY)	01295	SN74LS138NP3
A5A1U4	156-0153-02		MICROCKT,DGTL:HEX INVERTER BUFFER (4109 ONLY)	18324	N7406(NB OR FB)
A5A1U5	156-1080-01		MICROCKT,DGTL:HEX BUFFERS W/OC HV OUT,SCRN (4109 ONLY)	01295	SN7407NP3
A5A1U5	156-0865-02		MICROCKT,DGTL:OCTAL D FF W/CLEAR (CX4109 ONLY)	01295	SN74LS273NP3
A5A1U7	156-0140-02		MICROCKT,DGTL:HEX BUFFERS W/OC HV OUT, (CX4109 ONLY)	18324	N7417(NB OR FB)
A5A1U8	156-0093-02		MICROCKT,DGTL:HEX INV BUFFER (CX4109 ONLY)	18324	N7416(NB OR FB)
A5A1U9	118-0941-00		MICROCKT,LINEAR:KYBD DETECTOR,CAPACITIVE (CX4109 ONLY)	51181	22-00908-016
A5A1U10	156-0402-00		MICROCKT,LINEAR:TIMER (CX4109 ONLY)	27014	LM555CN
A5A1U11	156-0277-01		MICROCKT,LINEAR:POS VOLTAGE REG,BURN-IN (CX4109 ONLY)	04713	MC7805CTD
A5A1VR6	156-0277-01		MICROCKT,LINEAR:POS VOLTAGE REG,BURN-IN (4109 ONLY)	04713	MC7805CTD
A5A1Y1	118-3011-00		XTAL UNIT,QTZ:4.608MHZ (4109 ONLY)	51181	48-00300-107
A5A1Y1	118-4036-00		OSC,XTAL CLOCK:7.3728MHZ (CX4109 ONLY)	51181	48-00300-123
A5A1Z1	118-3012-00		MICROCKT,HYBRID: (4109 ONLY)	51181	22-00920-000

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6	620-0003-00	B010100	B010329	POWER SUPPLY:LOGIC (4109 ONLY)	80009	620-0003-00
A6	620-0003-15	B010330	B011584	POWER SUPPLY:LOGIC (4109 ONLY)	80009	620-0003-15
A6	620-0003-16	B011585	B022634	POWER SUPPLY:LOGIC (4109 ONLY)	80009	620-0003-16
A6	620-0019-05	B022635	B023234	POWER SUPPLY: (4109 ONLY)	80009	620-0019-05
A6	620-0019-05	B023235		POWER SUPPLY: (4109 ONLY)	80009	620-0019-05
A6	620-0019-05	B010100	B020199	POWER SUPPLY: (CX4109 ONLY)	80009	620-0019-95
A6	620-0019-05	B020200		POWER SUPPLY: (CX4109 ONLY)	80009	620-0019-05
A6	620-0019-05	B010100		POWER SUPPLY: (CX4109A ONLY)	80009	620-0019-05
A6C5	290-0942-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:100UF,+100-10%,25V (4109 ONLY)	55680	UPA1E101MAH
A6C11	290-0685-00			CAP,FXD,ELCTLT:3900UF,20%,10V	56289	512D398U010FV3DS
A6C12	290-0685-00			CAP,FXD,ELCTLT:3900UF,20%,10V	56289	512D398U010FV3DS
A6C15	290-0685-00			CAP,FXD,ELCTLT:3900UF,20%,10V	56289	512D398U010FV3DS
A6C16	290-0685-00			CAP,FXD,ELCTLT:3900UF,20%,10V	56289	512D398U010FV3DS
A6C17	290-0778-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C22	290-0778-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C25	290-0778-00	620-0019-01		CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C25	290-0778-00			CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (CX4109 ONLY)	54473	ECE-A50N1
A6C32	290-0778-00	620-0019-01		CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C32	290-0778-00			CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (CX4109 ONLY)	54473	ECE-A50N1
A6C34	290-0942-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:100UF,+100-10%,25V (4109 ONLY)	55680	UPA1E101MAH
A6C39	290-0768-00	620-0019-01		CAP,FXD,ELCTLT:10UF,+50-10%,100VDC (4109 ONLY)	54473	ECE-A100V10L
A6C39	290-0768-00			CAP,FXD,ELCTLT:10UF,+50-10%,100VDC (CX4109 ONLY)	54473	ECE-A100V10L
A6C104	290-0778-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C105	281-0773-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:0.01UF,10%,100V (4109 ONLY)	04222	MA201C103KAA
A6C105	290-0942-00	620-0019-01		CAP,FXD,ELCTLT:100UF,+100-10%,25V (4109 ONLY)	55680	UPA1E101MAH
A6C105	290-0942-00			CAP,FXD,ELCTLT:100UF,+100-10%,25V (CX4109 ONLY)	55680	UPA1E101MAH
A6C107	290-0768-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:10UF,+50-10%,100VDC (4109 ONLY)	54473	ECE-A100V10L
A6C111	290-0685-00	620-0019-01		CAP,FXD,ELCTLT:3900UF,20%,10V (4109 ONLY)	56289	512D398U010FV3DS
A6C111	290-0685-00			CAP,FXD,ELCTLT:3900UF,20%,10V (CX4109 ONLY)	56289	512D398U010FV3DS
A6C112	290-0800-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:250UF,+100-10%,20V (4109 ONLY)	56289	672D257H020DM5C
A6C115	290-0685-00	620-0019-01		CAP,FXD,ELCTLT:3900UF,20%,10V (4109 ONLY)	56289	512D398U010FV3DS
A6C115	290-0685-00			CAP,FXD,ELCTLT:3900UF,20%,10V (CX4109 ONLY)	56289	512D398U010FV3DS
A6C131	283-0425-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:650PF,10%,1000V (4109 ONLY)	60705	ORDER BY DESCR

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6C137	281-0775-00	620-0019-01		CAP,FXD,CER DI:0.1UF,20%,50V (4109 ONLY)	04222	MA205E104MAA
A6C137	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (CX4109 ONLY)	04222	MA205E104MAA
A6C215	290-0800-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:250UF,+100-10%,20V (4109 ONLY)	56289	672D257H020DM5C
A6C216	290-0683-00	620-0019-01		CAP,FXD,ELCTLT:100UF,+20%,200V (4109 ONLY)	TK0510	ECE-A2ES101
A6C216	290-0683-00			CAP,FXD,ELCTLT:100UF,+20%,200V (CX4109 ONLY)	TK0510	ECE-A2ES101
A6C220	290-0800-00	620-0019-01		CAP,FXD,ELCTLT:250UF,+100-10%,20V (4109 ONLY)	56289	672D257H020DM5C
A6C220	290-0800-00			CAP,FXD,ELCTLT:250UF,+100-10%,20V (CX4109 ONLY)	56289	672D257H020DM5C
A6C221	290-0800-00	620-0019-01		CAP,FXD,ELCTLT:250UF,+100-10%,20V (4109 ONLY)	56289	672D257H020DM5C
A6C221	290-0800-00			CAP,FXD,ELCTLT:250UF,+100-10%,20V (CX4109 ONLY)	56289	672D257H020DM5C
A6C230	281-0775-00	620-0003-16	620-0003-16	CAP,FXD,CER DI:0.1UF,20%,50V (4109 ONLY)	04222	MA205E104MAA
A6C231	283-0280-00	620-0019-01		CAP,FXD,CER DI:2200PF,10%,2000V (4109 ONLY)	60705	564CBA202EH222
A6C231	283-0280-00			CAP,FXD,CER DI:2200PF,10%,2000V (CX4109 ONLY)	60705	564CBA202EH222
A6C233	281-0826-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:2200PF,5%,100V (4109 ONLY)	20932	401EM100AD222K
A6C234	290-0768-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:10UF,+50-10%,100VDC (4109 ONLY)	54473	ECE-A100V10L
A6C238	290-0778-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C305	285-1259-00	620-0003-00	620-0003-15	CAP,FXD,MTLZD:0.015UF,10%,250V (4109 ONLY)	TK0515	PME271Y515
A6C305	285-1326-00	620-0003-16		CAP,FXD,MTLZD:0.15UF,20%,250VAC (4109 ONLY)	TK0515	PME265MB5150M
A6C305	285-1326-00			CAP,FXD,MTLZD:0.15UF,20%,250VAC (CX4109 ONLY)	TK0515	PME265MB5150M
A6C308	283-0008-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:0.1UF,20%,500V (4109 ONLY)	51642	500-500-X7R-104M
A6C308	285-1250-00	620-0019-01		CAP,FXD,PPR DI:0.1UF,20%,250VAC (4109 ONLY)	55112	158/.1M 250 IS
A6C308	285-1250-00			CAP,FXD,PPR DI:0.1UF,20%,250VAC (CX4109 ONLY)	55112	158/.1M 250 IS
A6C314	283-0008-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:0.1UF,20%,500V (4109 ONLY)	51642	500-500-X7R-104M
A6C314	285-1250-00	620-0019-01		CAP,FXD,PPR DI:0.1UF,20%,250VAC (4109 ONLY)	55112	158/.1M 250 IS
A6C314	285-1250-00			CAP,FXD,PPR DI:0.1UF,20%,250VAC (CX4109 ONLY)	55112	158/.1M 250 IS
A6C316	290-0683-00	620-0019-01		CAP,FXD,ELCTLT:100UF,+20%,200V (4109 ONLY)	TK0510	ECE-A2ES101
A6C316	290-0683-00			CAP,FXD,ELCTLT:100UF,+20%,200V (CX4109 ONLY)	TK0510	ECE-A2ES101
A6C317	290-0683-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:100UF,+20%,200V (4109 ONLY)	TK0510	ECE-A2ES101
A6C318	290-0683-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:100UF,+20%,200V (4109 ONLY)	TK0510	ECE-A2ES101
A6C325	283-0057-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:0.1UF,+80-20%,200V (4109 ONLY)	04222	SR306E104ZAA
A6C326	283-0057-00	620-0019-01		CAP,FXD,CER DI:0.1UF,+80-20%,200V (4109 ONLY)	04222	SR306E104ZAA
A6C326	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V (CX4109 ONLY)	04222	SR306E104ZAA
A6C329	285-1325-00	620-0019-01		CAP,FXD,MTLZD:1UF,10%,400VDC	TK0515	PHE404KF710

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
				(4109 ONLY)		
A6C329	285-1325-00			CAP,FXD,MTLZD:1UF,10%,400VDC (CX4109 ONLY)	TK0515	PHE404KF710
A6C331	285-1308-00	620-0003-00	620-0003-15	CAP,FXD,PPR DI:1.0UF,10%,400VAC (4109 ONLY)	TK1645	PME261VE7100K
A6C331	285-1325-00	620-0003-16	620-0003-16	CAP,FXD,MTLZD:1UF,10%,400VDC (4109 ONLY)	TK0515	PHE404KF710
A6C331	281-0775-00	620-0019-01		CAP,FXD,CER DI:0.1UF,20%,50V (4109 ONLY)	04222	MA205E104MAA
A6C331	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (CX4109 ONLY)	04222	MA205E104MAA
A6C332	281-0826-00	620-0019-01		CAP,FXD,CER DI:2200PF,5%,100V (4109 ONLY)	20932	401EM100AD222K
A6C332	281-0826-00			CAP,FXD,CER DI:2200PF,5%,100V (CX4109 ONLY)	20932	401EM100AD222K
A6C334	281-0774-00	620-0019-01		CAP,FXD,CER DI:0.022MFD,20%,100V (4109 ONLY)	04222	MA201E223MAA
A6C334	281-0774-00			CAP,FXD,CER DI:0.022MFD,20%,100V (CX4109 ONLY)	04222	MA201E223MAA
A6C335	281-0774-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:0.022MFD,20%,100V (4109 ONLY)	04222	MA201E223MAA
A6C336	281-0775-00	620-0003-00	620-0003-16	CAP,FXD,CER DI:0.1UF,20%,50V (4109 ONLY)	04222	MA205E104MAA
A6C336	281-0770-00	620-0019-01		CAP,FXD,CER DI:1000PF,20%,100V (4109 ONLY)	04222	MA101C102MAA
A6C336	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V (CX4109 ONLY)	04222	MA101C102MAA
A6C341	281-0775-00	620-0019-01		CAP,FXD,CER DI:0.1UF,20%,50V (4109 ONLY)	04222	MA205E104MAA
A6C341	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (CX4109 ONLY)	04222	MA205E104MAA
A6C342	290-0778-00	620-0019-01		CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (4109 ONLY)	54473	ECE-A50N1
A6C342	290-0778-00			CAP,FXD,ELCTLT:1UF,+50 -10%,50V,NPLZD (CX4109 ONLY)	54473	ECE-A50N1
A6C348	290-0844-00	620-0019-01		CAP,FXD,ELCTLT:100UF,+75-10%,35V (4109 ONLY)	54473	ECE-A35V100L
A6C348	290-0844-00			CAP,FXD,ELCTLT:100UF,+75-10%,35V (CX4109 ONLY)	54473	ECE-A35V100L
A6C403	285-1259-00	620-0003-00	620-0003-15	CAP,FXD,MTLZD:0.015UF,10%,250V (4109 ONLY)	TK0515	PME271Y515
A6C403	285-1326-00	620-0003-16		CAP,FXD,MTLZD:0.15UF,20%,250VAC (4109 ONLY)	TK0515	PME265MB5150M
A6C403	285-1326-00			CAP,FXD,MTLZD:0.15UF,20%,250VAC (CX4109 ONLY)	TK0515	PME265MB5150M
A6C405	285-1259-00	620-0003-00	620-0003-15	CAP,FXD,MTLZD:0.015UF,10%,250V (4109 ONLY)	TK0515	PME271Y515
A6C405	285-1326-00	620-0003-16		CAP,FXD,MTLZD:0.15UF,20%,250VAC (4109 ONLY)	TK0515	PME265MB5150M
A6C405	285-1326-00			CAP,FXD,MTLZD:0.15UF,20%,250VAC (CX4109 ONLY)	TK0515	PME265MB5150M
A6C406	285-1259-00	620-0003-00	620-0003-15	CAP,FXD,MTLZD:0.015UF,10%,250V (4109 ONLY)	TK0515	PME271Y515
A6C406	285-1326-00	620-0003-16		CAP,FXD,MTLZD:0.15UF,20%,250VAC (4109 ONLY)	TK0515	PME265MB5150M
A6C406	285-1326-00			CAP,FXD,MTLZD:0.15UF,20%,250VAC (CX4109 ONLY)	TK0515	PME265MB5150M
A6C417	290-0683-00	620-0019-01		CAP,FXD,ELCTLT:100UF,+20%,200V (4109 ONLY)	TK0510	ECE-A2ES101
A6C417	290-0683-00			CAP,FXD,ELCTLT:100UF,+20%,200V (CX4109 ONLY)	TK0510	ECE-A2ES101
A6C418	290-0683-00	620-0019-01		CAP,FXD,ELCTLT:100UF,+20%,200V (4109 ONLY)	TK0510	ECE-A2ES101

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6C418	290-0683-00			CAP,FXD,ELCTLT:100UF,+20%,200V (CX4109 ONLY)	TK0510	ECE-A2ES101
A6C432	290-0844-00	620-0003-00	620-0003-16	CAP,FXD,ELCTLT:100UF,+75-10%,35V (4109 ONLY)	54473	ECE-A35V100L
A6CR26	152-0141-02	620-0003-00	620-0003-16	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 (4109 ONLY)	03508	DA2527 (1N4152)
A6CR31	152-0400-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,400V,1A (4109 ONLY)	04713	SR1977K
A6CR32	152-0400-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,400V,1A (4109 ONLY)	04713	SR1977K
A6CR36	152-0398-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR37	152-0398-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR38	152-0398-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR116	152-0827-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,45V,3A (4109 ONLY)	04713	MBR2545CT
A6CR119	152-0523-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECTIFIER,SI,100V (4109 ONLY)	12969	VES1102
A6CR119	152-0884-00	620-0019-01		SEMICOND DVC,DI:16 AMP,35V,TO-220,AC PKG (4109 ONLY)	04713	MBR1635
A6CR119	152-0884-00			SEMICOND DVC,DI:16 AMP,35V,TO-220,AC PKG (CX4109 ONLY)	04713	MBR1635
A6CR125	152-0884-00	620-0019-01		SEMICOND DVC,DI:16 AMP,35V,TO-220,AC PKG (4109 ONLY)	04713	MBR1635
A6CR125	152-0884-00			SEMICOND DVC,DI:16 AMP,35V,TO-220,AC PKG (CX4109 ONLY)	04713	MBR1635
A6CR126	152-0141-02	620-0019-01		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 (4109 ONLY)	03508	DA2527 (1N4152)
A6CR126	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 (CX4109 ONLY)	03508	DA2527 (1N4152)
A6CR127	152-0523-00	620-0019-01		SEMICOND DVC,DI:RECTIFIER,SI,100V (4109 ONLY)	12969	VES1102
A6CR127	152-0523-00			SEMICOND DVC,DI:RECTIFIER,SI,100V (CX4109 ONLY)	12969	VES1102
A6CR128	152-0523-00	620-0019-01		SEMICOND DVC,DI:RECTIFIER,SI,100V (4109 ONLY)	12969	VES1102
A6CR128	152-0523-00			SEMICOND DVC,DI:RECTIFIER,SI,100V (CX4109 ONLY)	12969	VES1102
A6CR133	152-0398-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR133	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6CR136	152-0398-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR136	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6CR138	152-0066-03	620-0003-00	620-0003-15	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41 (4109 ONLY)	14433	LG4017
A6CR138	152-0398-00	620-0003-16		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR138	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6CR217	152-0523-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECTIFIER,SI,100V (4109 ONLY)	12969	VES1102
A6CR218	152-0066-03	620-0003-00	620-0003-15	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41 (4109 ONLY)	14433	LG4017
A6CR218	152-0398-00	620-0003-16	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR219	152-0400-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:RECT,SI,400V,1A (4109 ONLY)	04713	SR1977K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6CR222	152-0400-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,400V,1A (4109 ONLY)	04713	SR1977K
A6CR222	152-0400-00			SEMICOND DVC,DI:RECT,SI,400V,1A (CX4109 ONLY)	04713	SR1977K
A6CR226	152-0400-00			SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A6CR232	152-0066-03	620-0003-00	620-0003-15	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41 (4109 ONLY)	14433	LG4017
A6CR232	152-0398-00	620-0003-16	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR233	152-0066-03	620-0003-00	620-0003-15	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41 (4109 ONLY)	14433	LG4017
A6CR233	152-0398-00	620-0003-16	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR234	152-0398-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR234	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6CR235	152-0398-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR235	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6CR237	152-0398-00	620-0003-16	620-0003-16	SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR311	152-0848-00			SEMICOND DVC,DI:RECT BRDG,600V,2A,FAST RCVY	14936	RKBF06
A6CR336	152-0141-02	620-0003-00	620-0003-16	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 (4109 ONLY)	03508	DA2527 (1N4152)
A6CR346	152-0398-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR346	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6CR431	152-0398-00	620-0019-01		SEMICOND DVC,DI:RECT,SI,200V,1A (4109 ONLY)	04713	SR3609RL
A6CR431	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A (CX4109 ONLY)	04713	SR3609RL
A6DS325	150-0035-00	620-0003-00	620-0003-16	LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD (4109 ONLY)	TK0213	JH005/3011JA
A6DS328	150-0035-00	620-0019-01		LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD (4109 ONLY)	TK0213	JH005/3011JA
A6DS328	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD (CX4109 ONLY)	TK0213	JH005/3011JA
A6F505	159-0149-00			FUSE,CARTRIDGE:4 A,250 V, SLOW BLOW	75915	326.004
A6FL409	119-1168-00	620-0003-00	620-0003-15	CAPACITOR-RES:0.1UF,20% & 22 OHM,10%,250VAC (4109 ONLY)	14752	RG1782-1
A6FL409	119-1939-00	620-0003-16	620-0003-16	CAPACITOR-RES:100 OHM,0.1UF,250VAC (4109 ONLY)	TK0515	PMR210ME6100M100
A6FL509	119-1939-00	620-0019-01		CAPACITOR-RES:100 OHM,0.1UF,250VAC (4109 ONLY)	TK0515	PMR210ME6100M100
A6FL509	119-1939-00			CAPACITOR-RES:100 OHM,0.1UF,250VAC (CX4109 ONLY)	TK0515	PMR210ME6100M100
A6J1	131-3000-00			CONN,RCPT,ELEC:PWR,3 MALE,250VAC,6A	82389	5C1181B
A6J2	131-1737-00			CONN,RCPT,ELEC:CKT BD,9 CONT,W/LKG EARS	00779	350712-1
A6J3	131-3089-00			CONN,RCPT,ELEC:HEADER,3 X 1,0.175 SPACING	00779	350789-1(MAT-N-L
A6J4	131-2909-00			CONN,RCPT,ELEC:MOLEX,1 X 10,0.156 SPACING	27264	09-71-1101
A6J5	131-0608-00	620-0003-00	620-0003-15	TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 2) (4109 ONLY)	22526	48283-036
A6J5	131-1857-00	620-0003-16		TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS (QUANTITY OF 2) (4109 ONLY)	TK1483	082-3643-SS10
A6J5	131-1857-00			TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS (QUANTITY OF 2) (CX4109 ONLY)	TK1483	082-3643-SS10

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6J6	131-0608-00	620-0003-00	620-0003-15	TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 3) (4109 ONLY)	22526	48283-036
A6J6	131-1857-00	620-0003-16		TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS (QUANTITY OF 3) (4109 ONLY)	TK1483	082-3643-SS10
A6J6	131-1857-00			TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS (QUANTITY OF 3) (CX4109 ONLY)	TK1483	082-3643-SS10
A6J7	131-3380-00	620-0019-01		CONN,RCPT,ELEC:HEADER,1 X 4,0.156 CTR	00779	643990-1
A6J8	131-0589-00	620-0003-00	620-0003-15	TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ (QUANTITY OF 2) (4109 ONLY)	22526	48283-029
A6J8	131-3340-00	620-0003-16		CONN,ELEC,RCPT:HEADER,1 X 36,0.1 SPACING (QUANTITY OF 2) (4109 ONLY)	22526	65499-136
A6J8	131-3340-00			CONN,ELEC,RCPT:HEADER,1 X 36,0.1 SPACING (QUANTITY OF 2) (CX4109 ONLY)	22526	65499-136
A6L6	108-0554-00			COIL,RF:FIXED,5UH,+/-20%	TK1345	108-0554-00
A6L235	108-1266-00	620-0019-01		COIL,RF:4.5UH,10%,1/2W (4109 ONLY)	80009	108-1266-00
A6L235	108-1266-00			COIL,RF:4.5UH,10%,1/2W (CX4109 ONLY)	80009	108-1266-00
A6L324	108-1255-00	620-0019-01		COIL,RF:200UH,1.5ADC (4109 ONLY)	02113	F5152-A
A6L324	108-1255-00			COIL,RF:200UH,1.5ADC (CX4109 ONLY)	02113	F5152-A
A6L325	108-1255-00	620-0019-01		COIL,RF:200UH,1.5ADC (4109 ONLY)	02113	F5152-A
A6L325	108-1255-00			COIL,RF:200UH,1.5ADC (CX4109 ONLY)	02113	F5152-A
A6L425	108-1209-00			COIL,RF:FXD TOROIDAL,80UH MIN,3A DC	94617	ORDER BY DESCR
A6L525	108-1209-00			COIL,RF:FXD TOROIDAL,80UH MIN,3A DC	94617	ORDER BY DESCR
A6Q18	151-0503-00	620-0003-00	620-0003-16	SCR:SI,TO-92 (4109 ONLY)	04713	SCR5138
A6Q31	151-0503-00	620-0019-01		SCR:SI,TO-92 (4109 ONLY)	04713	SCR5138
A6Q31	151-0503-00			SCR:SI,TO-92 (CX4109 ONLY)	04713	SCR5138
A6Q37	151-0710-00	620-0003-00	620-0003-16	TRANSISTOR:NPN,SI,TO-92 PLUS (4109 ONLY)	04713	MPSW01A
A6Q109	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A6Q111	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A6Q117	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A6Q119	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A6Q135	151-0378-00	620-0003-00	620-0003-15	TRANSISTOR:NPN,SI,TO-220 (4109 ONLY)	61271	2SC3178
A6Q135	151-0707-00	620-0003-16	620-0003-16	TRANSISTOR:POWER,NPN,SI,TO-220 (4109 ONLY)	04713	MJE8503
A6Q139	151-0710-00	620-0019-01		TRANSISTOR:NPN,SI,TO-92 PLUS (4109 ONLY)	04713	MPSW01A
A6Q139	151-0710-00			TRANSISTOR:NPN,SI,TO-92 PLUS (CX4109 ONLY)	04713	MPSW01A
A6Q233	151-0707-00	620-0019-01		TRANSISTOR:POWER,NPN,SI,TO-220 (4109 ONLY)	04713	MJE8503
A6Q233	151-0707-00			TRANSISTOR:POWER,NPN,SI,TO-220 (CX4109 ONLY)	04713	MJE8503
A6Q237	151-0710-00	620-0019-01		TRANSISTOR:NPN,SI,TO-92 PLUS (4109 ONLY)	04713	MPSW01A
A6Q237	151-0710-00			TRANSISTOR:NPN,SI,TO-92 PLUS (CX4109 ONLY)	04713	MPSW01A

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6Q332	151-0188-00	620-0019-01		TRANSISTOR:PNP,SI,TO-92 (4109 ONLY)	80009	151-0188-00
A6Q332	151-0188-00			TRANSISTOR:PNP,SI,TO-92 (CX4109 ONLY)	80009	151-0188-00
A6Q333	151-0190-00	620-0003-00	620-0003-16	TRANSISTOR:NPN,SI,TO-92 (4109 ONLY)	80009	151-0190-00
A6Q334	151-0503-00	620-0003-00	620-0003-16	SCR:SI,TO-92 (4109 ONLY)	04713	SCR5138
A6Q337	151-0190-00	620-0019-01		TRANSISTOR:NPN,SI,TO-92 (4109 ONLY)	80009	151-0190-00
A6Q337	151-0190-00			TRANSISTOR:NPN,SI,TO-92 (CX4109 ONLY)	80009	151-0190-00
A6Q338	151-0188-00	620-0003-00	620-0003-16	TRANSISTOR:PNP,SI,TO-92 (4109 ONLY)	80009	151-0188-00
A6Q341	151-0503-00	620-0019-01		SCR:SI,TO-92 (4109 ONLY)	04713	SCR5138
A6Q341	151-0503-00			SCR:SI,TO-92 (CX4109 ONLY)	04713	SCR5138
A6R14	315-0331-00	620-0003-00	620-0003-16	RES,FXD,FILM:330 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E330E
A6R15	315-0101-00	620-0003-00	620-0003-16	RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R16	315-0101-00	620-0003-00	620-0003-16	RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R17	321-0248-00	620-0003-00	620-0003-16	RES,FXD,FILM:3.74K OHM,1%,0.125W,TC=T0 (4109 ONLY)	19701	5043ED3K740F
A6R18	315-0131-00	620-0003-00	620-0003-16	RES,FXD,FILM:130 OHM,5%,0.25W (4109 ONLY)	19701	5043CX130R0J
A6R23	315-0102-00	620-0003-00	620-0003-16	RES,FXD,FILM:1K OHM,5%,0.25W (4109 ONLY)	57668	NTR25JE01K0
A6R24	315-0682-00	620-0003-00	620-0003-16	RES,FXD,FILM:6.8K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E06K8
A6R25	321-0246-00	620-0003-00	620-0003-16	RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0 (4109 ONLY)	19701	5043ED3K570F
A6R26	321-0246-00	620-0019-01		RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0 (4109 ONLY)	19701	5043ED3K570F
A6R26	321-0246-00			RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0 (CX4109 ONLY)	19701	5043ED3K570F
A6R27	301-0391-00	620-0003-00	620-0003-16	RES,FXD,FILM:390 OHM,5%,0.5W (4109 ONLY)	01121	EB3915
A6R27	315-0101-00	620-0019-01		RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R27	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 100E
A6R28	315-0101-00	620-0019-01		RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R28	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 100E
A6R31	315-0822-00	620-0003-00	620-0003-16	RES,FXD,FILM:8.2K OHM,5%,0.25W (4109 ONLY)	19701	5043CX8K200J
A6R32	305-0431-00	620-0003-00	620-0003-16	RES,FXD,CMPSN:430 OHM,5%,2W (4109 ONLY)	01121	HB4315
A6R33	321-0248-00	620-0019-01		RES,FXD,FILM:3.74K OHM,1%,0.125W,TC=T0 (4109 ONLY)	19701	5043ED3K740F
A6R33	321-0248-00			RES,FXD,FILM:3.74K OHM,1%,0.125W,TC=T0 (CX4109 ONLY)	19701	5043ED3K740F
A6R34	315-0682-00	620-0019-01		RES,FXD,FILM:6.8K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E06K8
A6R34	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E06K8
A6R35	301-0102-00	620-0003-00	620-0003-16	RES,FXD,FILM:1K OHM,5%,0.50W (4109 ONLY)	19701	5053CX1K000J

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6R35	315-0102-00	620-0019-01		RES,FXD,FILM:1K OHM,5%,0.25W (4109 ONLY)	57668	NTR25JE01K0
A6R35	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25JE01K0
A6R102	321-0099-00	620-0003-00	620-0003-16	RES,FXD,FILM:105 OHM,1%,0.125W,TC=T0 (4109 ONLY)	07716	CEAD105R0F
A6R103	323-0214-00	620-0003-00	620-0003-16	RES,FXD,FILM:1.65K OHM,1%,0.5W,TC=T0 (4109 ONLY)	19701	5053RD1K650F
A6R105	303-0331-00	620-0019-01		RES,FXD,CMPSN:330 OHM,5%,1W (4109 ONLY)	01121	GB3315
A6R105	303-0331-00			RES,FXD,CMPSN:330 OHM,5%,1W (CX4109 ONLY)	01121	GB3315
A6R106	321-0153-00	620-0019-01		RES,FXD,FILM:383 OHM,1%,0.125W,TC=T0 (4109 ONLY)	07716	CEAD383R0F
A6R106	321-0153-00			RES,FXD,FILM:383 OHM,1%,0.125W,TC=T0 (CX4109 ONLY)	07716	CEAD383R0F
A6R107	303-0331-00	620-0003-00	620-0003-16	RES,FXD,CMPSN:330 OHM,5%,1W (4109 ONLY)	01121	GB3315
A6R107	321-0257-00	620-0019-01		RES,FXD,FILM:4.64K OHM,1%,0.125W,TC=T0 (4109 ONLY)	19701	5043ED4K640F
A6R107	321-0257-00			RES,FXD,FILM:4.64K OHM,1%,0.125W,TC=T0 (CX4109 ONLY)	19701	5043ED4K640F
A6R108	308-0757-00			RES,FXD,WW:0.025 OHM,3%,5W	14193	SA50-R025H
A6R111	315-0331-00	620-0003-00	620-0003-16	RES,FXD,FILM:330 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E330E
A6R114	315-0431-00	620-0003-00	620-0003-16	RES,FXD,FILM:430 OHM,5%,0.25W (4109 ONLY)	19701	5043CX430R0J
A6R115	315-0431-00	620-0003-00	620-0003-16	RES,FXD,FILM:430 OHM,5%,0.25W (4109 ONLY)	19701	5043CX430R0J
A6R116	308-0755-00			RES,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
A6R117	315-0431-00	620-0019-01		RES,FXD,FILM:430 OHM,5%,0.25W (4109 ONLY)	19701	5043CX430R0J
A6R117	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX430R0J
A6R118	315-0103-00	620-0003-00	620-0003-16	RES,FXD,FILM:10K OHM,5%,0.25W (4109 ONLY)	19701	5043CX10K00J
A6R118	315-0431-00	620-0019-01		RES,FXD,FILM:430 OHM,5%,0.25W (4109 ONLY)	19701	5043CX430R0J
A6R118	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX430R0J
A6R119	315-0331-00	620-0019-01		RES,FXD,FILM:330 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E330E
A6R119	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E330E
A6R125	301-0391-00	620-0019-01		RES,FXD,FILM:390 OHM,5%,0.5W (4109 ONLY)	01121	EB3915
A6R125	301-0391-00			RES,FXD,FILM:390 OHM,5%,0.5W (CX4109 ONLY)	01121	EB3915
A6R134	315-0822-00	620-0019-01	620-0019-01	RES,FXD,FILM:8.2K OHM,5%,0.25W (4109 ONLY)	19701	5043CX8K200J
A6R134	315-0203-00	620-0019-02		RES,FXD,FILM:20K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 20K
A6R134	315-0822-00			RES,FXD,FILM:8.2K OHM,5%,0.25W (CX4109 ONLY)	19701	5043CX8K200J
A6R134	315-0203-00	620-0019-02		RES,FXD,FILM:20K OHM,5%,0.25W (CX4109A ONLY)	57668	NTR25J-E 20K
A6R135	308-0872-00	620-0003-00	620-0003-16	RES,FXD,WW:36 OHM,5%,FUSIBLE (4109 ONLY)	TK1815	RGUSL 36 10%
A6R135	301-0202-00	620-0019-01		RES,FXD,FILM:2K OHM,5%,0.5W (4109 ONLY)	19701	5053CX2K000J
A6R135	301-0202-00			RES,FXD,FILM:2K OHM,5%,0.5W (CX4109 ONLY)	19701	5053CX2K000J

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6R136	308-0872-00	620-0003-00	620-0003-16	RES,FXD,WW:36 OHM,5%,FUSIBLE (4109 ONLY)	TK1815	RGUSL 36 10%
A6R223	308-0363-00	620-0003-00	620-0003-16	RES,FXD,WW:3K OHM,5%,8W (4109 ONLY)	14193	SAV96-3001J
A6R223	308-0067-00	620-0019-01		RES,FXD,WW:750 OHM,5%,5W (4109 ONLY)	00213	1550S 750R0J
A6R223	308-0067-00			RES,FXD,WW:750 OHM,5%,5W (CX4109 ONLY)	00213	1550S 750R0J
A6R230	315-0104-00	620-0003-16	620-0003-16	RES,FXD,FILM:100K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E100K
A6R232	308-0590-00	620-0003-00	620-0003-16	RES,FXD,WW:0.25 OHM,5%,3W (4109 ONLY)	00213	1240S-R250-5
A6R233	315-0102-00	620-0003-00	620-0003-16	RES,FXD,FILM:1K OHM,5%,0.25W (4109 ONLY)	57668	NTR25JE01K0
A6R234	315-0203-00	620-0003-00	620-0003-16	RES,FXD,FILM:20K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 20K
A6R235	315-0303-00	620-0003-00	620-0003-16	RES,FXD,FILM:30K OHM,5%,0.25W (4109 ONLY)	19701	5043CX30K00J
A6R236	315-0243-00	620-0003-00	620-0003-16	RES,FXD,FILM:24K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E24K0
A6R236	315-0102-00	620-0019-01		RES,FXD,FILM:1K OHM,5%,0.25W (4109 ONLY)	57668	NTR25JE01K0
A6R236	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25JE01K0
A6R237	301-0471-00	620-0003-00	620-0003-16	RES,FXD,FILM:470 OHM,5%,0.5W (4109 ONLY)	19701	5053CX 470R0J
A6R317	301-0154-00	620-0003-00	620-0003-16	RES,FXD,FILM:150K OHM,5%,0.5W (4109 ONLY)	19701	5053CX150K0J
A6R317	303-0473-00	620-0019-01		RES,FXD,CMPSN:47K OHM,5%,1W (4109 ONLY)	01121	GB4735
A6R317	303-0473-00			RES,FXD,CMPSN:47K OHM,5%,1W (CX4109 ONLY)	01121	GB4735
A6R321	301-0154-00	620-0003-00	620-0003-16	RES,FXD,FILM:150K OHM,5%,0.5W (4109 ONLY)	19701	5053CX150K0J
A6R322	308-0873-00	620-0003-00	620-0003-16	RES,FXD,WW:3 OHM,10%,5W,FUSIBLE (4109 ONLY)	TK1815	RGUSL3.0 OHMK10%
A6R324	308-0873-00	620-0003-00	620-0003-16	RES,FXD,WW:3 OHM,10%,5W,FUSIBLE (4109 ONLY)	TK1815	RGUSL3.0 OHMK10%
A6R325	315-0915-00	620-0003-00	620-0003-16	RES,FXD,FILM:9.1M OHM,5%,0.25W (4109 ONLY)	01121	CB9155
A6R325	315-0101-00	620-0019-01		RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R325	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 100E
A6R326	305-0104-00	620-0003-00	620-0003-16	RES,FXD,CMPSN:100K OHM,5%,2W (4109 ONLY)	01121	HB1045
A6R327	315-0101-00	620-0019-01		RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R327	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 100E
A6R328	315-0915-00	620-0019-01		RES,FXD,FILM:9.1M OHM,5%,0.25W (4109 ONLY)	01121	CB9155
A6R328	315-0915-00			RES,FXD,FILM:9.1M OHM,5%,0.25W (CX4109 ONLY)	01121	CB9155
A6R330	308-0173-00	620-0019-01		RES,FXD,WW:0.2 OHM,1%,3W (4109 ONLY)	07088	KM300
A6R330	308-0173-00			RES,FXD,WW:0.2 OHM,1%,3W (CX4109 ONLY)	07088	KM300
A6R332	315-0104-00	620-0019-01		RES,FXD,FILM:100K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E100K
A6R332	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E100K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6R334	315-0203-00	620-0019-01		RES,FXD,FILM:20K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 20K
A6R334	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 20K
A6R335	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A6R336	315-0102-00	620-0003-00	620-0003-16	RES,FXD,FILM:1K OHM,5%,0.25W (4109 ONLY)	57668	NTR25JE01K0
A6R336	305-0431-00	620-0019-01		RES,FXD,CMPSN:430 OHM,5%,2W (4109 ONLY)	01121	HB4315
A6R336	305-0431-00			RES,FXD,CMPSN:430 OHM,5%,2W (CX4109 ONLY)	01121	HB4315
A6R337	301-0471-00	620-0019-01		RES,FXD,FILM:470 OHM,5%,0.5W (4109 ONLY)	19701	5053CX 470R0J
A6R337	301-0471-00			RES,FXD,FILM:470 OHM,5%,0.5W (CX4109 ONLY)	19701	5053CX 470R0J
A6R338	315-0101-00	620-0003-00	620-0003-16	RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R338	315-0102-00	620-0019-01		RES,FXD,FILM:1K OHM,5%,0.25W (4109 ONLY)	57668	NTR25JE01K0
A6R338	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25JE01K0
A6R340	315-0203-00	620-0003-00	620-0003-16	RES,FXD,FILM:20K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 20K
A6R343	315-0243-00	620-0019-01		RES,FXD,FILM:24K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E24K0
A6R343	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E24K0
A6R344	315-0101-00	620-0019-01		RES,FXD,FILM:100 OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 100E
A6R344	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 100E
A6R345	315-0203-00	620-0019-01		RES,FXD,FILM:20K OHM,5%,0.25W (4109 ONLY)	57668	NTR25J-E 20K
A6R345	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W (CX4109 ONLY)	57668	NTR25J-E 20K
A6R419	303-0473-00	620-0019-01		RES,FXD,CMPSN:47K OHM,5%,1W (4109 ONLY)	01121	GB4735
A6R419	303-0473-00			RES,FXD,CMPSN:47K OHM,5%,1W (CX4109 ONLY)	01121	GB4735
A6R426	305-0154-00	620-0019-01		RES,FXD,CMPSN:150K OHM,5%,2W (4109 ONLY)	01121	HB1545
A6R426	305-0154-00			RES,FXD,CMPSN:150K OHM,5%,2W (CX4109 ONLY)	01121	HB1545
A6R504	301-0105-00			RES,FXD,FILM:1M OHM,5%,0.50W	19701	5053CX1M000J
A6RT307	307-0746-00			RES,THERMAL:5 OHM,10%,7A/DEG C	15454	SG200-S
A6S201	260-2116-00			SWITCH,SLIDE:DPDT,10A,125VAC,LINE SEL	22753	SE1022SCCEPRHKRA
A6S301	260-2116-00			SWITCH,SLIDE:DPDT,10A,125VAC,LINE SEL	22753	SE1022SCCEPRHKRA
A6S435	260-2229-00	620-0003-00	620-0003-15	SW,PUSH-PUSH:DPST,5A,250V (4109 ONLY)	31918	N30X (602057)
A6S435	260-2259-00	620-0003-16		SWITCH,PUSH:DPST,5A,250V (4109 ONLY)	31918	N30X-2A (602214)
A6S435	260-2259-00			SWITCH,PUSH:DPST,5A,250V (CX4109 ONLY)	31918	N30X-2A (602214)
A6S535	260-2196-00			SWITCH,PUSH:MOMENTARY,4A,250V	31918	NE150.A/01000300
A6T125	120-1496-00	620-0003-00	620-0003-16	XFMR,PWR,STPDN:HF FLYBACK (4109 ONLY)	80009	120-1496-00
A6T125	120-1589-01	620-0019-01		XFMR,POWER:HIGH FREQUENCY FLYBACK (4109 ONLY)	80009	120-1589-01
A6T125	120-1589-01			XFMR,POWER:HIGH FREQUENCY FLYBACK (CX4109 ONLY)	80009	120-1589-01
A6T235	120-1585-00	620-0019-01		XFMR,BASE DRIVE:PROPORTIONAL,3.5/7:1 (4109 ONLY)	TK1601	PE97001

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6T235	120-1585-00			XFMR,BASE DRIVE:PROPORTIONAL,3.5/7:1 (CX4109 ONLY)	TK1601	PE97001
A6T415	120-1480-01	620-0003-00	620-0003-16	XFMR,COM MODE:CHOKE (4109 ONLY)	02113	E-4534-A
A6T515	120-1480-01	620-0019-01		XFMR,COM MODE:CHOKE (4109 ONLY)	02113	E-4534-A
A6T515	120-1480-01			XFMR,COM MODE:CHOKE (CX4109 ONLY)	02113	E-4534-A
A6U27	156-0430-00	620-0003-00	620-0003-16	CPLR,OPTOELECTR:LED & PXSTR,10KV ISOLATION (4109 ONLY)	58361	CNY 65
A6U27	156-0430-00	620-0019-00	620-0019-00	CPLR,OPTOELECTR:LED & PXSTR,10KV ISOLATION (CX4109 ONLY)	58361	CNY 65
A6U37	156-2474-00	620-0019-01		CPLR,OPTOELECTR:LED & PXSTR,10KV ISOLATION	24972	CNY21
A6U238	156-1799-00	620-0019-01		MICROCKT,LINEAR:SWITCHED MODE PWR SPLY CONT (4109 ONLY)	56289	ULN8161M
A6U238	156-1799-00			MICROCKT,LINEAR:SWITCHED MODE PWR SPLY CONT (CX4109 ONLY)	56289	ULN8161M
A6U335	156-1799-00	620-0003-00	620-0003-16	MICROCKT,LINEAR:SWITCHED MODE PWR SPLY CONT (4109 ONLY)	56289	ULN8161M
A6VR16	152-0175-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.4W,DO-7 (4109 ONLY)	14552	TD3810976
A6VR17	152-0149-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:ZEN,SI,10V,5%,0.4W,DO-7 (4109 ONLY)	15238	Z5406
A6VR24	156-1631-00			MICROCKT,LINEAR:ADJUSTABLE SHUNT REGULATOR	01295	TL431C-LP
A6VR35	152-0175-00	620-0019-01		SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.4W,DO-7 (4109 ONLY)	14552	TD3810976
A6VR35	152-0175-00			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.4W,DO-7 (CX4109 ONLY)	14552	TD3810976
A6VR104	156-1529-00	620-0003-00	620-0003-16	MICROCKT,LINEAR:3-TERM ADJ OUT POS V RGLTR (4109 ONLY)	04713	LM317LZ
A6VR237	152-0055-00	620-0003-16	620-0003-16	SEMICOND DVC,DI:ZEN,SI,11V,5%,0.4W,DO-7 (4109 ONLY)	14433	Z5407
A6VR317	152-0599-00			SEMICOND DVC,DI:ZENER,SI,200V	04713	1N6303A
A6VR329	152-0599-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:ZENER,SI,200V (4109 ONLY)	04713	1N6303A
A6VR336	152-0168-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:ZEN,SI,12V,5%,0.4W,DO-763B (4109 ONLY)	14552	TD331689
A6VR337	152-0168-00	620-0019-01		SEMICOND DVC,DI:ZEN,SI,12V,5%,0.4W,DO-763B (4109 ONLY)	14552	TD331689
A6VR337	152-0168-00			SEMICOND DVC,DI:ZEN,SI,12V,5%,0.4W,DO-763B (CX4109 ONLY)	14552	TD331689
A6VR338	152-0571-00	620-0003-00	620-0003-16	SEMICOND DVC,DI:ZEN,SI,16V,5%,0.4W,DO-7 (4109 ONLY)	04713	SZG35014KIRL
A6VR347	152-0571-00	620-0019-01		SEMICOND DVC,DI:ZEN,SI,16V,5%,0.4W,DO-7 (4109 ONLY)	04713	SZG35014KIRL
A6VR347	152-0571-00			SEMICOND DVC,DI:ZEN,SI,16V,5%,0.4W,DO-7 (CX4109 ONLY)	04713	SZG35014KIRL
A6VR417	152-0599-00	620-0019-01		SEMICOND DVC,DI:ZENER,SI,200V (4109 ONLY)	04713	1N6303A
A6VR417	152-0599-00			SEMICOND DVC,DI:ZENER,SI,200V (CX4109 ONLY)	04713	1N6303A
A6VR431	152-0120-00	620-0019-01		SEMICOND DVC,DI:ZEN,SI,10V,5%,1W,A31A (4109 ONLY)	04713	SZ1619
A6VR431	152-0120-00			SEMICOND DVC,DI:ZEN,SI,10V,5%,1W,A31A (CX4109 ONLY)	04713	SZ1619
A7	670-8721-00			CIRCUIT BD ASSY:CX INTERFACE (CX4109 ONLY)	80009	670-8721-00
A7C28	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C115	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C125	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C131	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C211	290-1086-00			CAP,FXD,ELCTLT:22UF,+/-20%,16V	29309	TYPEMDI22UF16V

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A7C221	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C231	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C305	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C315	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C335	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C340	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C345	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C405	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C411	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C421	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C440	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C445	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C505	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C515	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C521	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C525	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C535	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C541	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C601	281-0771-00			CAP,FXD,CER DI:2200PF,20%,200V	04222	MA106E222MAA
A7C615	281-0911-00			CAP,FXD,CER DI:12PF,10%,50V	56289	592CCOG120K050B
A7C626	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C635	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C641	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C740	283-0423-00			CAP,FXD,CER DI:0.22UF,+80-20%,50V	04222	MD015E224ZAA
A7C745	290-1086-00			CAP,FXD,ELCTLT:22UF,+/-20%,16V	29309	TYPEMDI22UF16V
A7CR61	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A7DS20	150-1111-00			LT EMITTING DIO:GREEN,D565NM,35MA	15513	PCL200-MG
A7J1	131-3277-00			CONN,RCPT,ELEC:HDR,2 X 30,SQ,0.1 SPACING	22526	66506-057
A7J2	131-2817-00			CONN,RCPT,ELEC:BNC,FEM,PC MOUNT	00779	227222-1
A7K615	148-0165-00			RELAY,REED:SPDT,5VDC 56 OHM	12300	T81S5D111-05
A7P13	131-2963-00			CONN,RCPT,ELEC:MALE,3 X 32,0.1 CTR	81312	94P032110105-589
A7Q25	151-0728-00			TRANSISTOR:NPN,SI,TO-202	04713	SDS363
A7Q611	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A7R13	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
A7R14	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R46	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
A7R47	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R48	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A7R49	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A7R140	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R225	315-0220-00			RES,FXD,FILM:22 OHM,5%,0.25W	19701	5043CX22R00J
A7R326	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R327	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R435	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R436	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R437	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R438	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R545	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R546	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R621	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R622	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A7R623	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A7R624	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A7R625	315-0121-00			RES,FXD,FILM:120 OHM,5%,0.25W	19701	5043CX120R0J
A7R721	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A7R722	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A7R723	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A7R726	315-0560-00			RES,FXD,FILM:56 OHM,5%,0.25W	57668	NTR25J-E56E0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A7R728	315-0560-00			RES,FXD,FILM:56 OHM,5%,0.25W	57668	NTR25J-E56E0
A7R735	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A7R737	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A7T715	120-1576-00			TRANSFORMER,RF:PULSE	TK1601	5762
A7U45	156-0303-01			MICROCKT,DGTL:QUAD 2 INP NAND GATE	18324	N74S03(NB OR FB)
A7U115	160-2989-00			MICROCKT,DGTL:2048 X 8 ROM,PRGM	80009	160-2989-00
A7U125	160-2990-00			MICROCKT,DGTL:2048 X 8 ROM,PRGM	80009	160-2990-00
A7U131	160-2991-00			MICROCKT,DGTL:2048 X 8 ROM,PRGM	80009	160-2991-00
A7U140	156-2241-00			MICROCKT,DGTL:BIPOLAR MICRO CONT,8 X 305	18324	N8X305N
A7U215	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A7U221	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
A7U225	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
A7U231	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
A7U305	156-1111-02			MICROCKT,DGTL:OCTAL BUS XCVR W/3 STATE OUT	01295	SN74LS245N3
A7U311	156-0541-02			MICROCKT,DGTL:DUAL 2-TO 4-LINE DCDR/DEMUX	04713	SN74LS139NDS
A7U315	156-0989-02			MICROCKT,DGTL:4 X 4 RGTR FILE W/3 STATE OUT	01295	SN74LS670NP3
A7U321	156-0989-02			MICROCKT,DGTL:4 X 4 RGTR FILE W/3 STATE OUT	01295	SN74LS670NP3
A7U335	156-1842-00			MICROCKT,DGTL:CMOS,8192 X 8 SRAM	62786	HM6264P-15
A7U340	156-0323-02			MICROCKT,DGTL:HEX INVERTER,BURN-IN	18324	N74S04(NB OR FB)
A7U345	156-0948-02			MICROCKT,DGTL:QUAD D FF,SCRN	01295	SN74S175J4
A7U405	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A7U411	156-0469-02			MICROCKT,DGTL:3/8 LINE DCDR	01295	SN74LS138NP3
A7U415	156-0989-02			MICROCKT,DGTL:4 X 4 RGTR FILE W/3 STATE OUT	01295	SN74LS670NP3
A7U421	156-0989-02			MICROCKT,DGTL:4 X 4 RGTR FILE W/3 STATE OUT	01295	SN74LS670NP3
A7U425	156-0388-03			MICROCKT,DGTL:DUAL D FLIP-FLOP	01295	SN74LS74ANP3
A7U440	156-0321-02			MICROCKT,DGTL:TRIPLE 3 INP NAND GATE	18324	N74S10(NB OR FB)
A7U445	156-0718-03			MICROCKT,DGTL:TRIPLE 3-INP NOR GATE	01295	SN74LS27NP3
A7U505	156-0385-02			MICROCKT,DGTL:HEX INVERTER	07263	74LS04PCQR
A7U515	156-2243-00			MICROCKT,DGTL:SERIAL BIPHASE RCVR/DECODER	27014	DP8341NA+
A7U521	156-2242-00			MICROCKT,DGTL:SERIAL BIPHASE XMTR/ENCODER	27014	DP8340NA+
A7U525	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A7U531	156-0956-02			MICROCKT,DGTL:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A7U535	156-0694-02			MICROCKT,DGTL:DECODER/3 LINE TO 8 LINE,SCRN	01295	SN74S138N3/J4
A7U541	156-0694-02			MICROCKT,DGTL:DECODER/3 LINE TO 8 LINE,SCRN	01295	SN74S138N3/J4
A7U545	156-0388-03			MICROCKT,DGTL:DUAL D FLIP-FLOP	01295	SN74LS74ANP3
A7U635	156-0865-02			MICROCKT,DGTL:OCTAL D FF W/CLEAR	01295	SN74LS273NP3
A7U640	156-1373-01			MICROCKT,DGTL:QUAD BUS BFR GATES W/3 STATE OUT,SCREENED	27014	DM74LS125 NA+
A7U641	156-0388-03			MICROCKT,DGTL:DUAL D FLIP-FLOP	01295	SN74LS74ANP3
A7U725	156-2244-00			MICROCKT,DGTL:QUAD LINE DRVR W/3-STATE OUT	04713	MC3487PD
A7U730	156-0388-03			MICROCKT,DGTL:DUAL D FLIP-FLOP	01295	SN74LS74ANP3
A7U740	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A7Y45	119-1897-00			OSCILLATOR,RF:XTAL CONTROLLED,8.00MHZ,0.01%	01537	RASCO-1-8.00 MHZ
A7Y627	119-1898-00			OSCILLATOR,RF:XTAL CONT,18.868MHZ,0.01%	01537	RASCO1E18.868MHZ
DS5001	150-1071-00			LT EMITTING DIO:GREEN,565NM,20MA MAX	50434	HLMP3910

Section 10

DIAGRAMS

INTRODUCTION

This section includes the block diagrams, address space diagrams, and interconnect diagrams for the 4109 and CX4109. Some of these diagrams are part of the theory section; they are repeated here for easy reference while reading other parts of the manual.

BLOCK DIAGRAMS

System Block Diagram
Terminal Control Block Diagram
RAM3 Block Diagram
Display Control Block Diagram
Digital Piggyback Block Diagram
Display Module Block Diagram
Keyboard Module Block Diagram
Power Supply Block Diagram (Early Version)
Power Supply Block Diagram (Later Version)
CX Interface Block Diagram

ADDRESS SPACE DIAGRAMS

Map of Memory Address Space
Map of I/O Address Space
Map of Host Comm I/O Space
Map of 2-Port Peripheral Interface I/O Space
Map of Video I/O Space
Map of Printer Interface I/O Space

INTERCONNECT DIAGRAMS

Main Interconnect Diagram
Display Module Interconnect Diagram

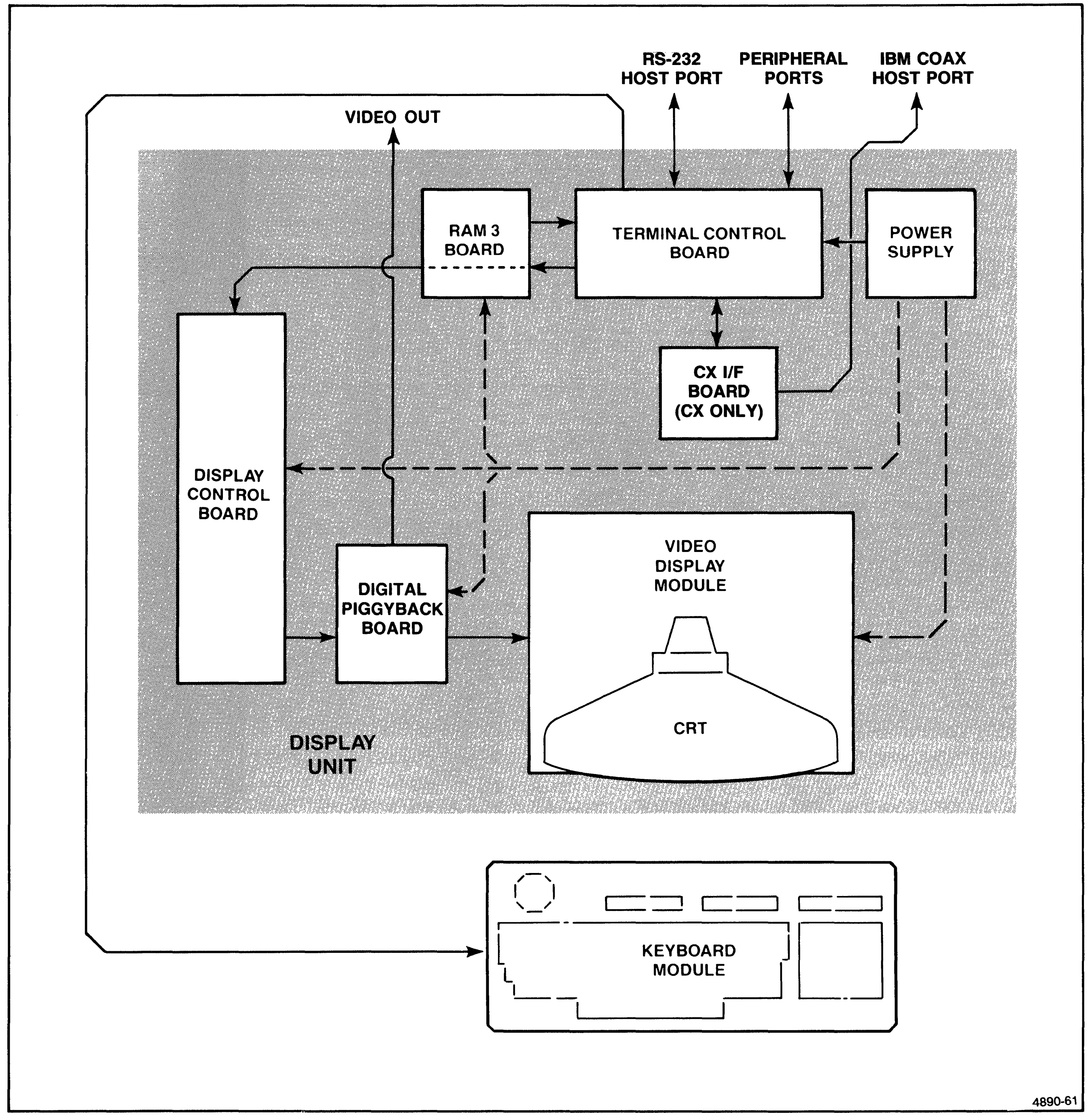


Figure 10-1. System Block Diagram.

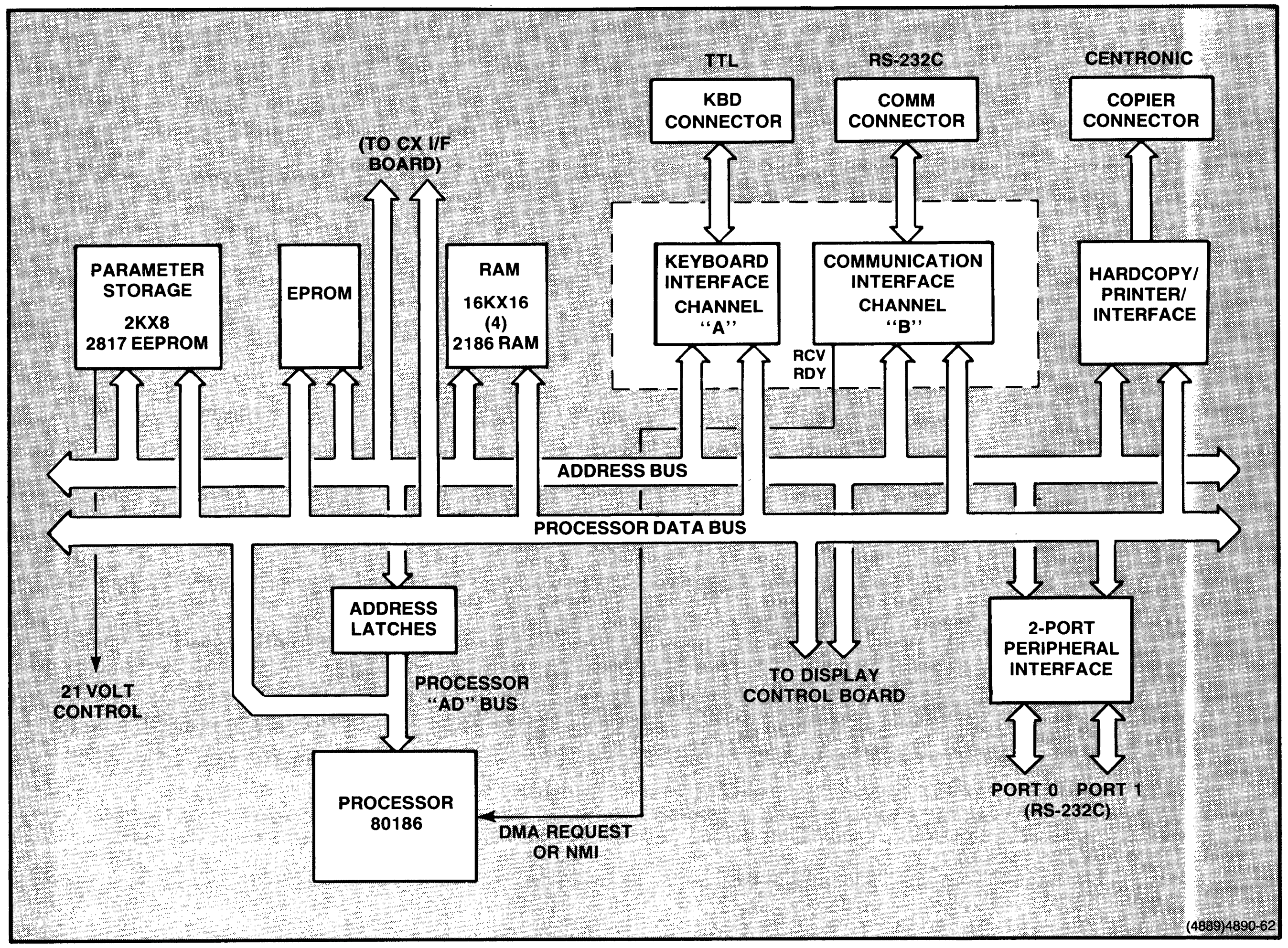


Figure 10-2. Terminal Control Block Diagram.

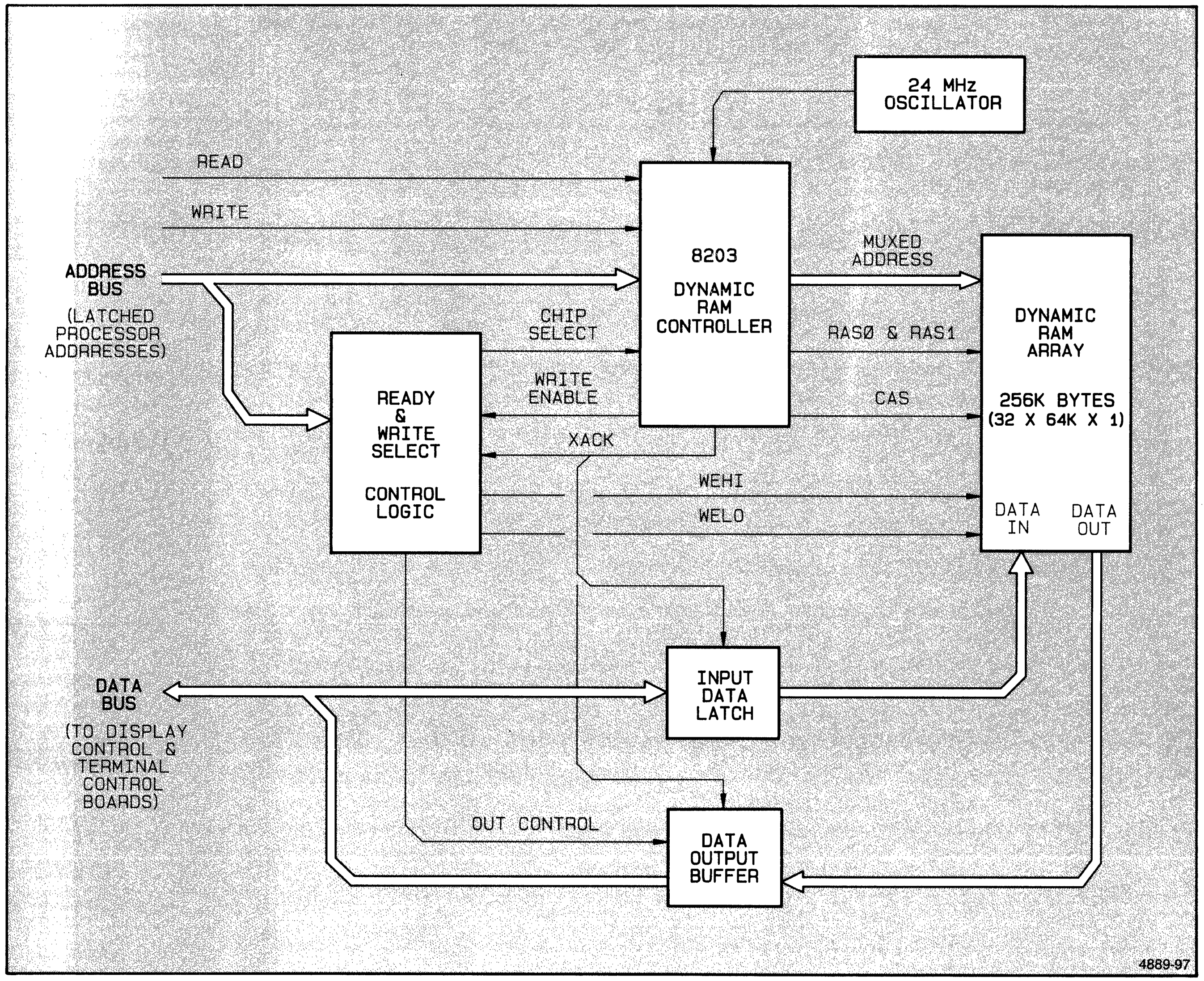


Figure 10-3. RAM3 Block Diagram.

FIGURES 10-2,10-3
TERMINAL CONTROL & RAM3
BLOCK DIAGRAMS

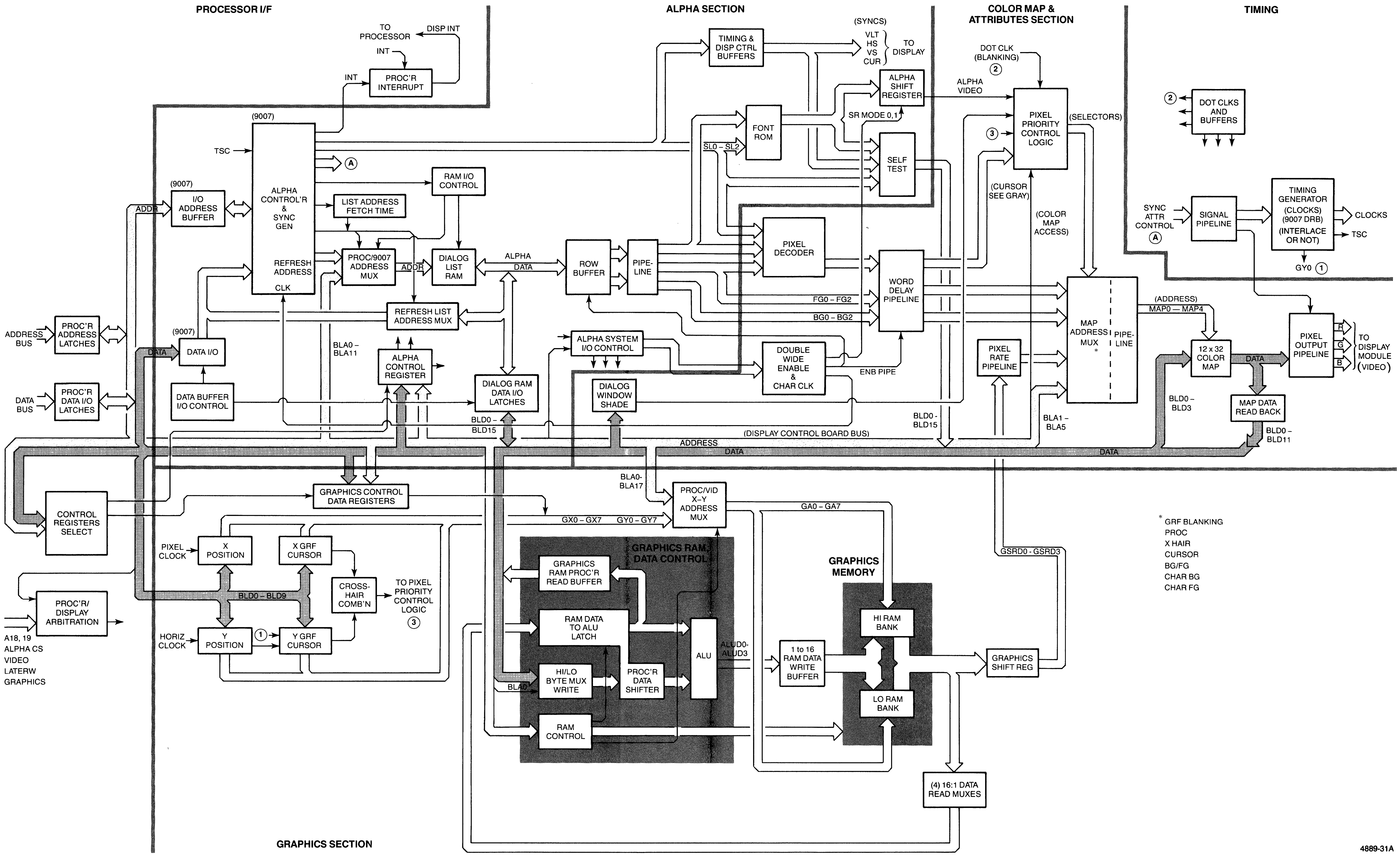


Figure 10-4. Display Control Block Diagram.

FIGURE 10-4 DISPLAY CONTROL BLOCK DIAGRAM

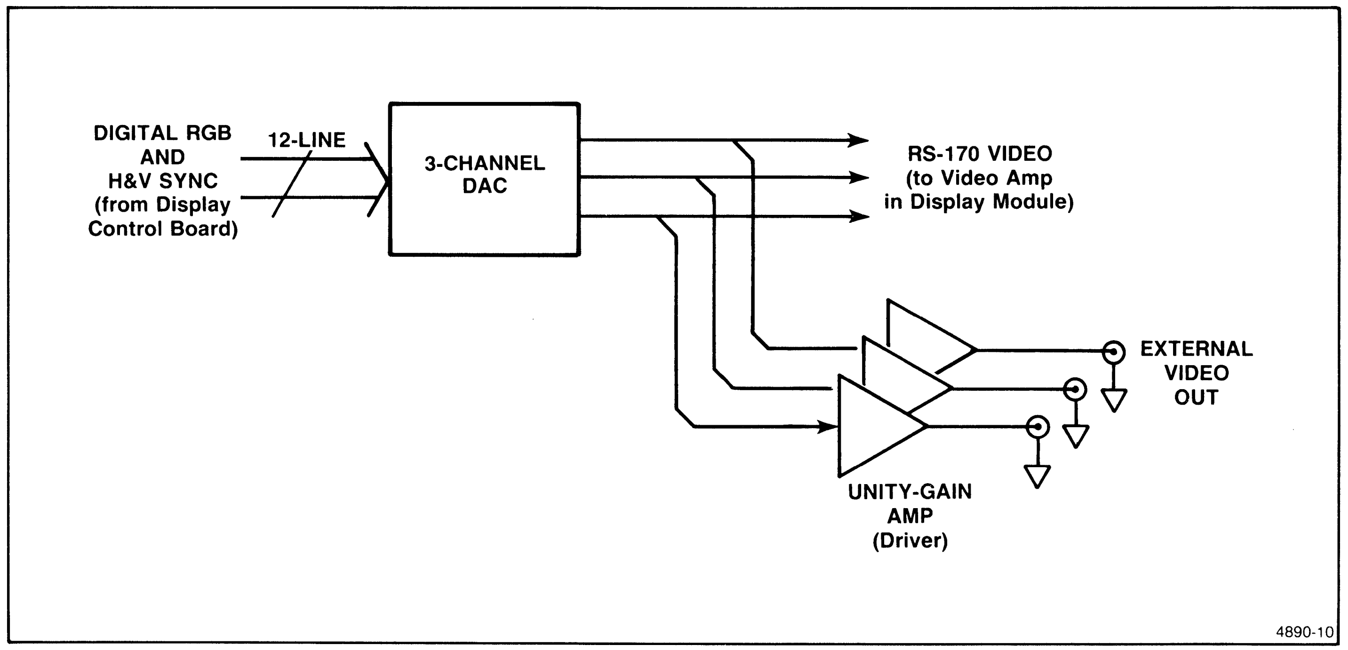


Figure 10-5. Digital Piggyback Block Diagram.

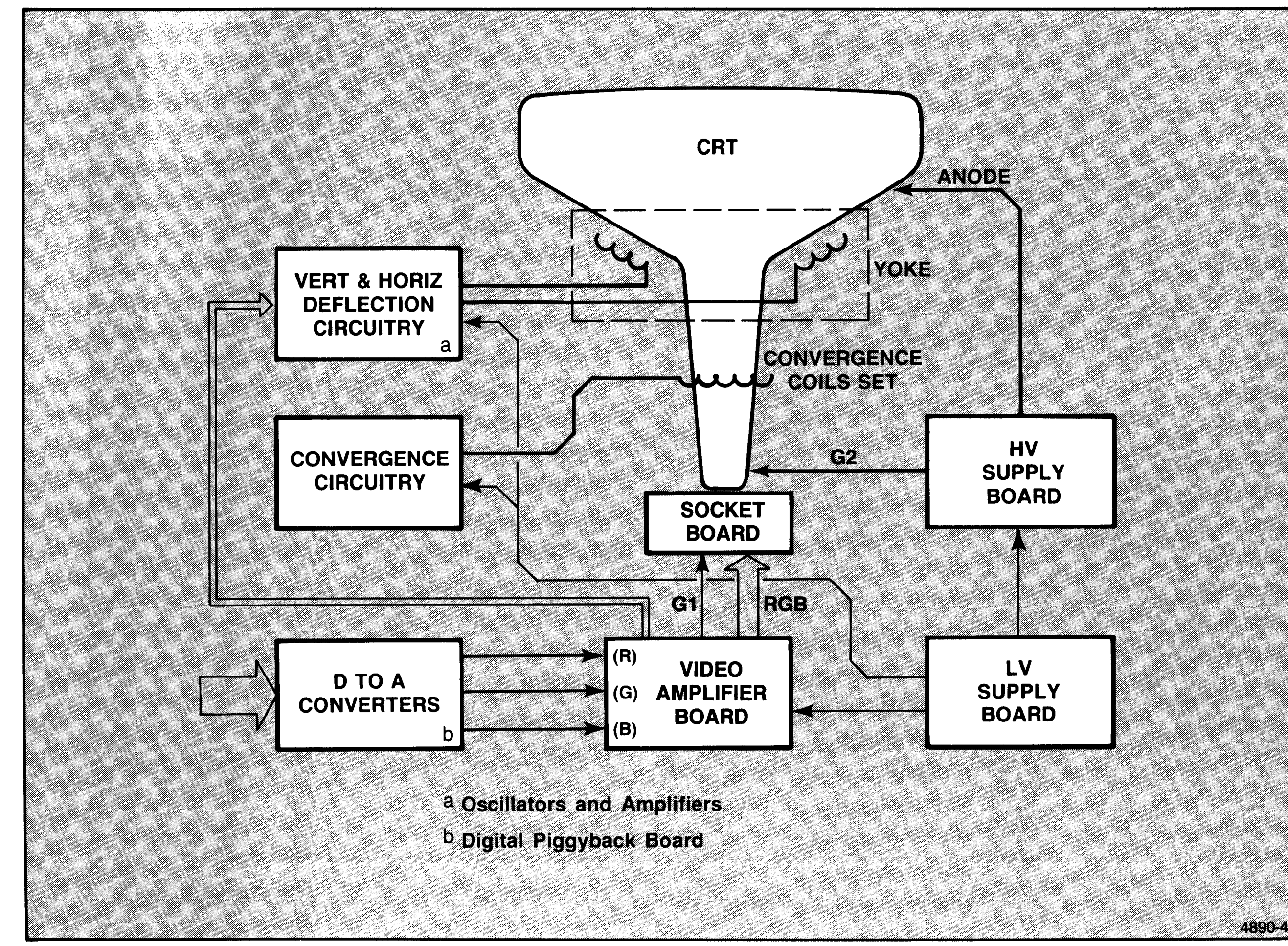


Figure 10-6. GMA301 Display Module Block Diagram.

NOTE

See 119-2023-00 Display Module Service Manual *for its own block diagram.*

FIGURES 10-5, 10-6
DIGITAL PIGGYBACK &
DISPLAY MODULE DIAGRAMS

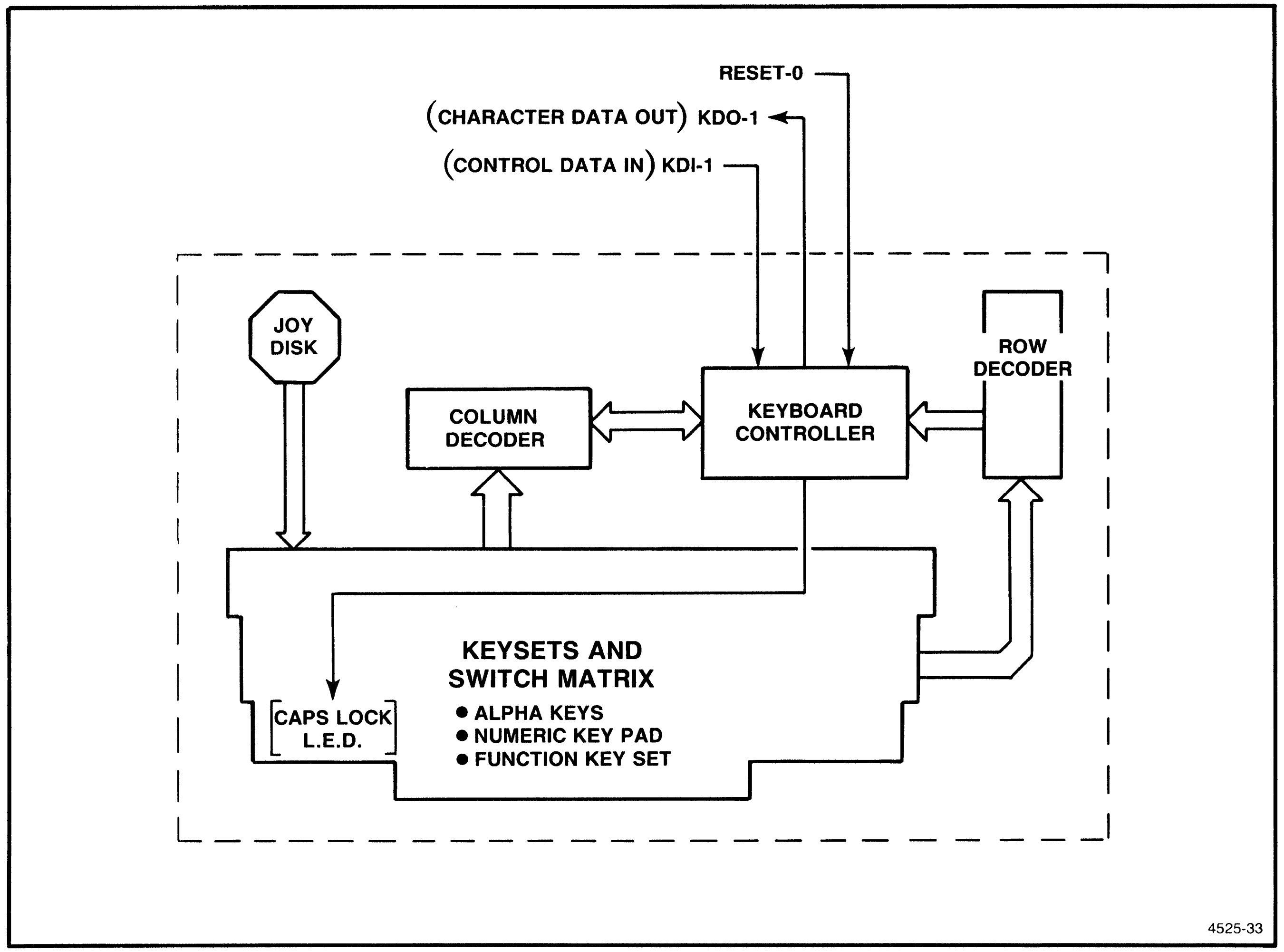


Figure 10-7. Keyboard Module Block Diagram.

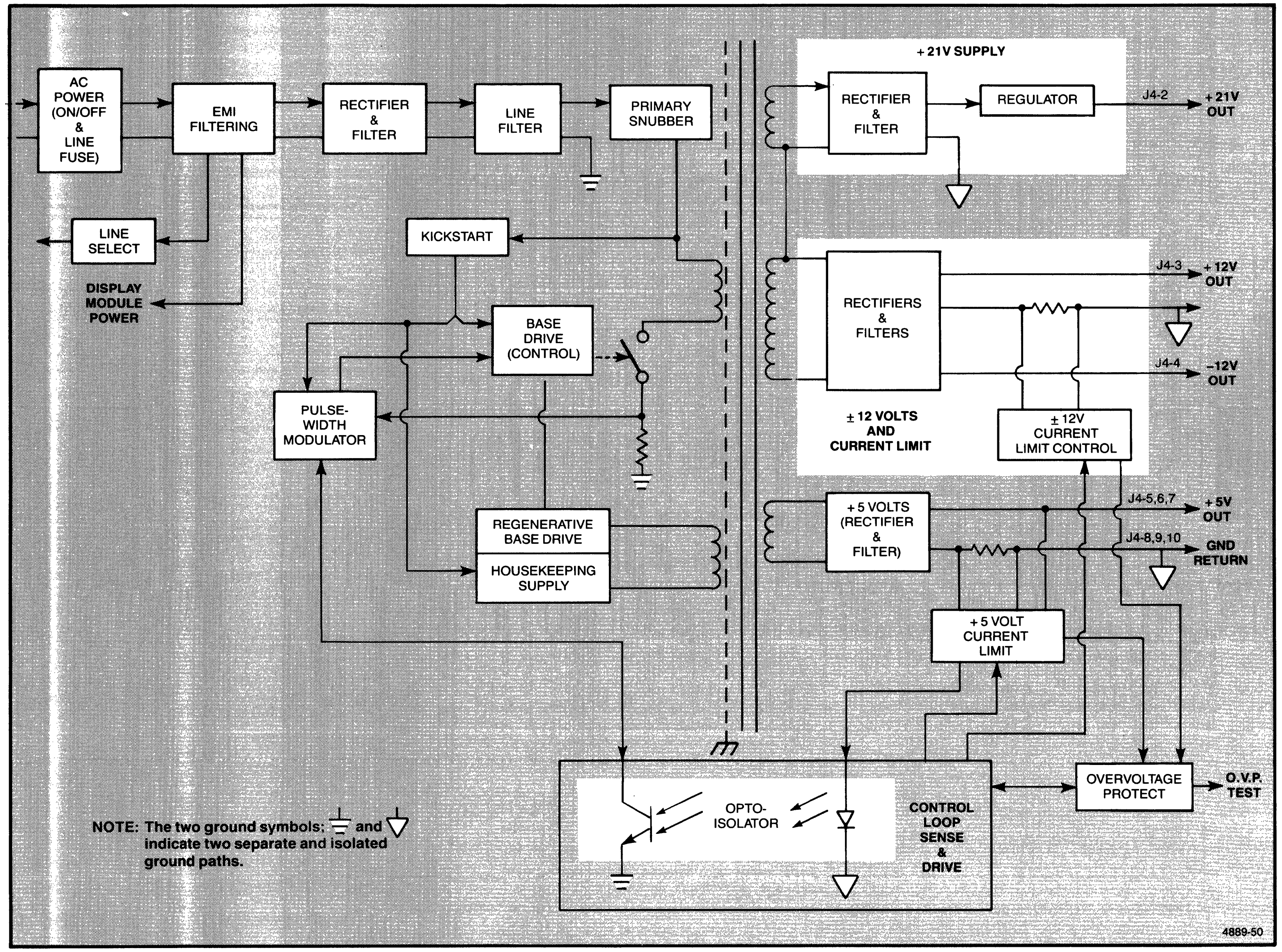


Figure 10-8. Power Supply (Early Version) Block Diagram.

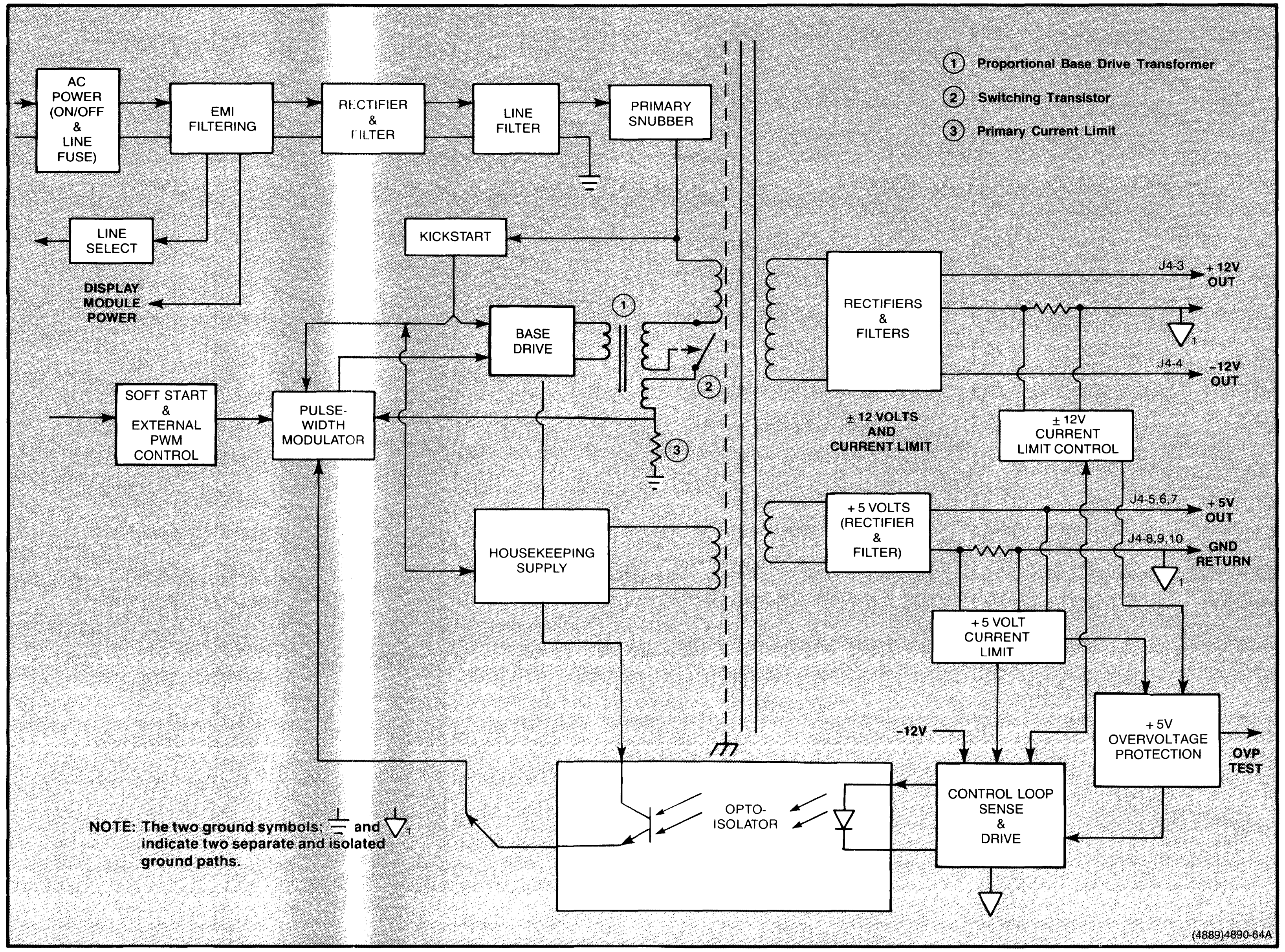


Figure 10-9. Power Supply (Later Version) Block Diagram.

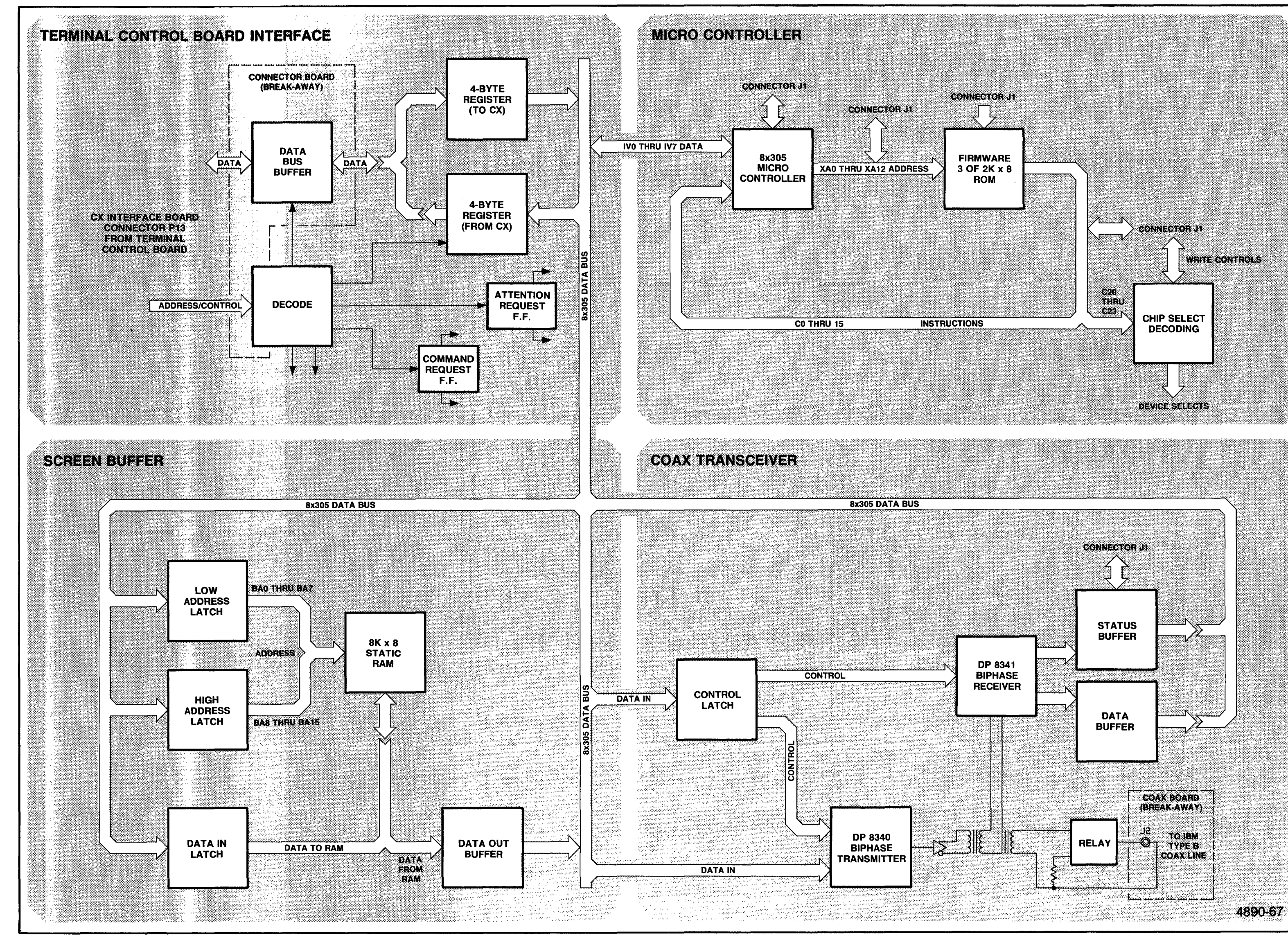


Figure 10-10. CX Interface Block Diagram.

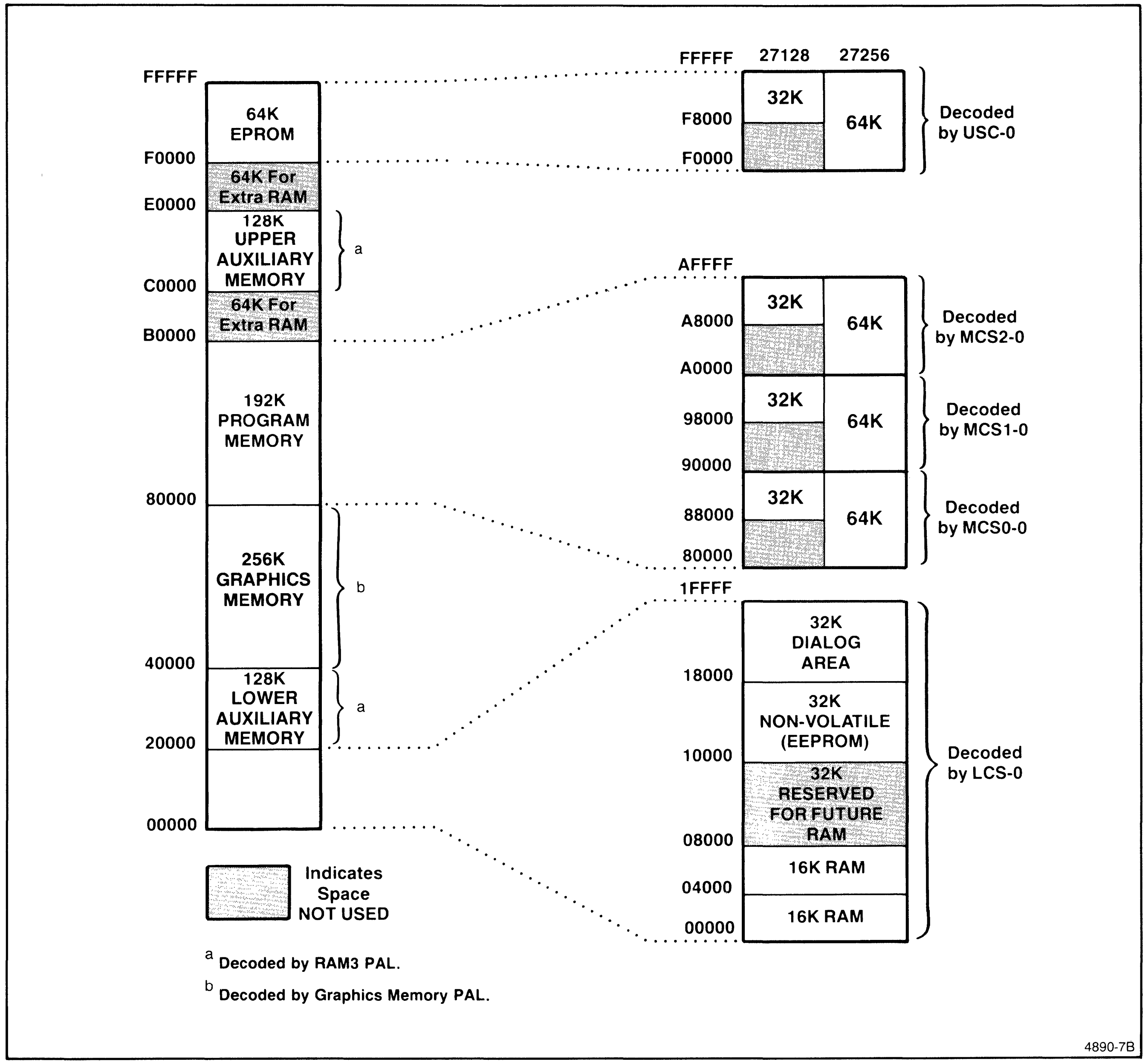


Figure 10-11. Map of Memory I/O Address Space.

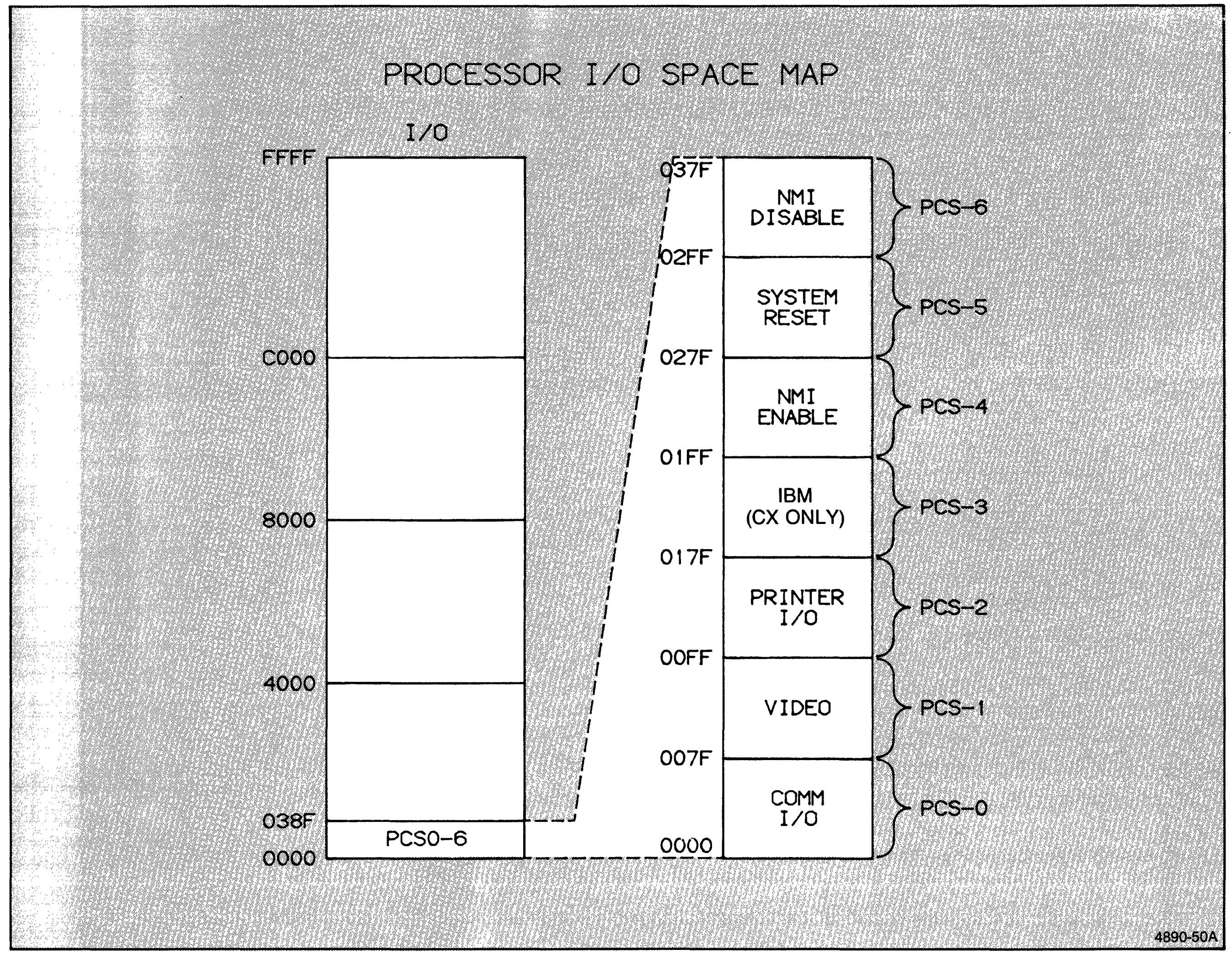
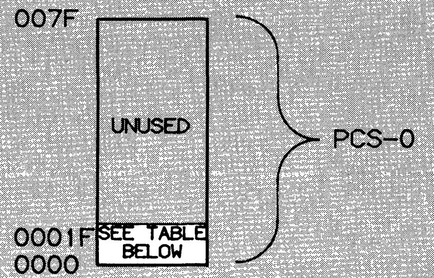


Figure 10-12. Map of Processor I/O Address Space.

COMMUNICATIONS I/O
(U290)



ADDRESS

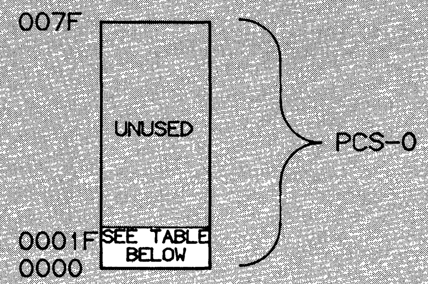
A4	A3	A2	A1	A0	READ(RDN=0)	WRITE(WRN=0)
0	0	0	0	0	Mode Register A(MR1A,MR2A)	Mode Register A(MR1A,MR2A)
0	0	0	1	0	Status Register A(SRA)	Clock Select Reg. A(CSRA)
0	0	1	0	0	*Reserved*	Command Register A(CRA)
0	0	1	1	0	RX Holding Register A(RHRA)	TX Holding Register A(THRA)
0	1	0	0	0	Input Port Change Reg.(IPCR)	Aux. Control Register(ACR)
0	1	0	1	0	Interrupt Status Reg.(ISR)	Interrupt Mask Reg.(IMR)
0	1	1	0	0	Counter/Timer Upper(CTU)	C/T Upper Register(CTUR)
0	1	1	1	0	Counter/Timer Lower(CTL)	C/T Lower Register(CTLR)
1	0	0	0	0	Mode Register B(MR1B,MR2B)	Mode Register B(MR1B,MR2B)
1	0	0	1	0	Status Register B(SRB)	Clock Select Reg.B(CSRB)
1	0	1	0	0	*Reserved*	Command Register B(CRB)
1	0	1	1	0	RX Holding Register B(RHRB)	TX Holding Register B(THRB)
1	1	0	0	0	*Reserved*	*Reserved*
1	1	0	1	0	Input Port	Output Port Conf. Reg.(OPCR)
1	1	1	0	0	Start Counter Command	Set Output Port Bits Command
1	1	1	1	0	Stop Counter Command	Reset Output Port Bits Command

NOTE: THIS DUART USES LOW DATA BYTE

4890-52

Figure 10-13. Map of Communications I/O Address Space.

2PPI I/O SPACE
(U437)



ADDRESS

A4	A3	A2	A1	A0	READ(RDN=0)	WRITE(WRN=0)
0	0	0	0	1	Mode Register A(MR1A,MR2A)	Mode Register A(MR1A,MR2A)
0	0	0	1	1	Status Register A(SRA)	Clock Select Reg. A(CSRA)
0	0	1	0	1	*Reserved*	Command Register A(CRA)
0	0	1	1	1	RX Holding Register A(RHRA)	TX Holding Register A(THRA)
0	1	0	0	1	Input Port Change Reg.(IPCR)	Aux. Control Register(ACR)
0	1	0	1	1	Interrupt Status Reg.(ISR)	Interrupt Mask Reg.(IMR)
0	1	1	0	1	Counter/Timer Upper(CTU)	C/T Upper Register(CTUR)
0	1	1	1	1	Counter/Timer Lower(CTL)	C/T Lower Register(CTLR)
1	0	0	0	1	Mode Register B(MR1B,MR2B)	Mode Register B(MR1B,MR2B)
1	0	0	1	1	Status Register B(SRB)	Clock Select Reg.B(CSRB)
1	0	1	0	1	*Reserved*	Command Register B(CRB)
1	0	1	1	1	RX Holding Register B(RHRB)	TX Holding Register B(THRB)
1	1	0	0	1	*Reserved*	*Reserved*
1	1	0	1	1	Input Port	Output Port Conf. Reg.(OPCR)
1	1	1	0	1	Start Counter Command	Set Output Port Bits Command
1	1	1	1	1	Stop Counter Command	Reset Output Port Bits Command

NOTE: THIS DUART USES HI DATA BYTE
PORT A IS P20
PORT B IS P23

4890-53

Figure 10-14. Map of 2PPI I/O Address Space.

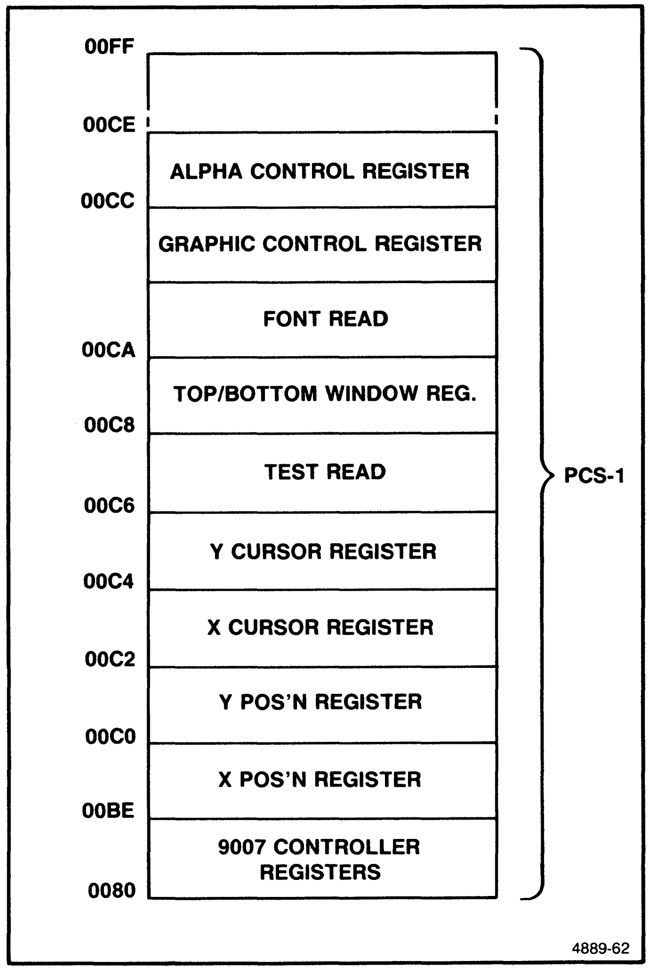
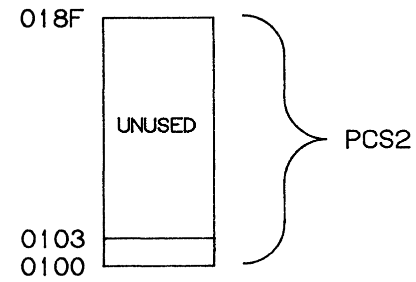


Figure 10-15. Map of Video I/O Address Space.

PRINTER INTERFACE I/O

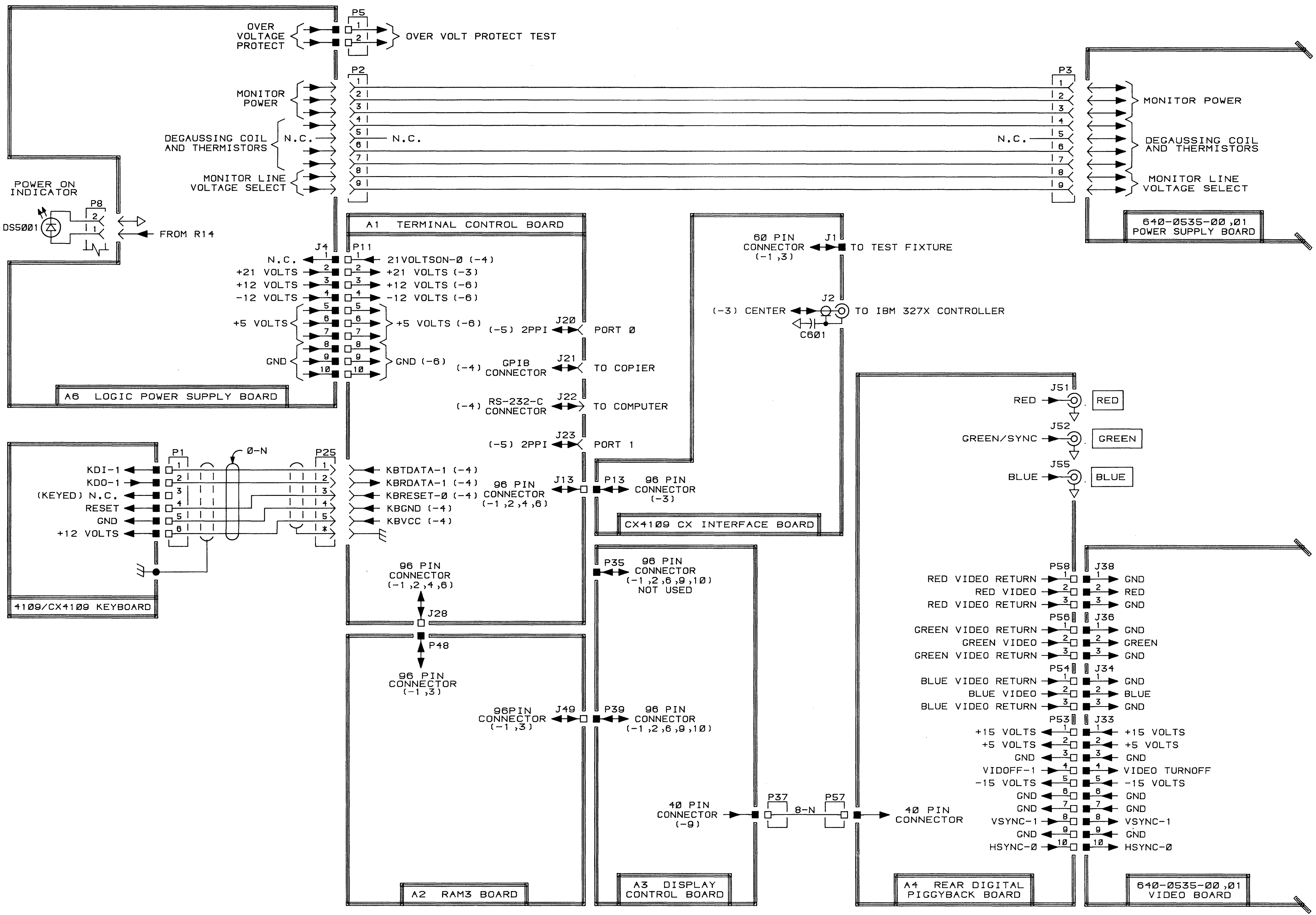


Port Select 0 and Port Select 1. These input signals in conjunction with the selection of one of the three ports or the control word registers.

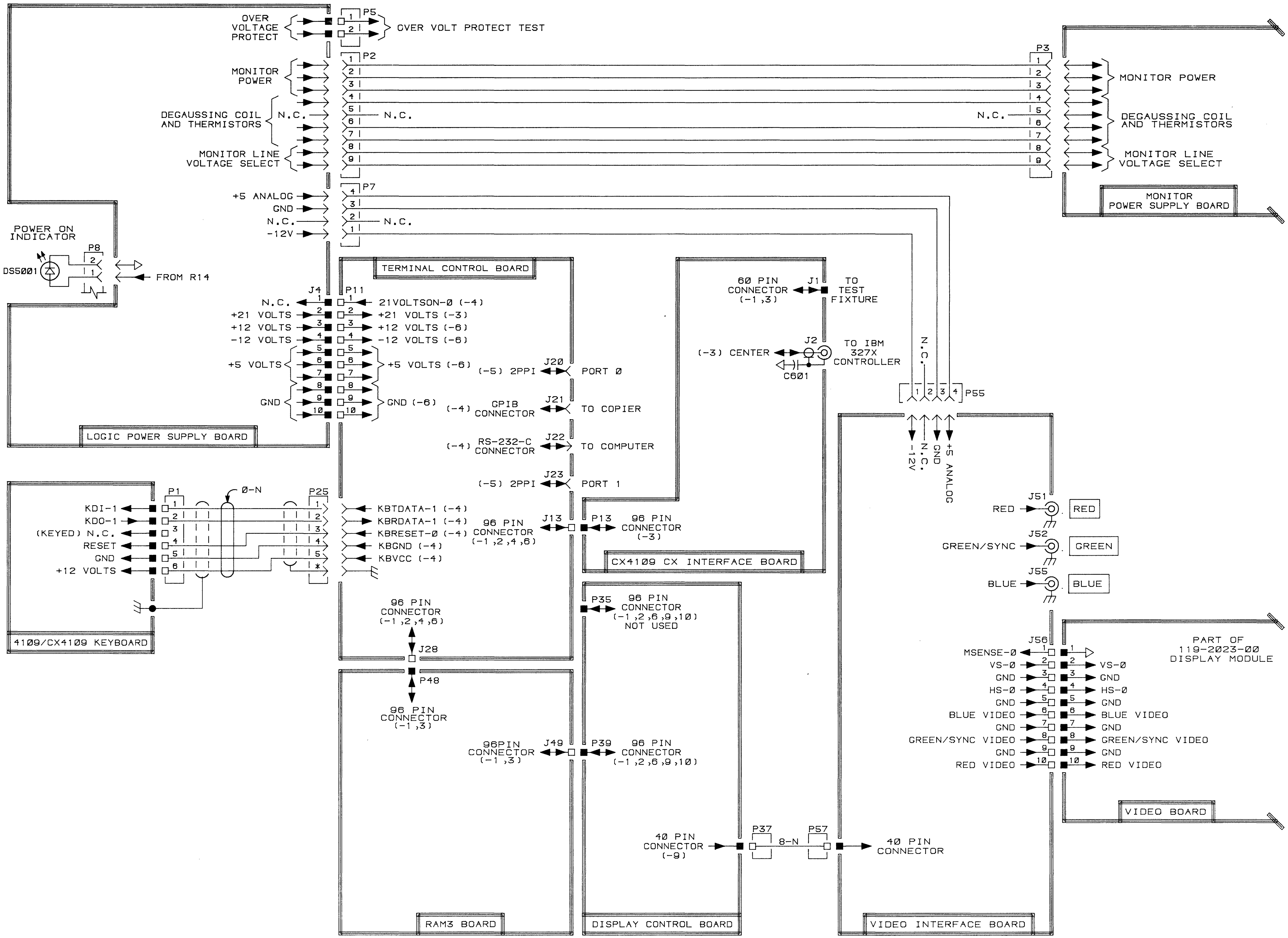
A2	A1	$\overline{RD}$	$\overline{WR}$	$\overline{CS}$	INPUT OPERATION (READ)
0	0	0	1	0	PORT A - DATA BUS
0	1	0	1	0	PORT B - DATA BUS
1	0	0	1	0	PORT C - DATA BUS
					OUTPUT OPERATION (WRITE)
0	0	1	0	0	DATA BUS - PORT A
0	1	1	0	0	DATA BUS - PORT B
1	0	1	0	0	DATA BUS - PORT C
1	1	1	0	0	DATA BUS - CONTROL
					DISABLE FUNCTION
X	X	X	X	1	DATA BUS - 3-STATE
1	1	0	1	0	ILLEGAL CONDITION
X	X	1	1	0	DATA BUS - 3-STATE

4890-51

Figure 10-16. Map of Printer Interface I/O Address Space.



FIRST USE: 4109	OTHER USES:	NOTES: P25-PIN * IS THE CONNECTOR BODY KEYWAY.	TITLE:	Tektronix®	ASSEMBLY:
DATE: REV, 19 JULY 1984	CX4109		MAIN INTERCONNECT		
CONTROL NO.: IDA001.000		TEKTRONIX, INC. © 1984			SHEET: 1 OF 1



FIRST USE: 4109	OTHER USES:	NOTES: P25-PIN * IS THE CONNECTOR BODY KEYWAY.	TITLE:		ASSEMBLY:
DATE: 15 APRIL 1985	CX4109	FOR INSTRUMENTS WITH SERIAL # B020000 AND UP.	MAIN INTERCONNECT	Tektronix®	MICVI-1
CONTROL NO.: IDA006.A01		TEKTRONIX, INC. © 1984			SHEET: 1 OF 1

MAIN INTERCONNECT

Section 11
SCHEMATICS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).

Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

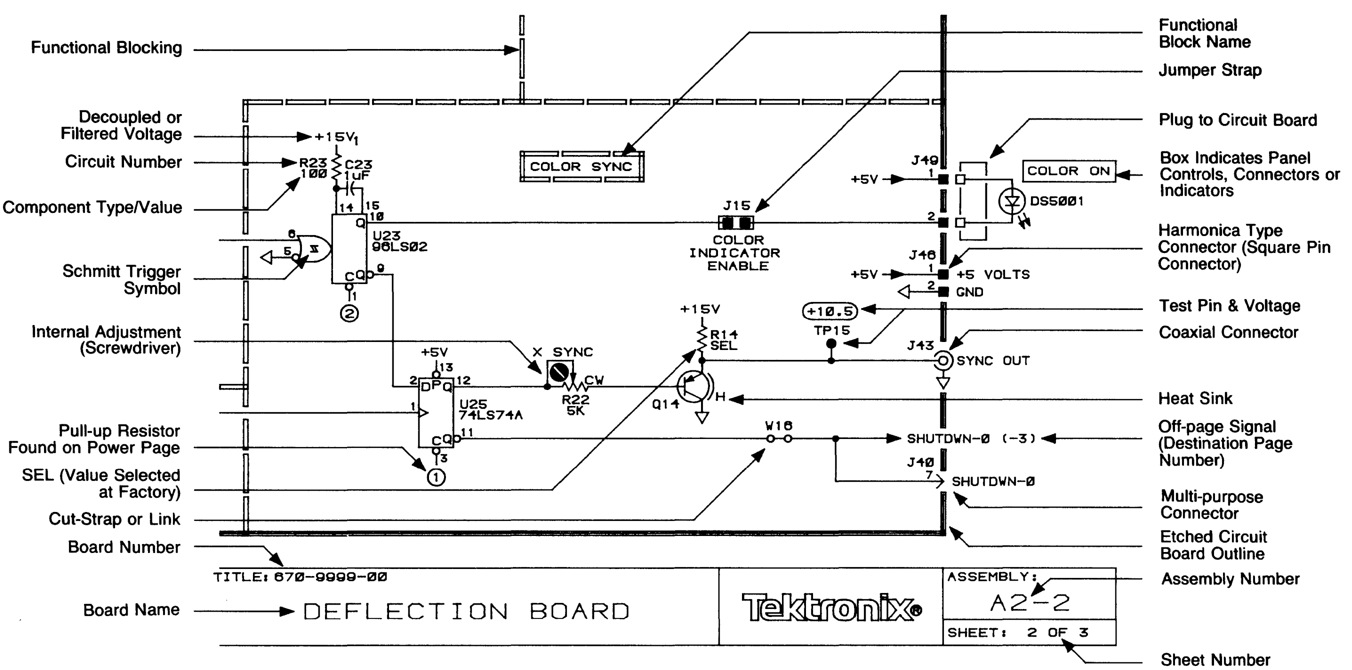
Abbreviations are based on ANSI Y1.1-1972. Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc., are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CB	Circuit breaker
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
E	Spark Gap, Ferrite bead
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
HY	Hybrid circuit
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
M	Meter
P	Connector, movable portion
Q	Transistor or silicon-controlled rectifier
R	Resistor, fixed or variable
RT	Thermistor
S	Switch or contactor
T	Transformer
TC	Thermocouple
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
W	Wirestrap or cable
Y	Crystal
Z	Phase shifter

The following special symbols may appear on the diagrams:



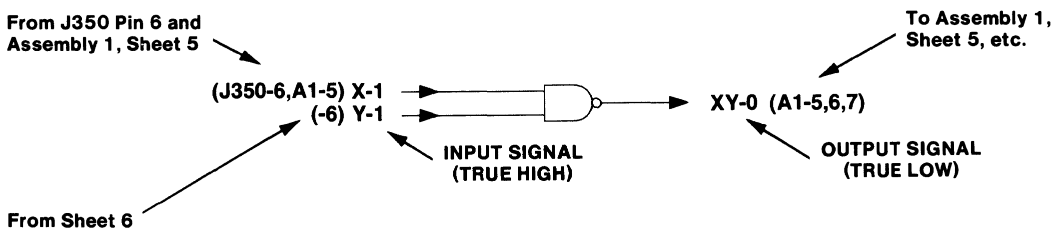
1. True High and True Low Signals

Signal names on the schematics are followed by -1 or a -0. A TRUE HIGH signal is indicated by -1, and a TRUE LOW signal is indicated by -0.

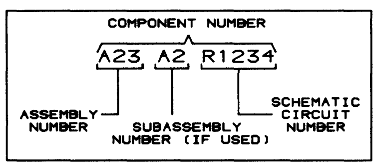
SIGNAL -1 = TRUE HIGH
SIGNAL -0 = TRUE LOW

2. Cross-References

Schematic cross-references (from/to information) are included on the schematics. The "from" reference only indicates the signal "source," and the "to" reference lists all loads where the signal is used. All from/to information will be enclosed in parentheses.



3. Component Number Example



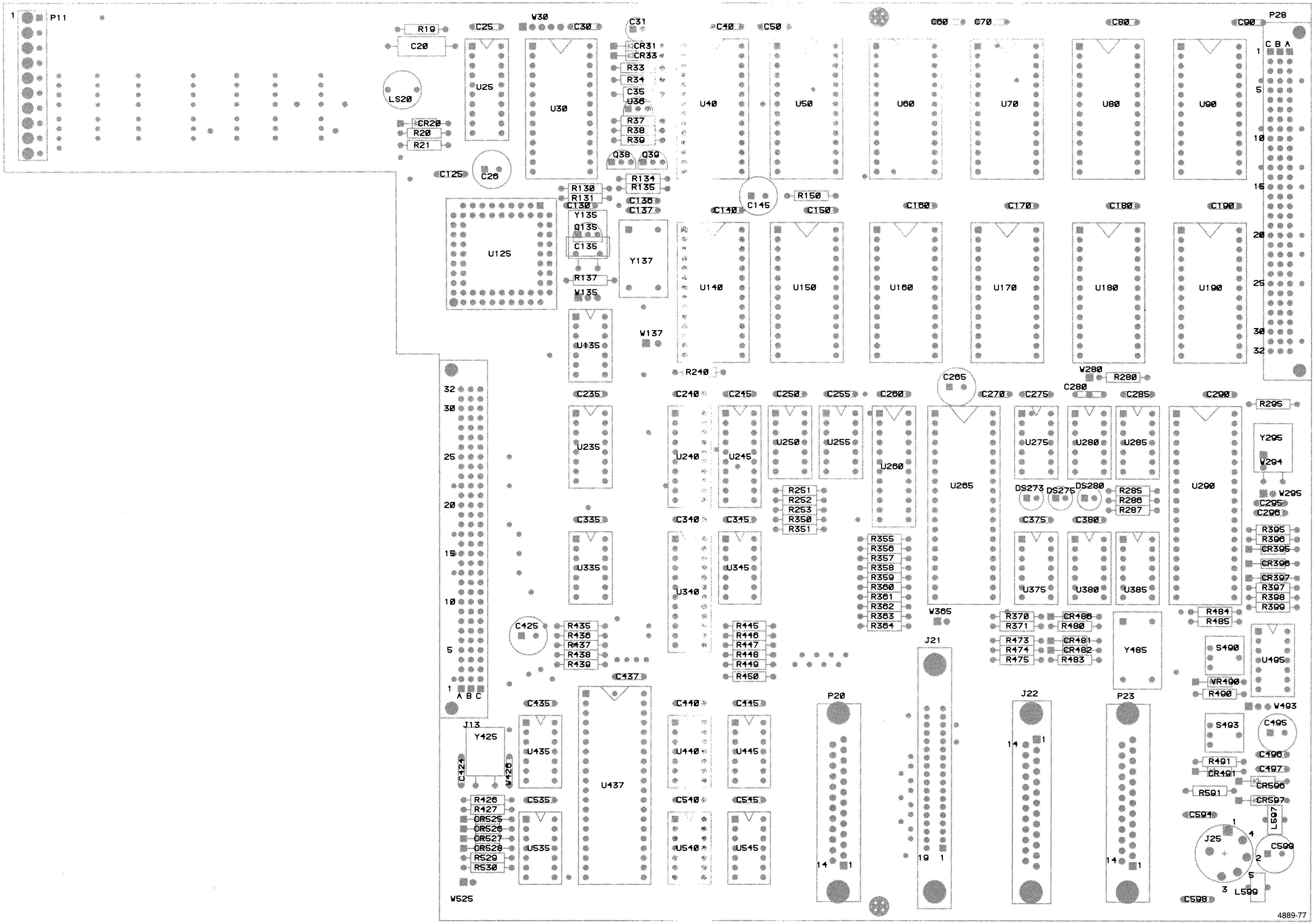
CHASSIS-MOUNTED COMPONENTS HAVE NO ASSEMBLY NUMBER
PREFIX— SEE END OF REPLACEABLE ELECTRICAL PARTS LIST.

SCHEMATIC LIST

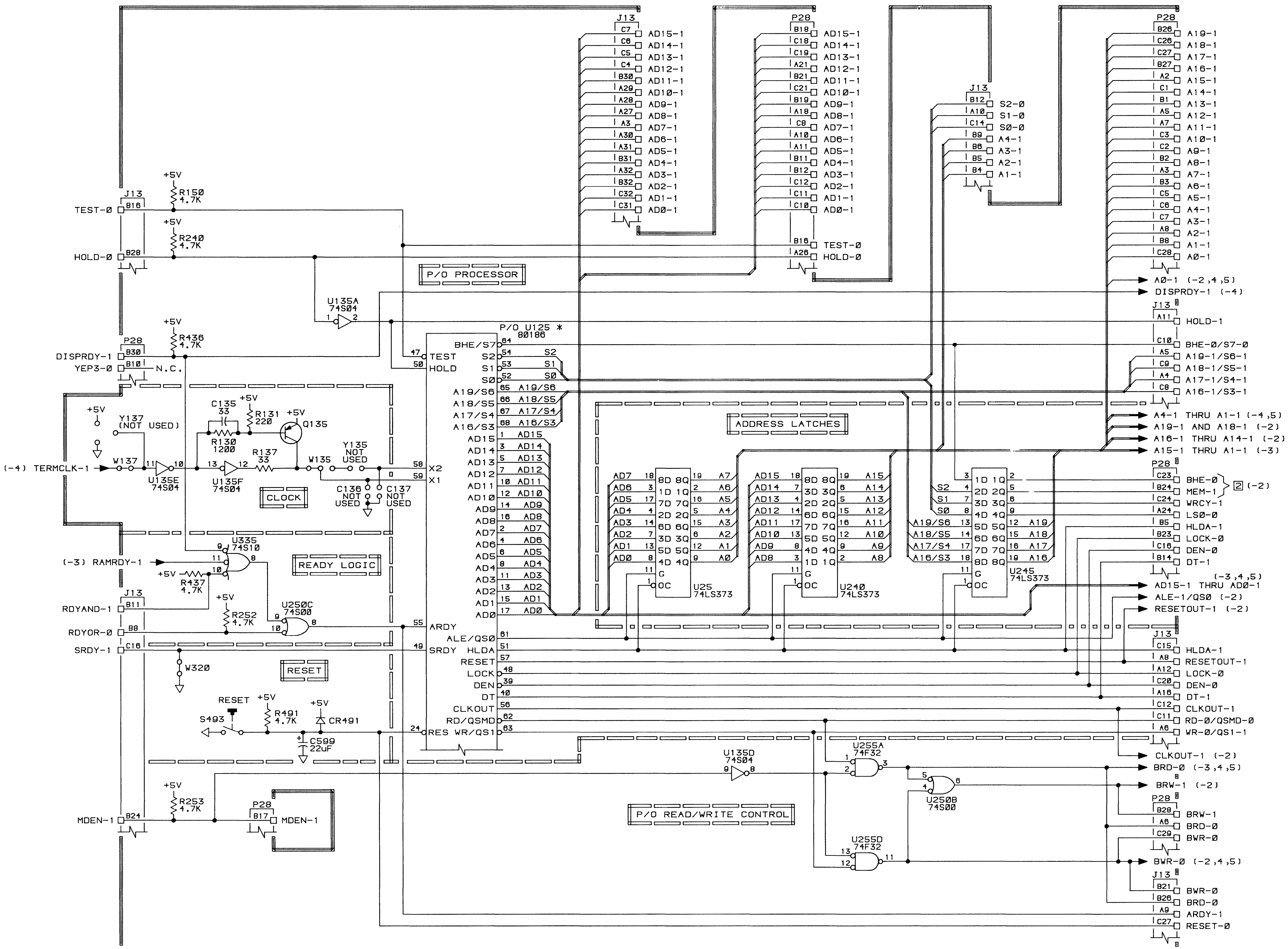
This section contains the schematic diagrams and component location diagrams for all 4109 and CX4109 circuit boards except those that are part of the Display Module and the CX Interface board. Separate service manuals contain parts lists and schematics for the 640-0535-00 (also called GMA301) Display Module and for the 119-2023-00 Display Module. The detailed schematic for the CX Interface is proprietary information, so it is located in the CX Interface Test Fixture manual.

The schematics and diagrams in this section are arranged in the following order:

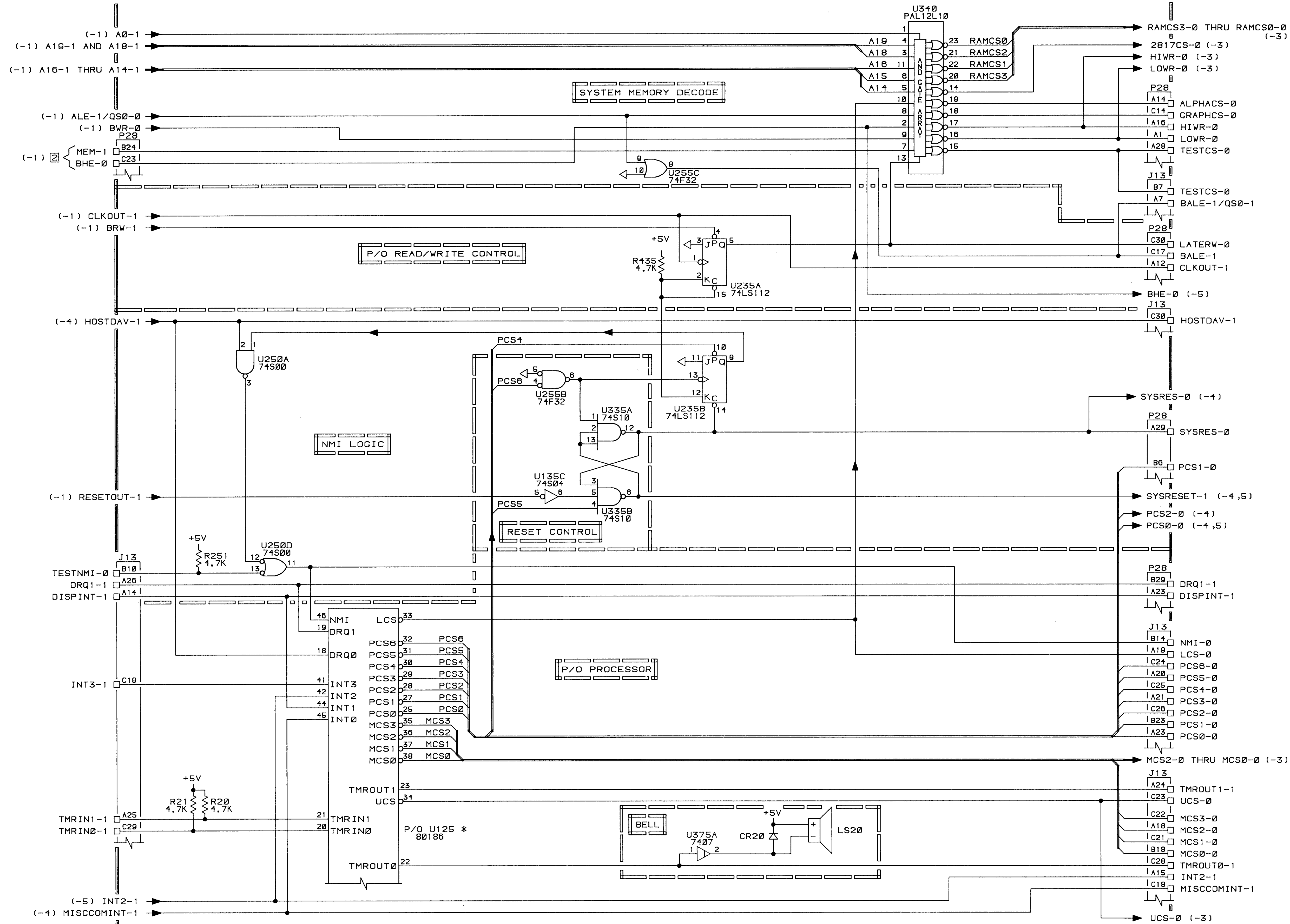
1. Terminal Control Board Component Locations
2. Terminal Control Board Schematics (A1-1 thru A1-6)
3. RAM3 Board Component Locations
4. RAM3 Board Schematics (A2-1 thru A2-3)
5. Display Control Component Locations
6. Display Control Board Schematics (A3-1 thru A3-10)
7. Digital Piggyback Component Locations
8. Digital Piggyback (670-8151-00) Schematic (A4A)
9. Video Interface Component Locations
10. Video Interface (670-9045-00) Schematic (A4B)
11. Keyboard (119-1593-00) Component Locations
12. Keyboard (119-1593-00) Schematics (A5A-1)
13. CX Keyboard (119-1860-00) Component Locations
14. CX Keyboard (119-1860-00) Schematic (A5B-1)
15. Logic Power Supply (620-0003-00,15) Component Locations
16. Logic Power Supply (620-0003-00,15) Schematic (A6A-1)
17. Logic Power Supply (620-0019-00,01) Component Locations
18. Logic Power Supply (620-0019-00) Schematic (A6B-1)
19. Logic Power Supply (620-0019-01) Schematic (A6C-1)
20. CX Interface Component Locations
21. CX Interface Board Block Diagram (A7)



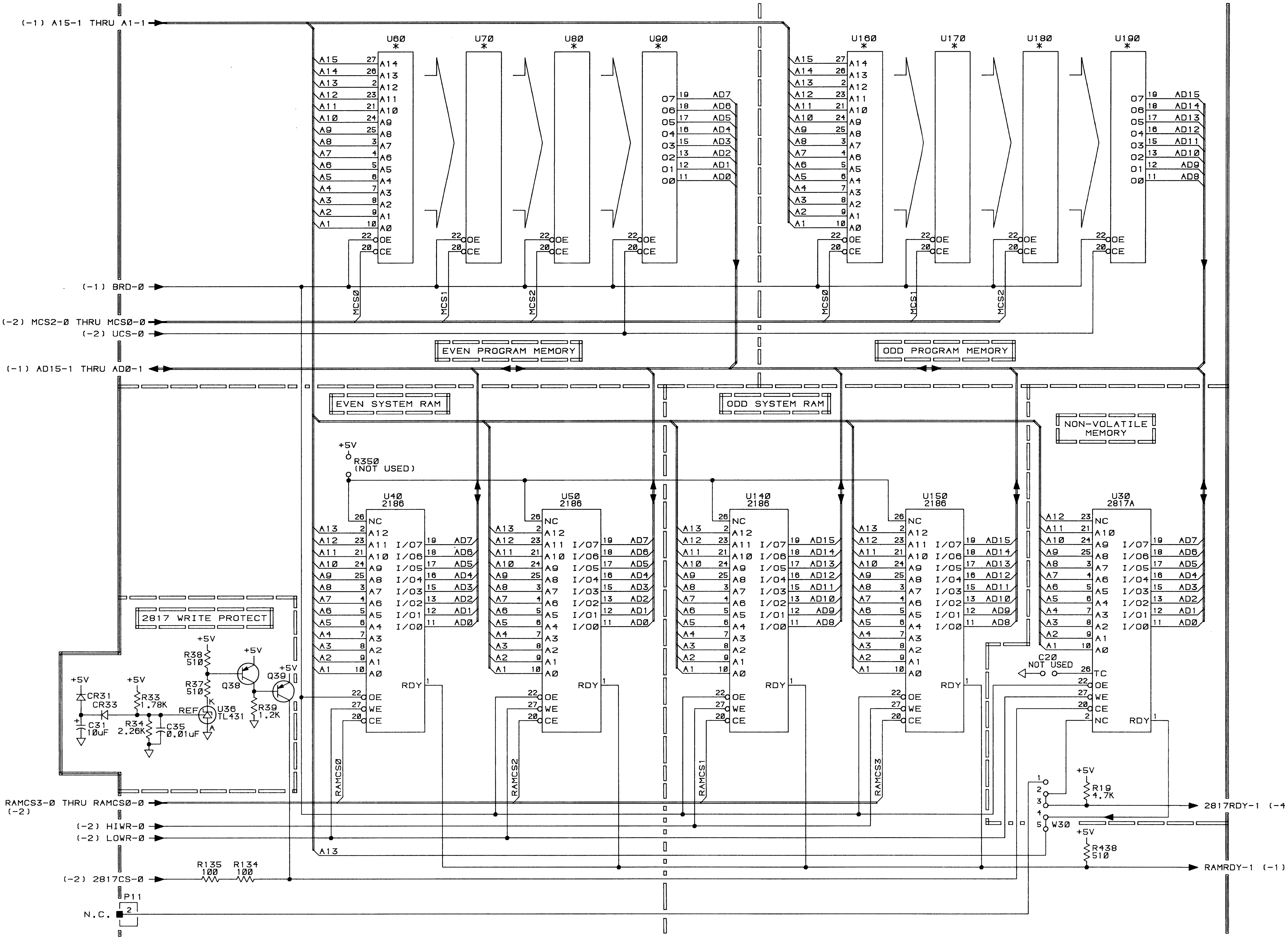
Terminal Control Component Locations.



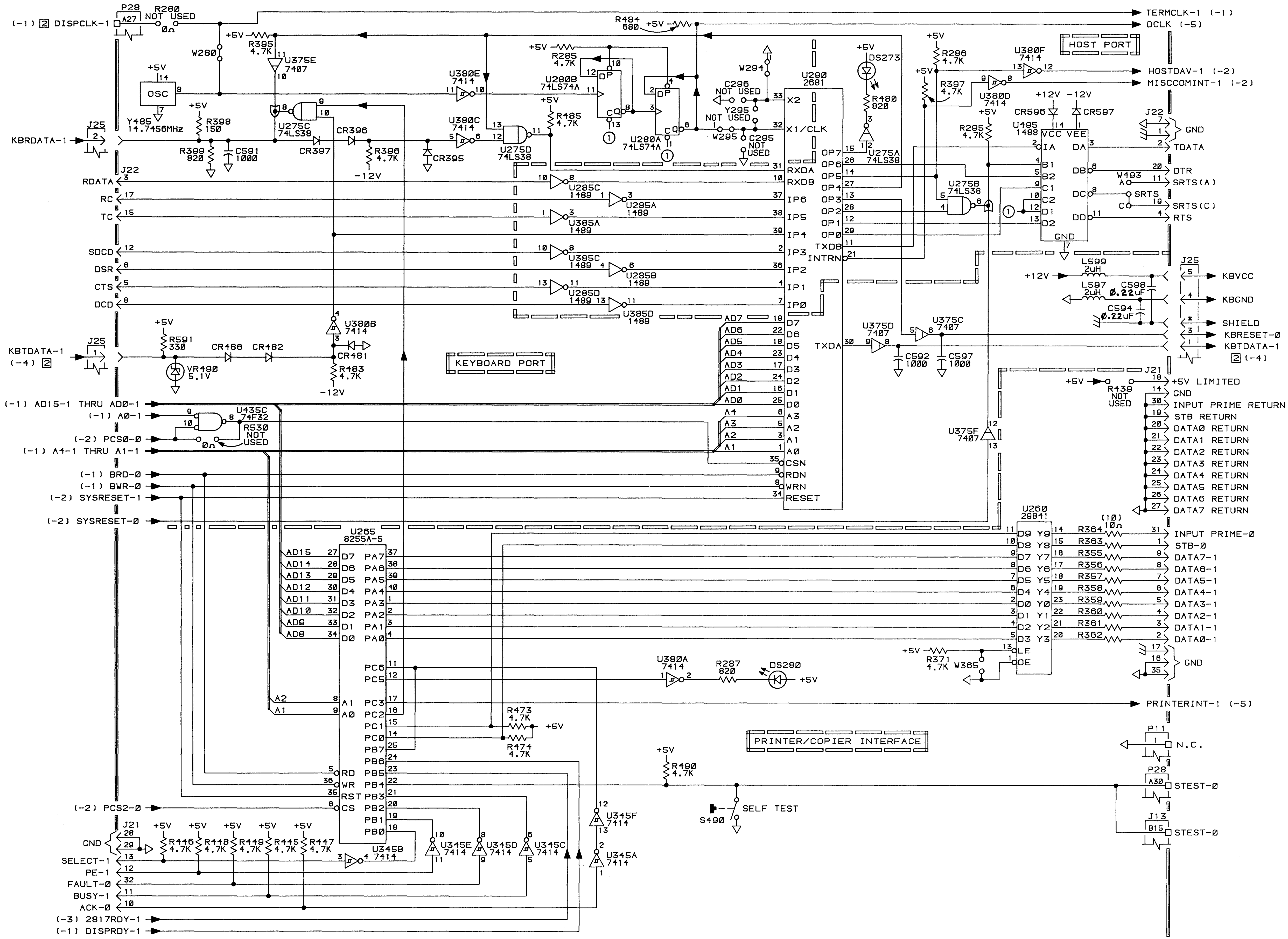
FIRST USE: 4109	OTHER USES: 4107 CX4107 CX4109 4106	NOTES: * P/O U125 IS ON SHEET 2. ☐ INDICATES SHOWN MORE THAN ONCE AND WHERE (-)	TITLE: 670-8234-01,15,16,17,18 & 670-8776-00 670-8814-00 TERMINAL CONTROL BOARD	Tektronix®	ASSEMBLY: -1
DATE: REV, 26 JUNE 1984					
CONTROL NO.: SDA001.001		TEKTRONIX, INC. © 1984			SHEET: 1 OF 6



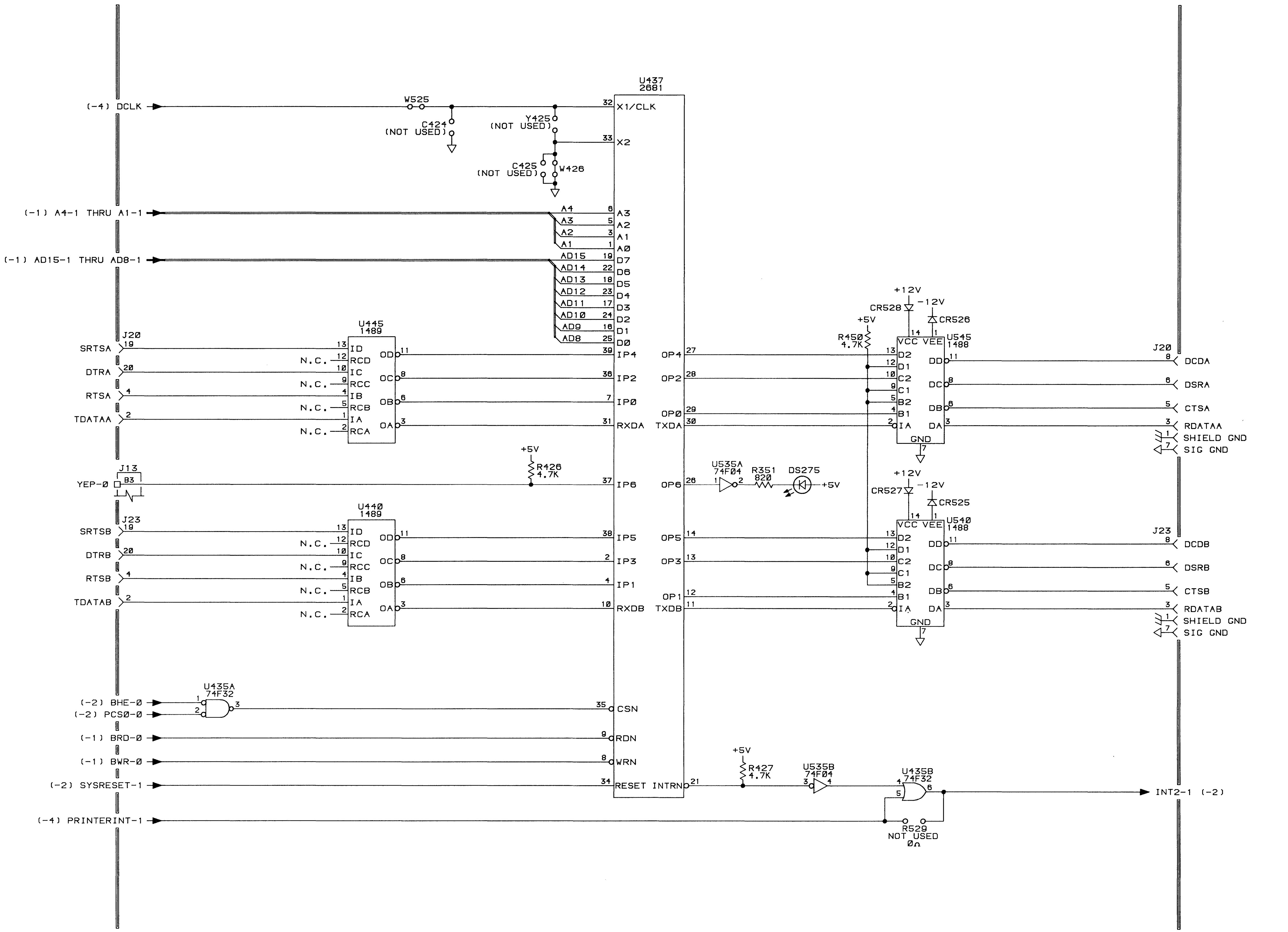
FIRST USE: 4109 DATE: REV, 26 JUNE 1984 CONTROL NO.: SDA001.001	OTHER USES: 4107 CX4107 CX4109 4106	NOTES: * P/O U125 IS ON SHEET 1. ☐ INDICATES SHOWN MORE THAN ONCE AND WHERE (-) TEKTRONIX, INC. © 1984	TITLE: 670-8234-01,15,16,17,18 & 670-8776-00 670-8814-00 TERMINAL CONTROL BOARD	Tektronix®	ASSEMBLY: -2 SHEET: 2 OF 6



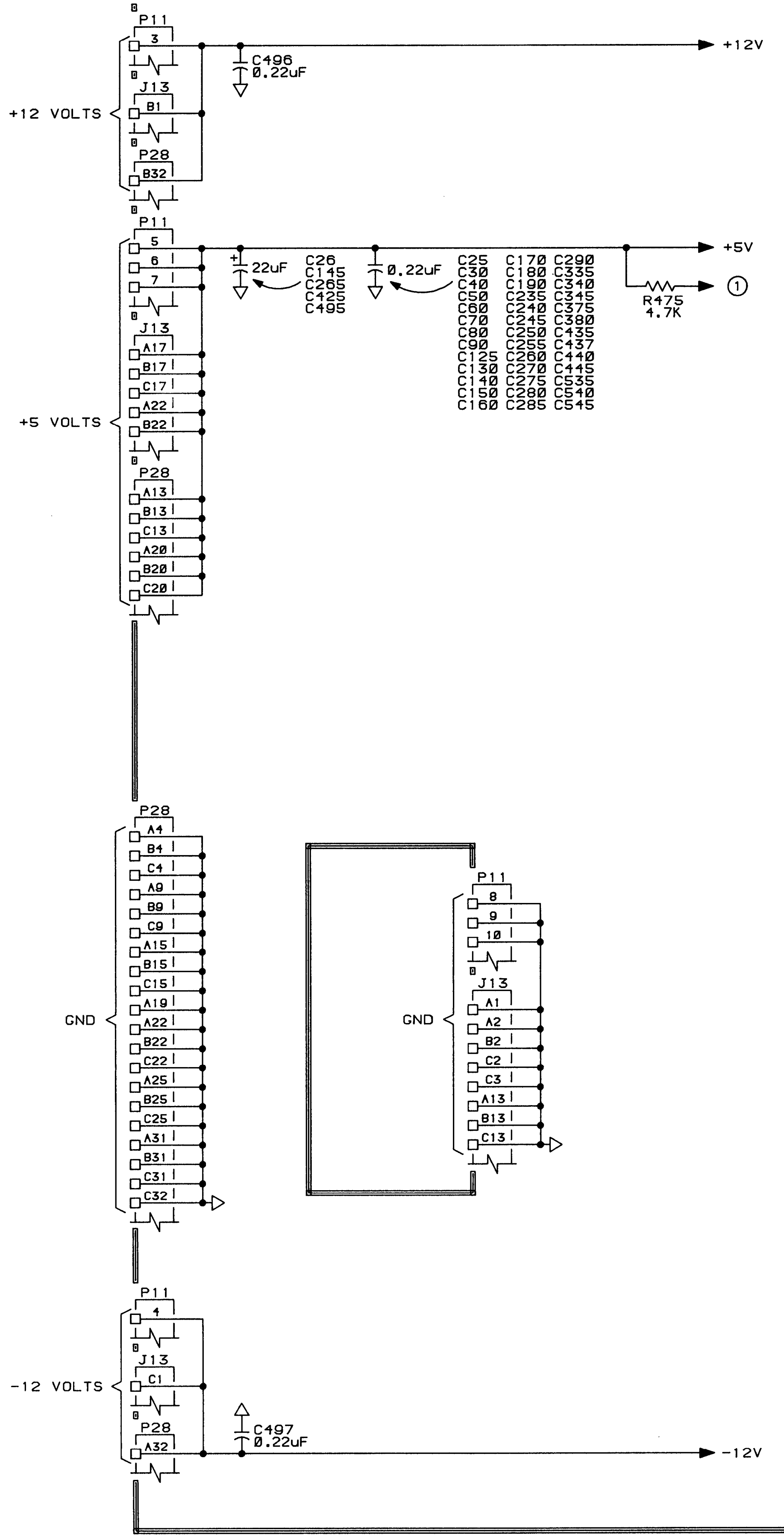
FIRST USE: 4109	OTHER USES: 4106 4107 CX4107 CX4109	NOTES: * THIS VALUE MAY BE 2764, 27128, OR 27256.	TITLE: 670-8234-01,15,16,17,18 & 670-8776-00 670-8814-00	Tektronix®	ASSEMBLY:
DATE: REV, 16 APR 1984			TERMINAL CONTROL BOARD		-3
CONTROL NO.: SDA001.001		TEKTRONIX, INC. © 1984			SHEET: 3 OF 6



FIRST USE: 4109	OTHER USES: 4107 CX4107 CX4109 4106	NOTES: P25 PIN * IS THE CONNECTOR BODY KEYWAY. ☐ INDICATES SHOWN MORE THAN ONCE AND WHERE (-)	TITLE: 670-8234-01,15,16,17,18 & 670-8776-00 670-8814-00 TERMINAL CONTROL BOARD	Tektronix®	ASSEMBLY: -4
DATE: REV, 27 JUNE 1984					
CONTROL NO.: SDA001.001		TEKTRONIX, INC. © 1984			SHEET: 4 OF 6

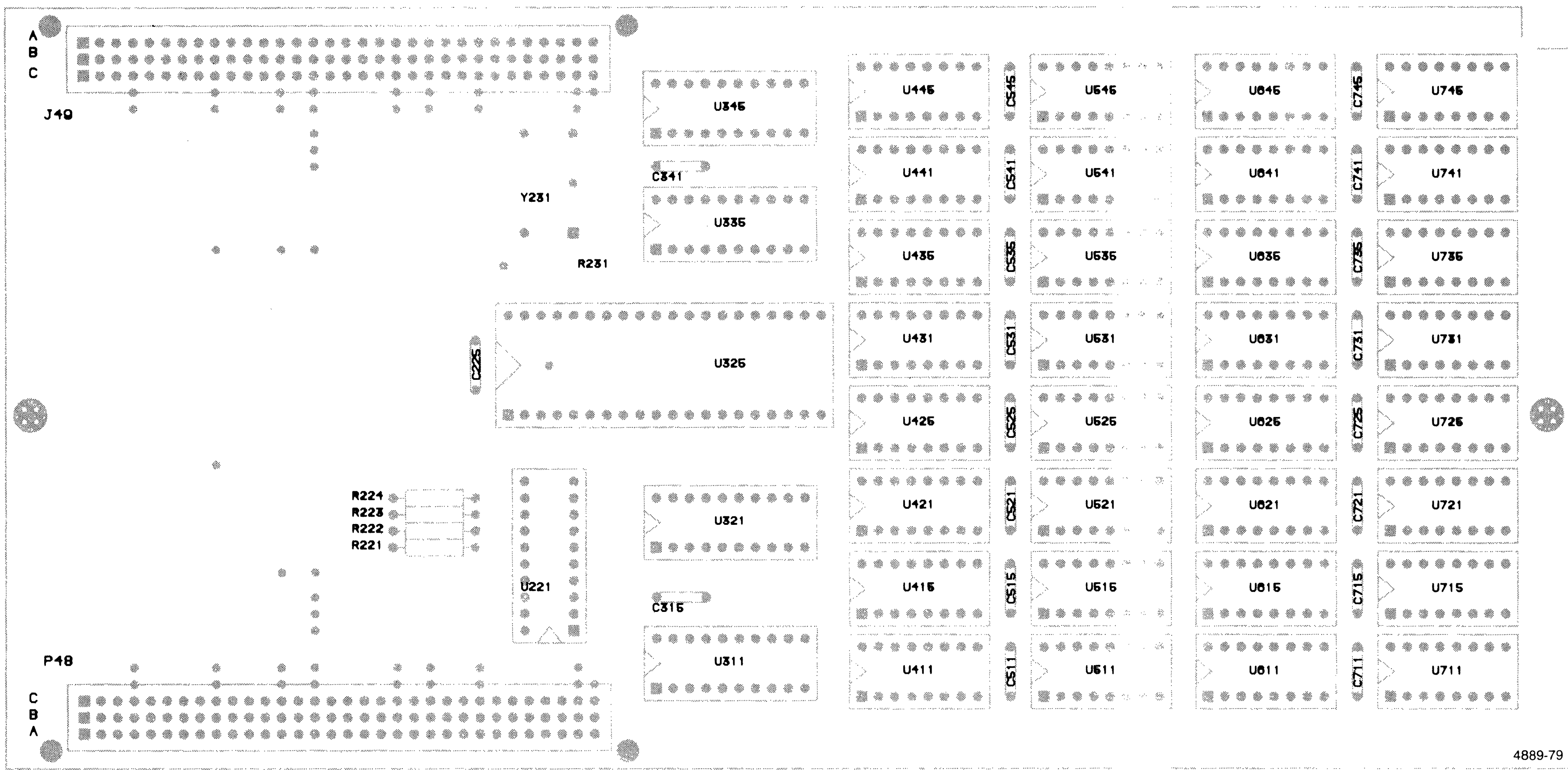


FIRST USE: 4109	OTHER USES: 4107 CX4107 CX4109 4106	NOTES: TEKTRONIX, INC. © 1984	TITLE: 670-8234-01,15,16,17,18 & 670-8776-00 670-8814-00 TERMINAL CONTROL BOARD 2 PPI	Tektronix®	ASSEMBLY: -5
DATE: REV, 27 JUNE 1984					SHEET: 5 OF 6
CONTROL NO.: SDA001,001					

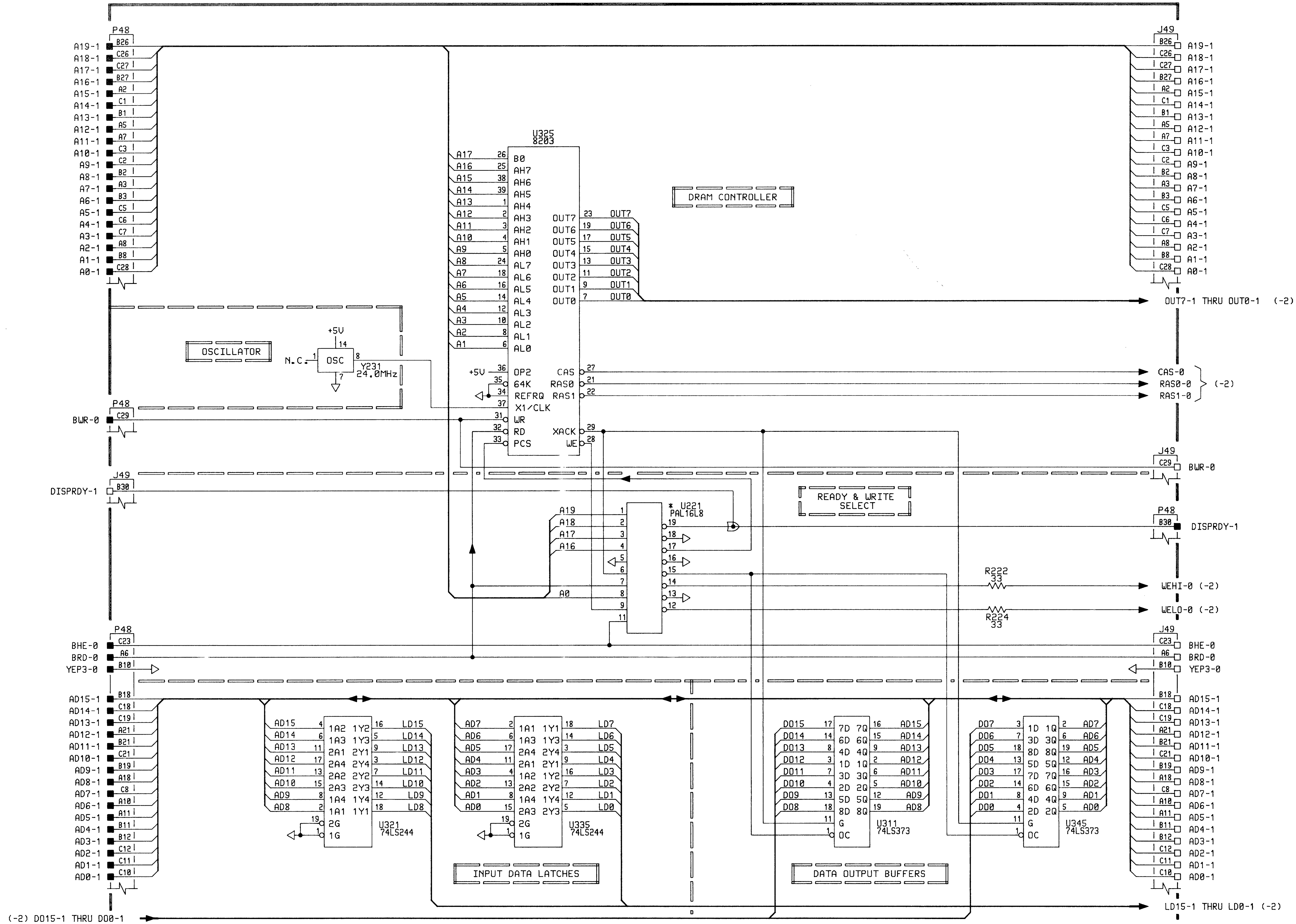


IC SUPPLIES		
DEVICE TYPE	PINS	
	+5V	GND
ALL 14 PIN IC'S	14	7
74LS112	16	8
74LS373	20	10
29841 PAL12L10	24	12
8255A-5	26	7
27128 27256	28 ,1	14
2186 2817A	28	14
2681	1,40	20

FIRST USE: 4109 DATE: REV, 27 JUNE 1984 CONTROL NO.: SDA001.001	OTHER USES: 4107 CX4107 CX4109 4106	NOTES:	TITLE: 670-8234-01,15,16,17,18 & 670-8776-00 670-8814-00 TERMINAL CONTROL BOARD POWER	Tektronix®	ASSEMBLY: -6 SHEET: 6 OF 6



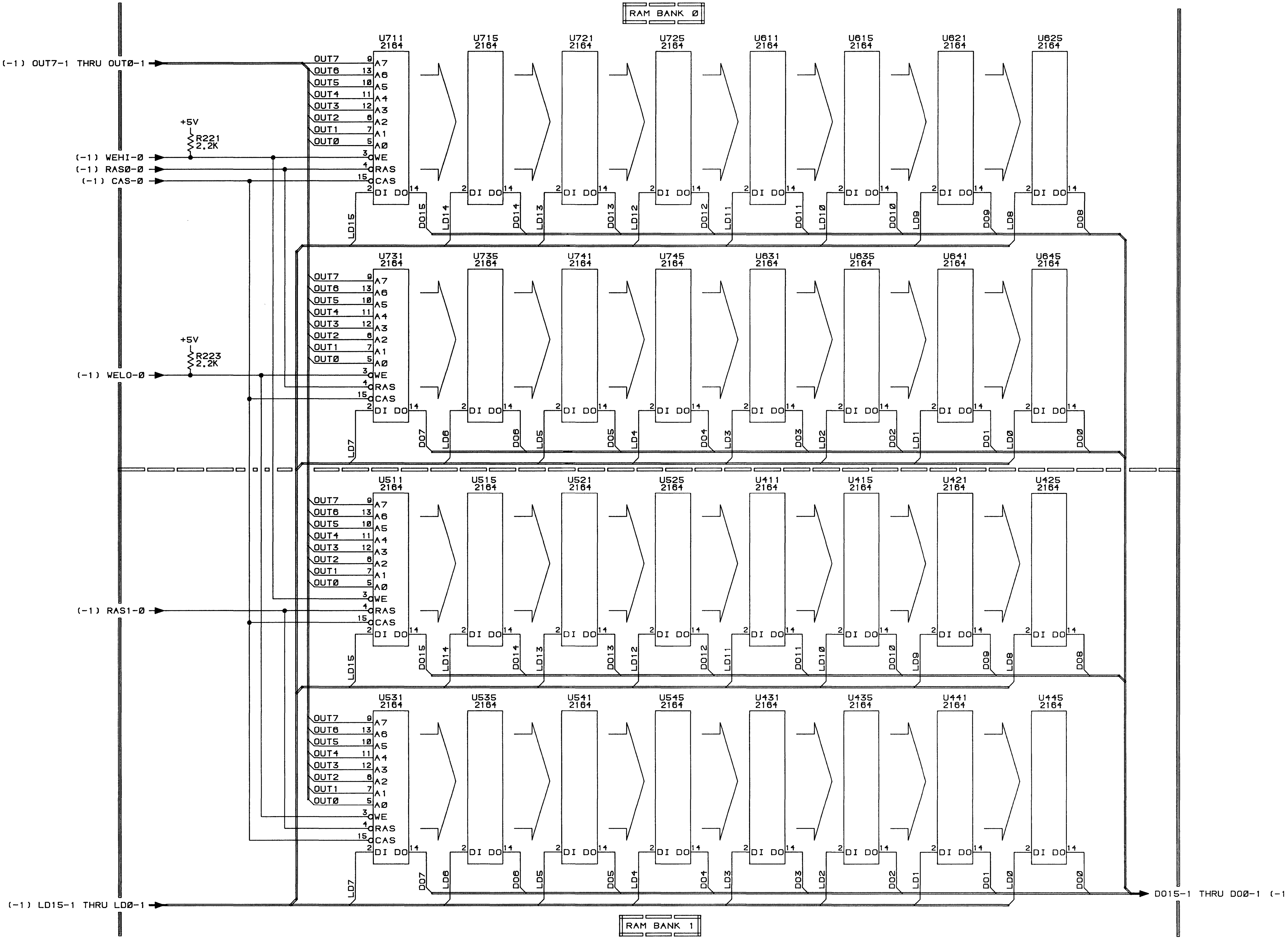
RAM3 Component Locations.



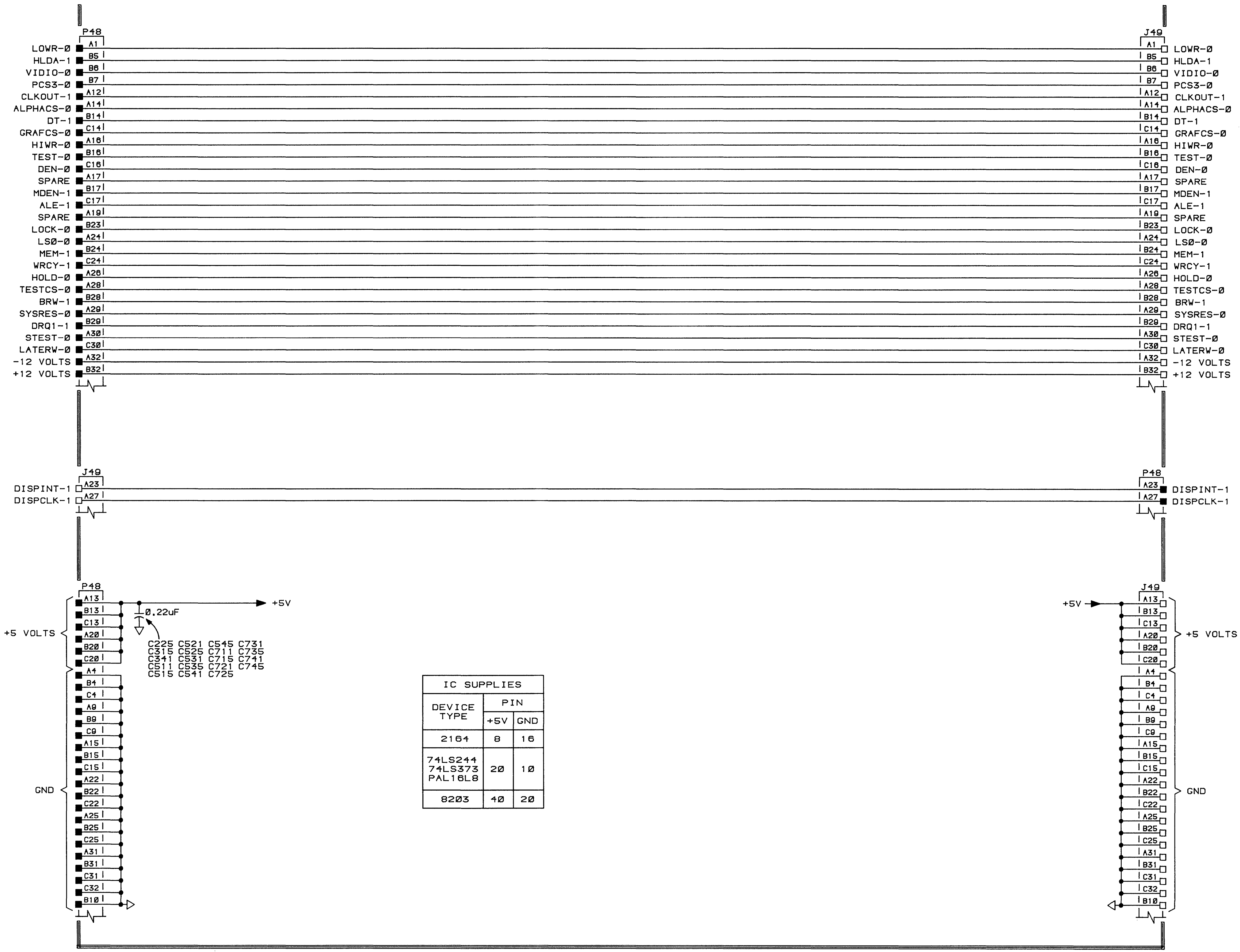
FIRST USE: 4107 DATE: REV, 3 DEC 1985 CONTROL NO.: SDA002.A01	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: * REFER TO THEORY OF OPERATION. TEKTRONIX, INC. © 1984	TITLE: 670-7196-00 ,15 ,16 RAM3 BOARD	Tektronix®	ASSEMBLY: A2-1 SHEET: 1 OF 3

RAM3

A2-1

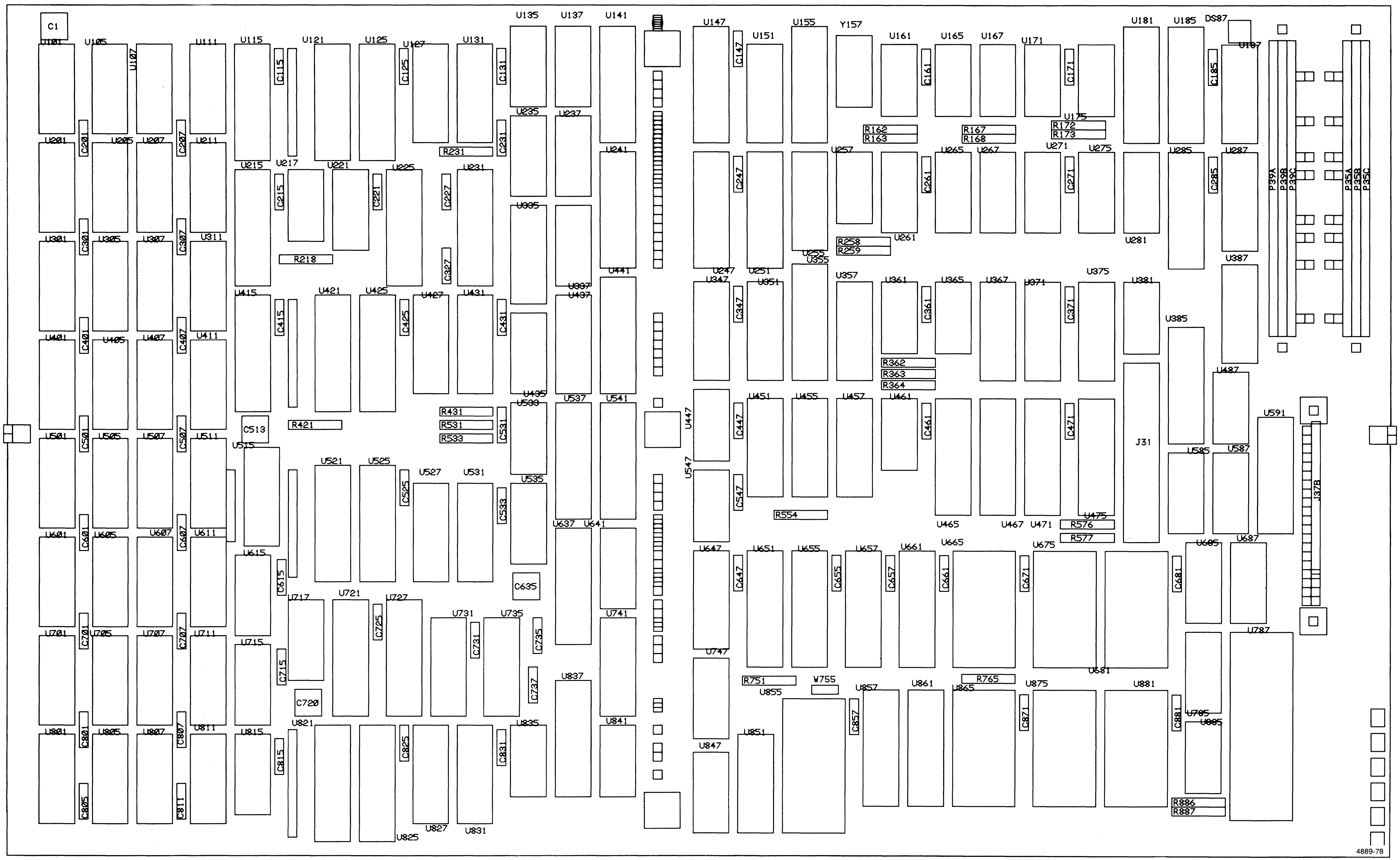


FIRST USE: 4107	OTHER USES: 41Ø9 CX41Ø7 CX41Ø9	NOTES: TEKTRONIX, INC. © 1984	TITLE: 67Ø-7196-ØØ ,15 RAM3 BOARD	Tektronix®	ASSEMBLY: -2
DATE: REV, 29 JUNE 1984					
CONTROL NO.: SDAØØ2.ØØØ					SHEET: 2 OF 3

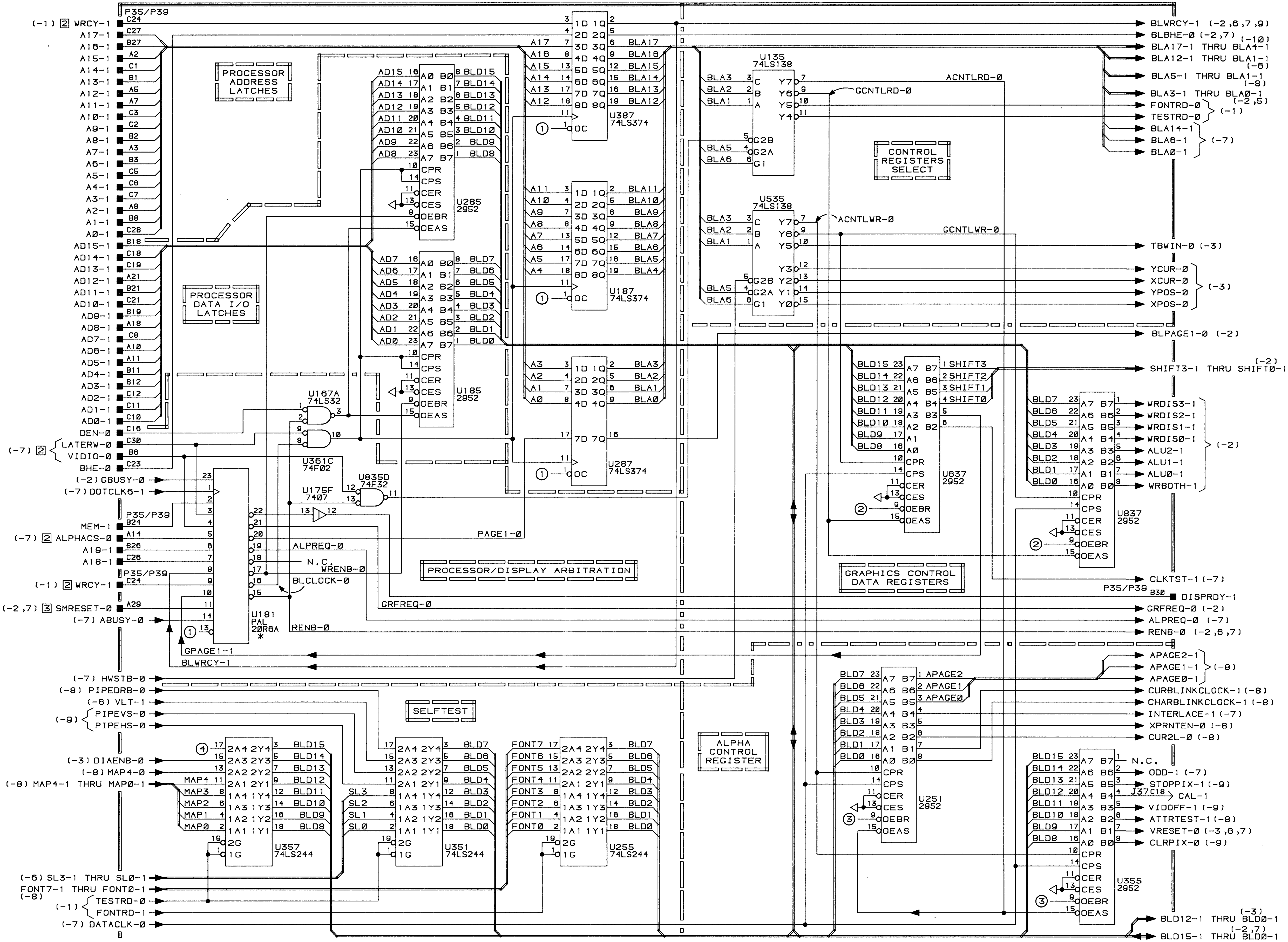


IC SUPPLIES		
DEVICE TYPE	PIN	
	+5V	GND
2164	8	16
74LS244 74LS373 PAL16L8	2Ø	1Ø
82Ø3	4Ø	2Ø

FIRST USE: 41Ø7	OTHER USES: 41Ø9 CX41Ø7 CX41Ø9	NOTES:	TITLE: 67Ø-7196-ØØ ,15	Tektronix®	ASSEMBLY: -3
DATE: REV, 29 JUNE 1984			RAM3 BOARD		
CONTROL NO.: SDAØØ2.ØØØ					SHEET: 3 OF 3



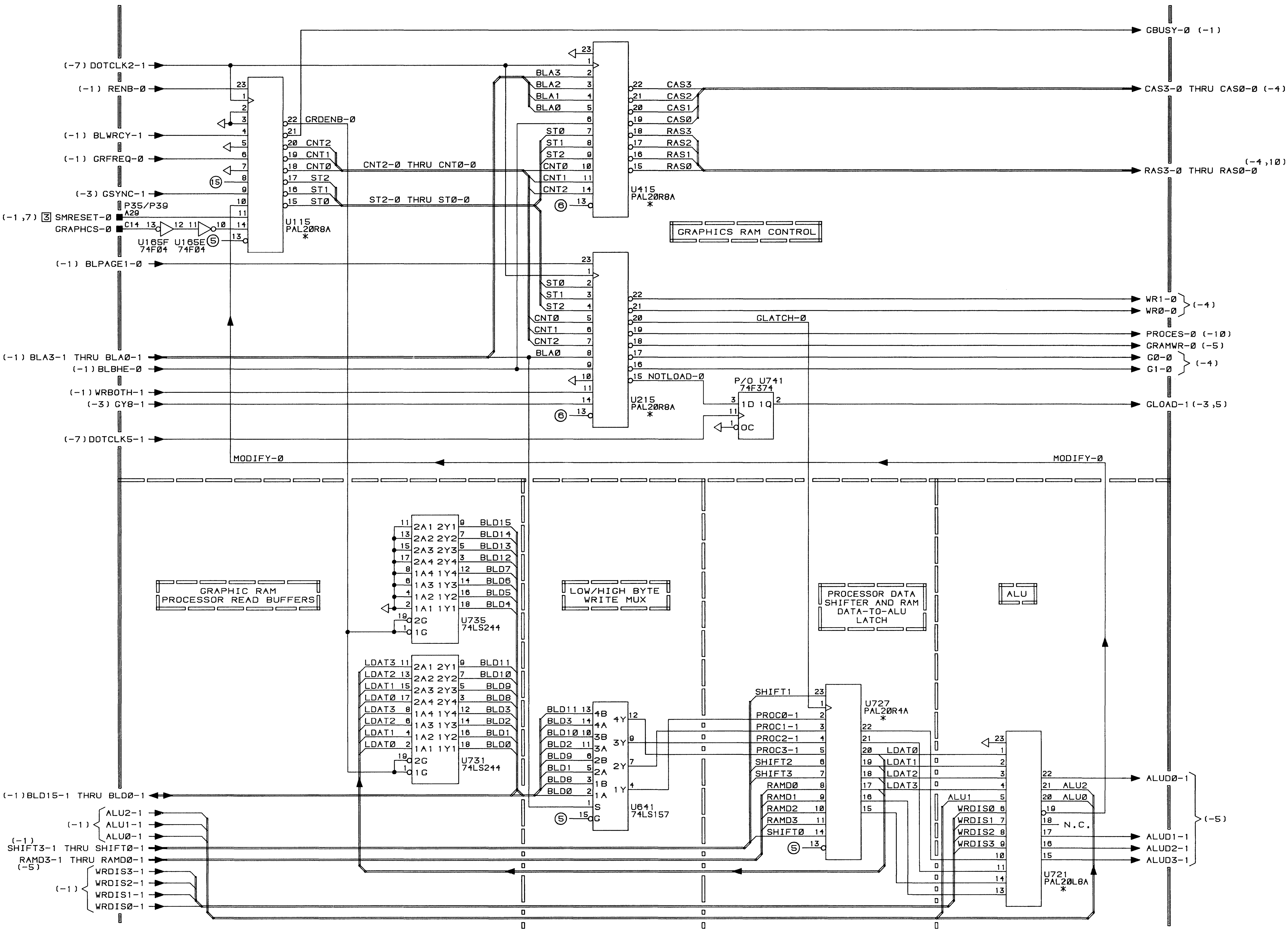
Display Control Component Locations.



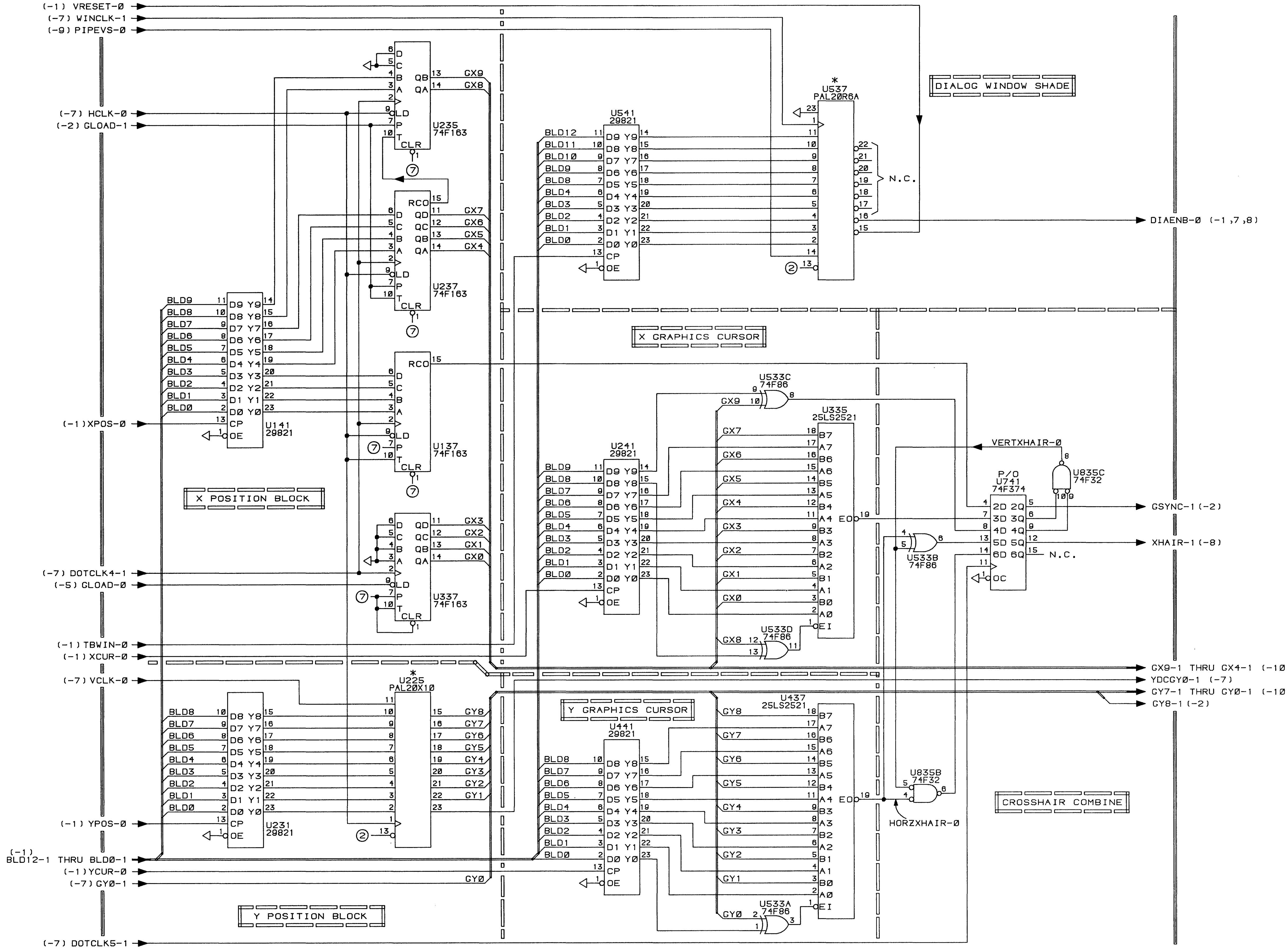
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: * REFER TO THEORY OF OPERATION. □ INDICATES SHOWN MORE THAN ONCE AND WHERE (-)	TITLE: 670-8233-00,02,03,15 670-8815-00 DISPLAY CONTROL BOARD	Tektronix®	ASSEMBLY: -1
DATE: REV, 29 JUNE 1984		TEKTRONIX, INC. © 1984			SHEET: 1 OF 10
CONTROL NO.: SDAØØ3.ØØØ					

DISPLAY CONTROL

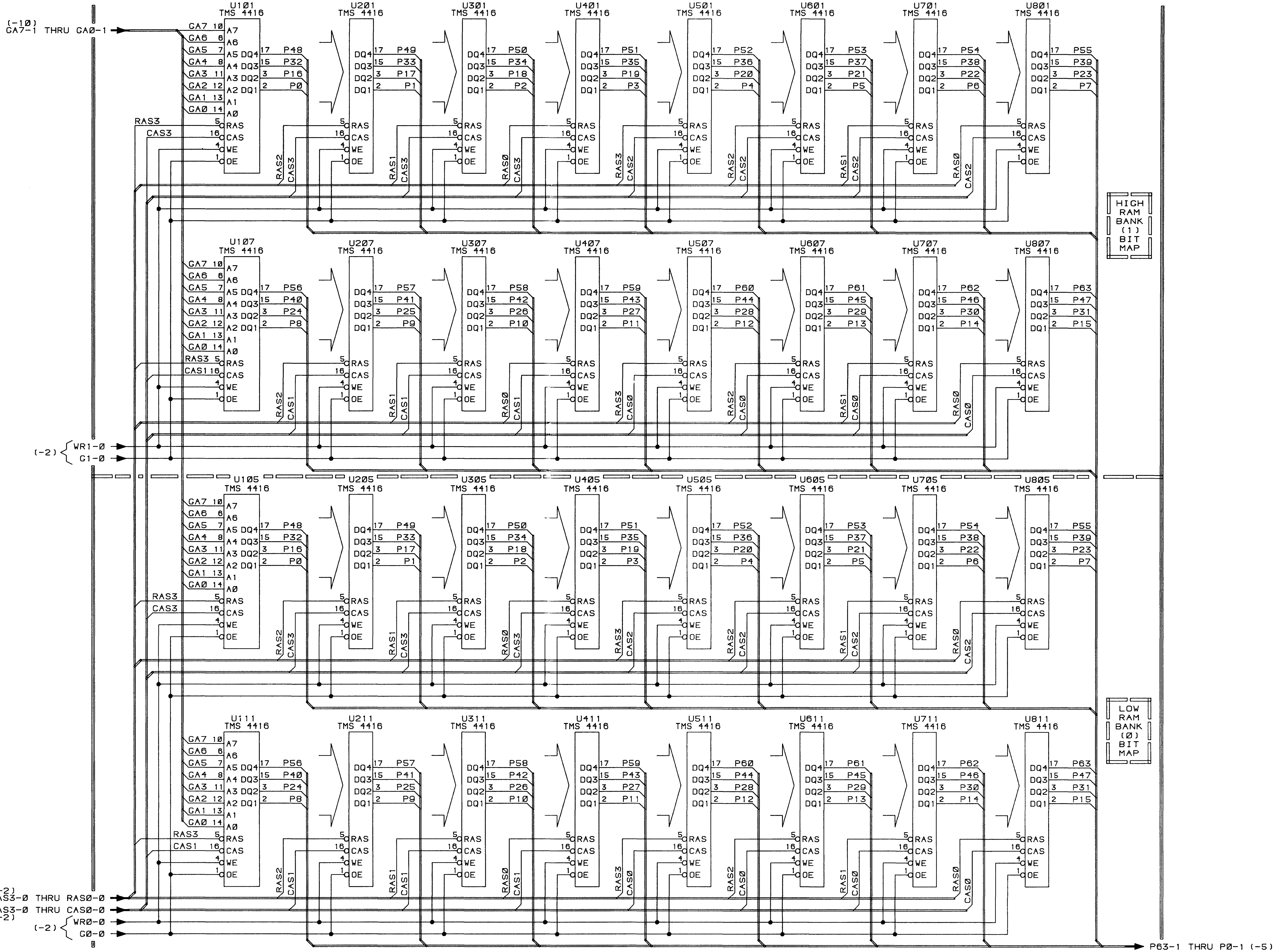
A3-1



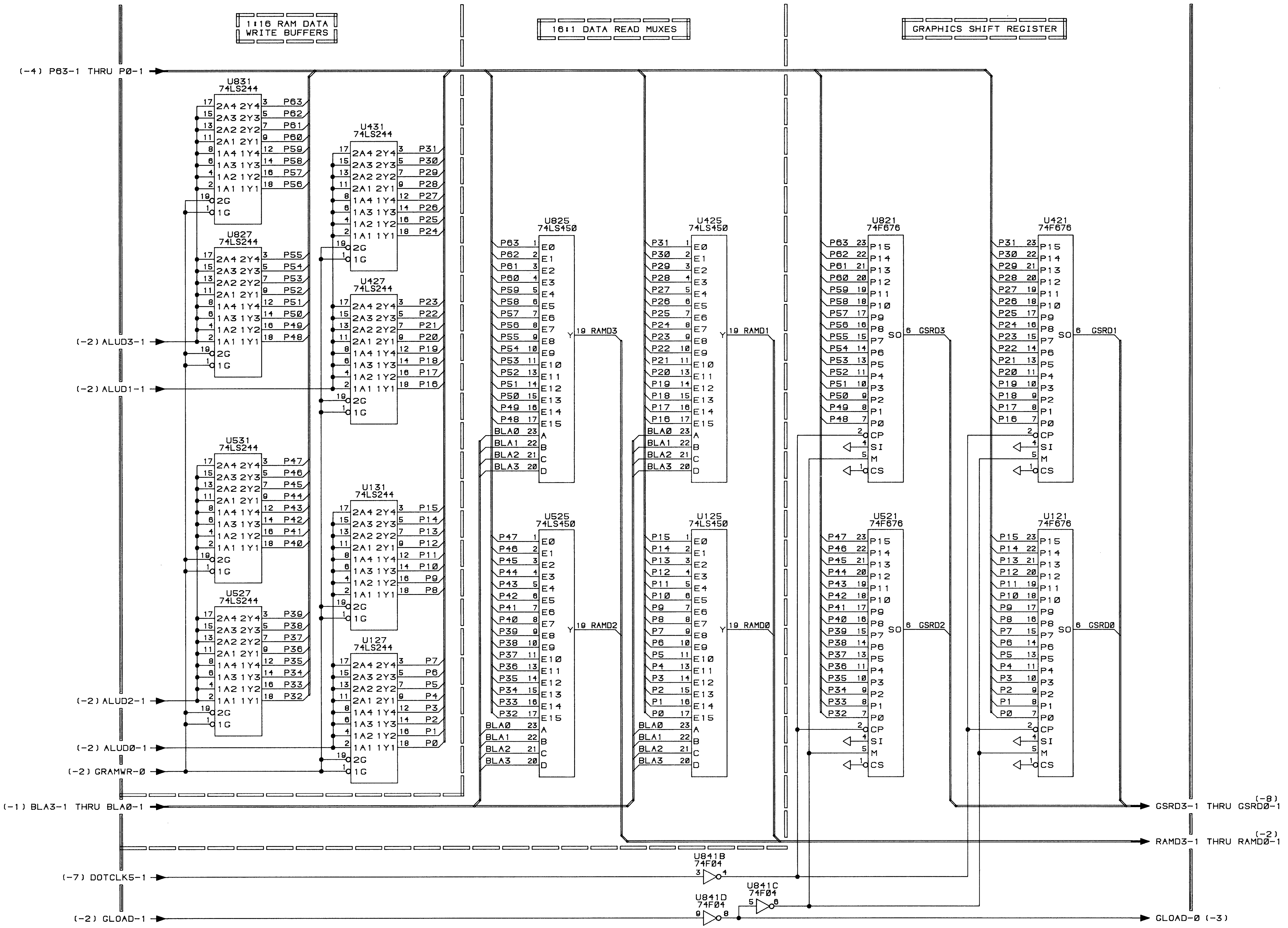
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: * REFER TO THEORY OF OPERATION. ☐ INDICATES SHOWN MORE THAN ONCE AND WHERE (-)	TITLE: 670-8233-00,02,03,15,16 670-8815-00 DISPLAY CONTROL BOARD	ASSEMBLY: -2
DATE: REV, 29 JUNE 1984			Tektronix®	
CONTROL NO.: SDA003.000		TEKTRONIX, INC. © 1984		SHEET: 2 OF 10



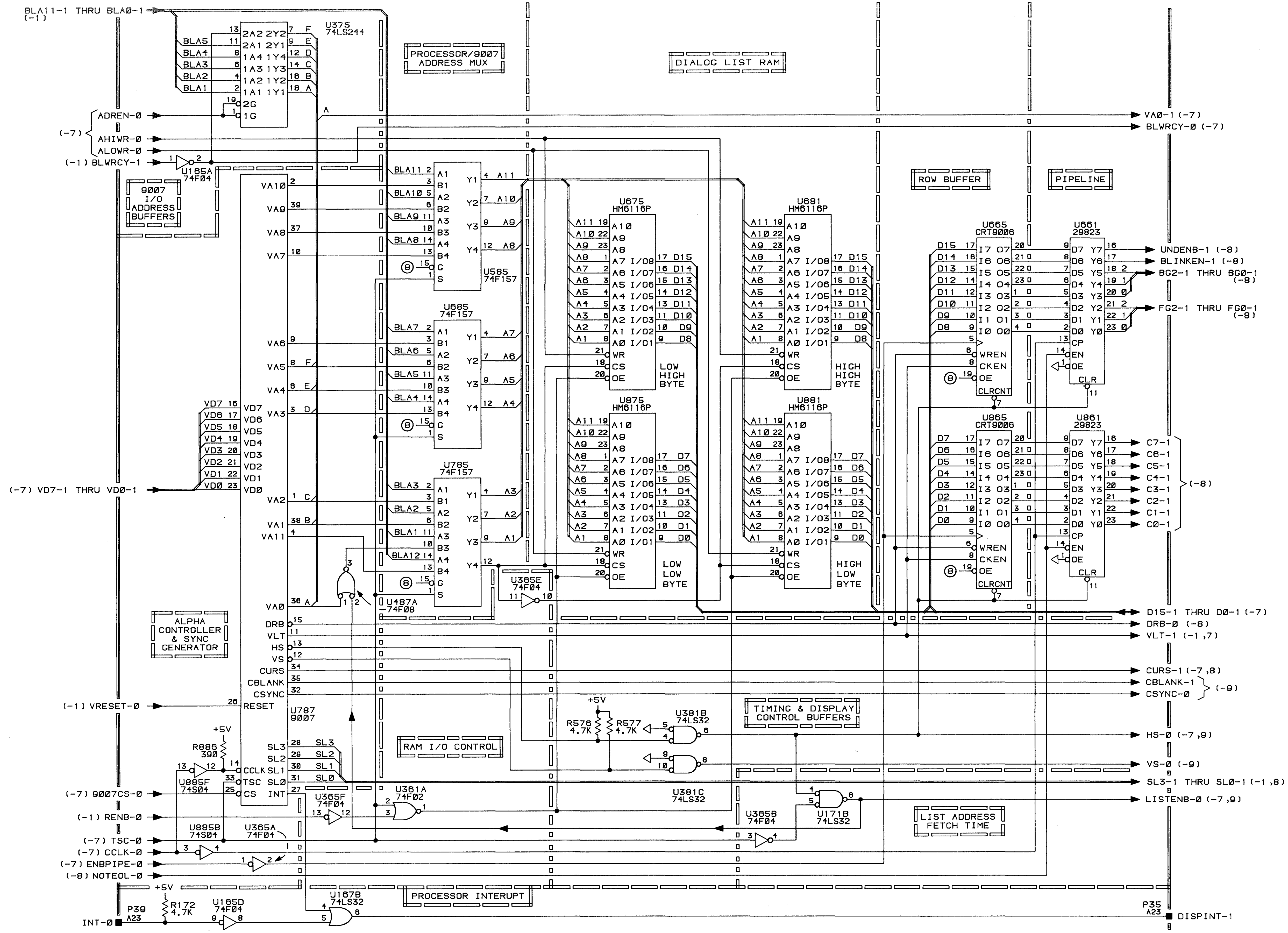
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: * REFER TO THEORY OF OPERATION.	TITLE: 670-8233-00,02,03,15,16 670-8815-00	Tektronix®	ASSEMBLY: -3
DATE: REV, 29 JUNE 1984			DISPLAY CONTROL BOARD		
CONTROL NO.: SDA003.000					SHEET: 3 OF 10



FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES:	TITLE: 670-8233-00,02,03,15,16 670-8815-00	Tektronix®	ASSEMBLY: -4
DATE: REV, 29 JUNE 1984			DISPLAY CONTROL BOARD		
CONTROL NO.: SDA003.000		TEKTRONIX, INC. © 1984			SHEET: 4 OF 10



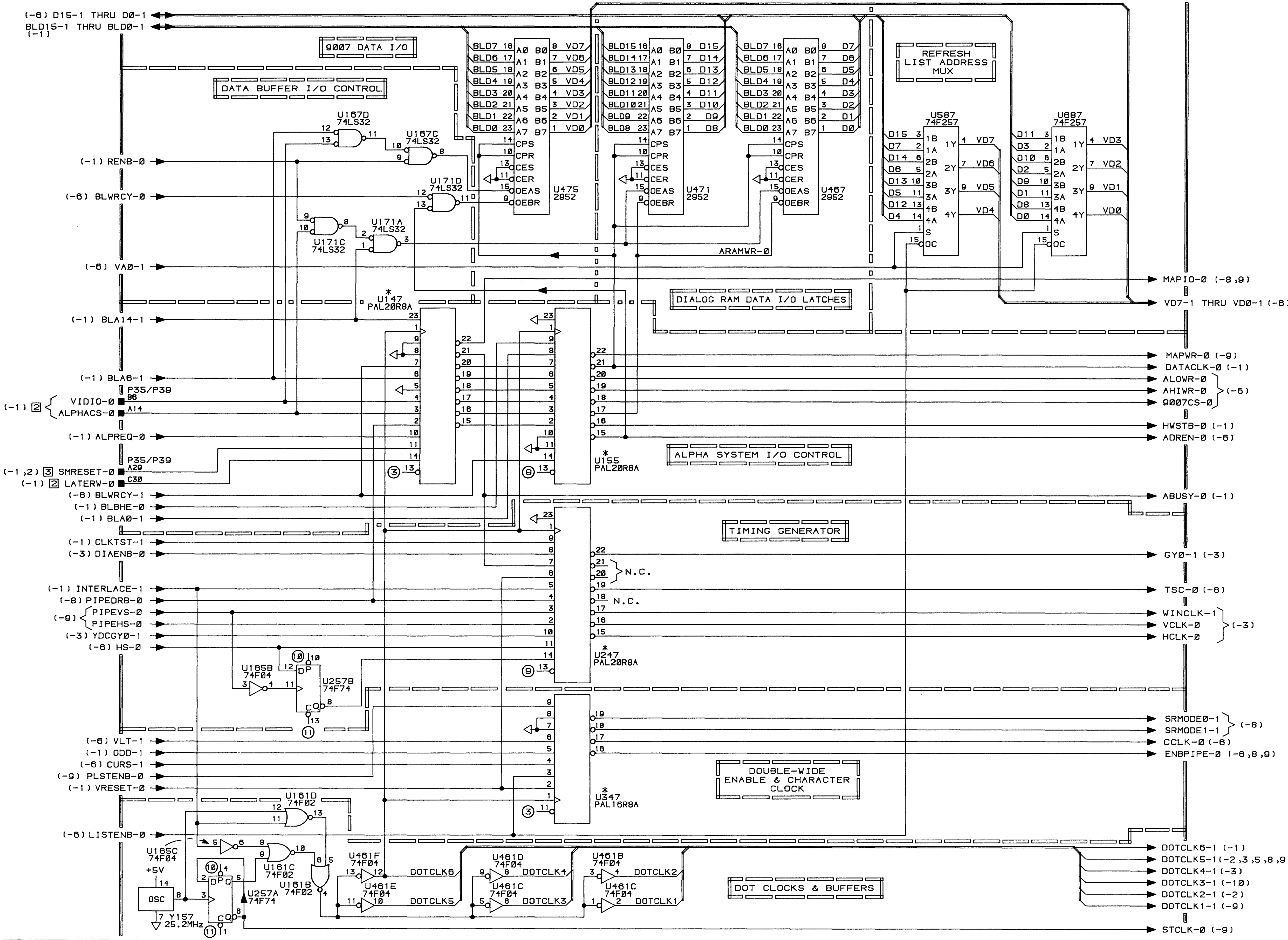
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: TEKTRONIX, INC. © 1984	TITLE: 670-8233-00,02,03,15,16 670-8815-00 DISPLAY CONTROL BOARD	Tektronix®	ASSEMBLY: -5
DATE: REV, 29 JUNE 1984					
CONTROL NO.: SDA003.000					SHEET: 5 OF 10



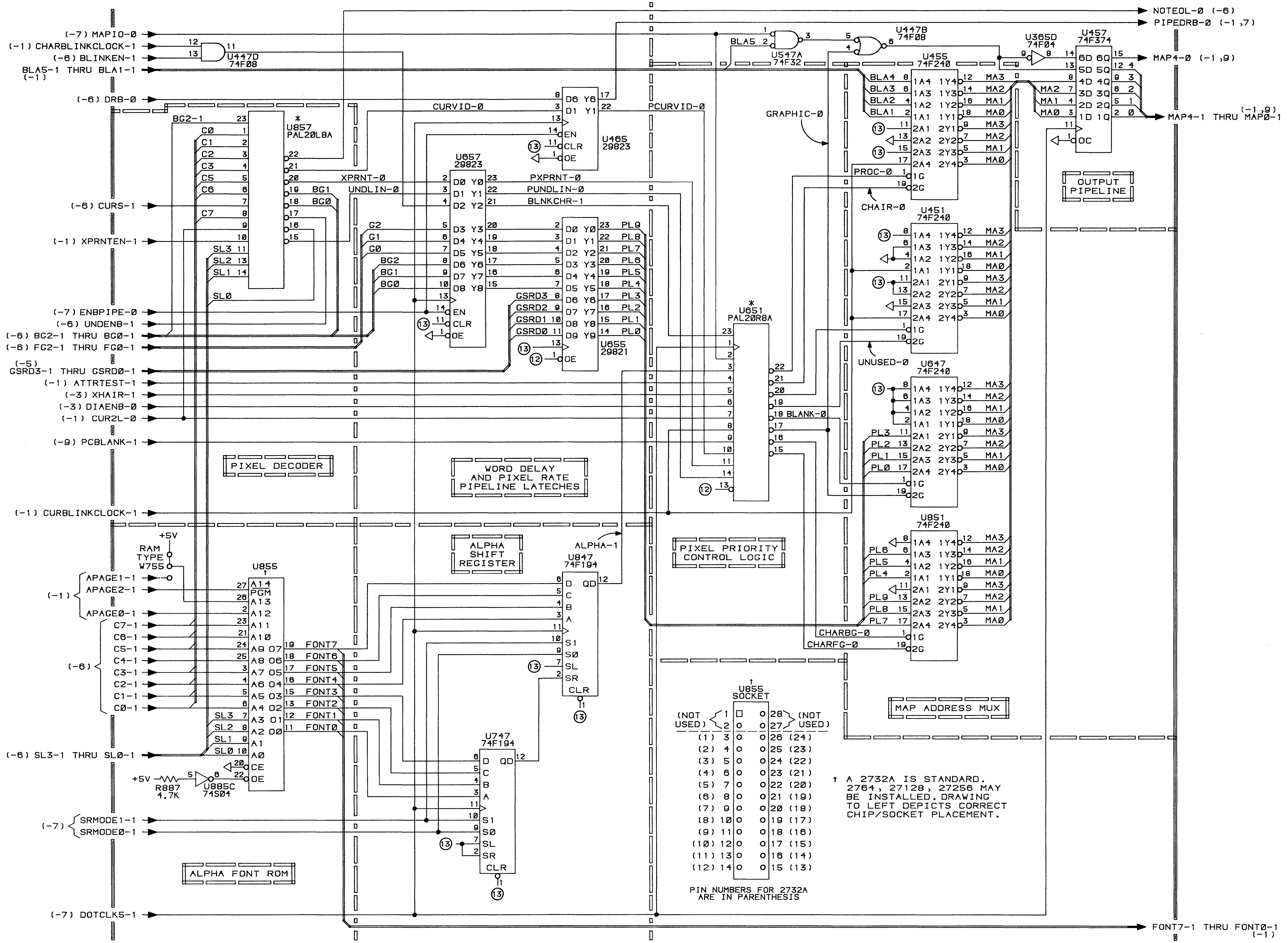
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: TEKTRONIX, INC. © 1984	TITLE: 670-8233-00,02,03,15,16 670-8815-00 DISPLAY CONTROL BOARD	Tektronix®	ASSEMBLY: -6
DATE: REV,29 JUNE 1984					
CONTROL NO.: SDAØØ3.ØØØ					SHEET: 6 OF 10

DISPLAY CONTROL

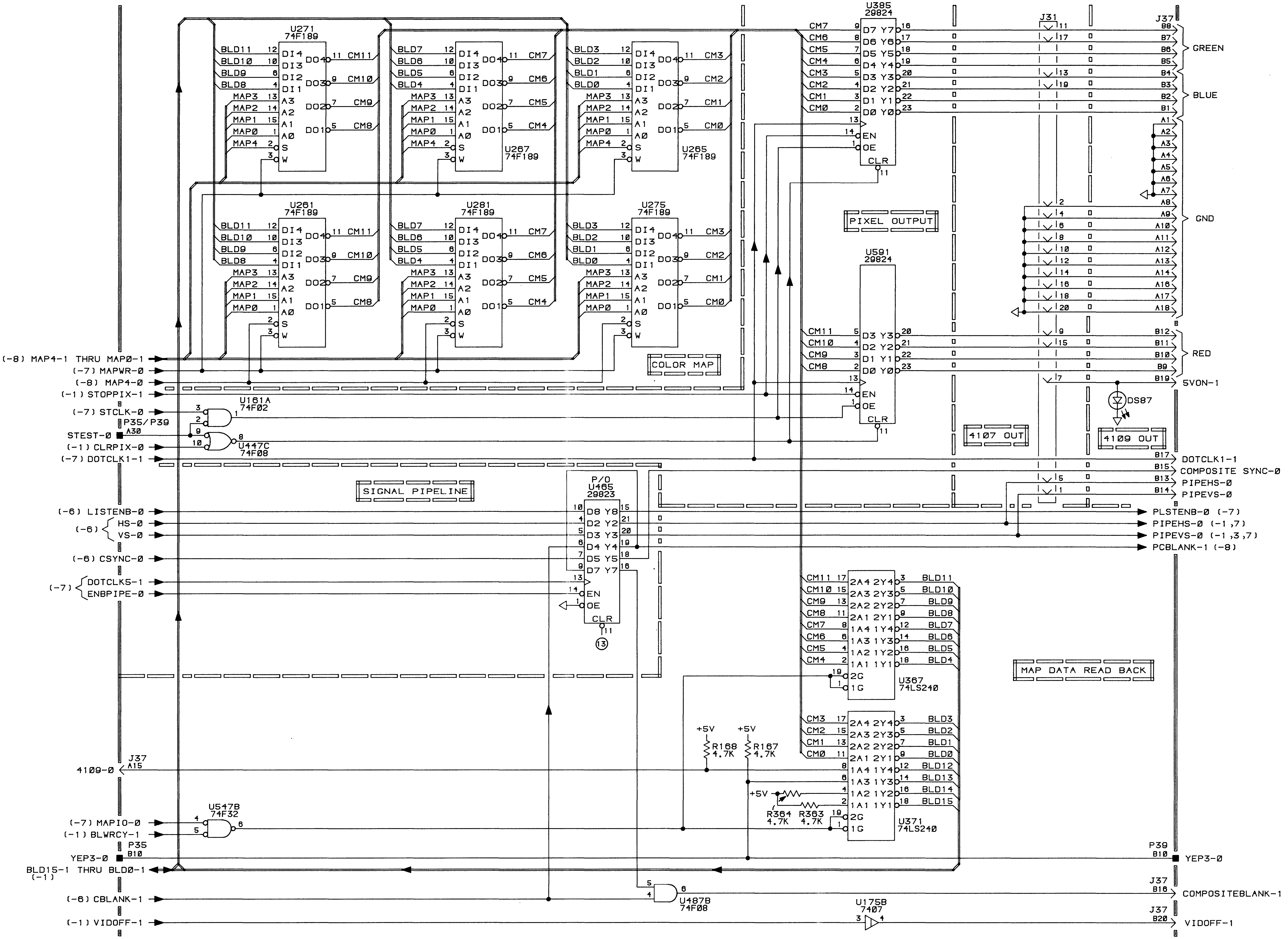
A3-6



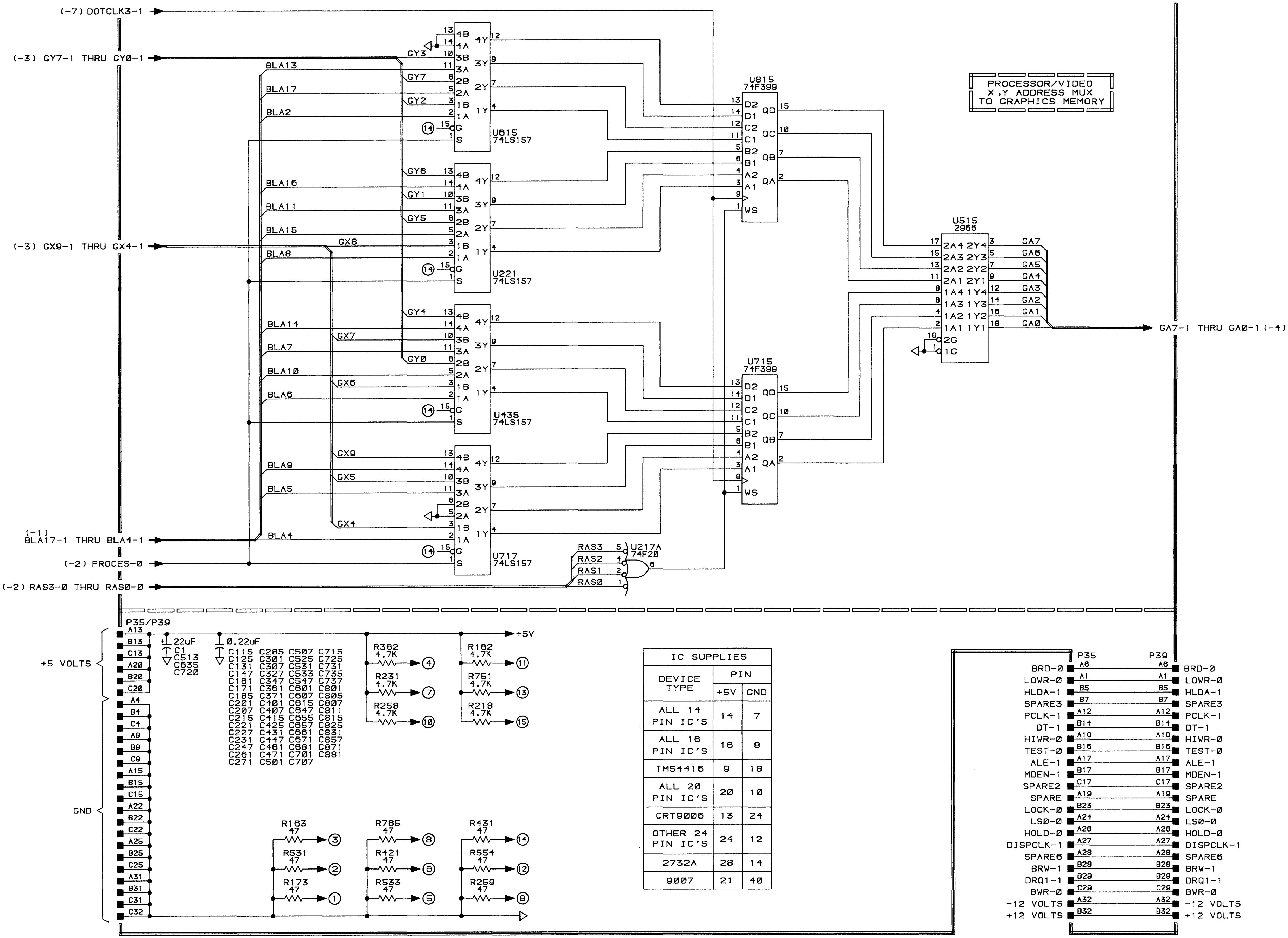
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: * REFER TO THEORY OF OPERATION. □ INDICATES SHOWN MORE THAN ONCE AND WHERE (-)	TITLE: 670-8233-00,02,03,15,16 670-8815-00 DISPLAY CONTROL BOARD	Tektronix®	ASSEMBLY: -7
DATE: REV, 29 JUNE 1984					
CONTROL NO.: SDA003.000		TEKTRONIX, INC. © 1984			SHEET: 7 OF 10



FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: * REFER TO THEORY OF OPERATION.	TITLE: 670-8233-00,02,03,15,16 670-8815-00 DISPLAY CONTROL BOARD	Tektronix®	ASSEMBLY: -8
DATE: REV, 29 JUNE 1984					SHEET: 8 OF 10
CONTROL NO.: SDA003.000					



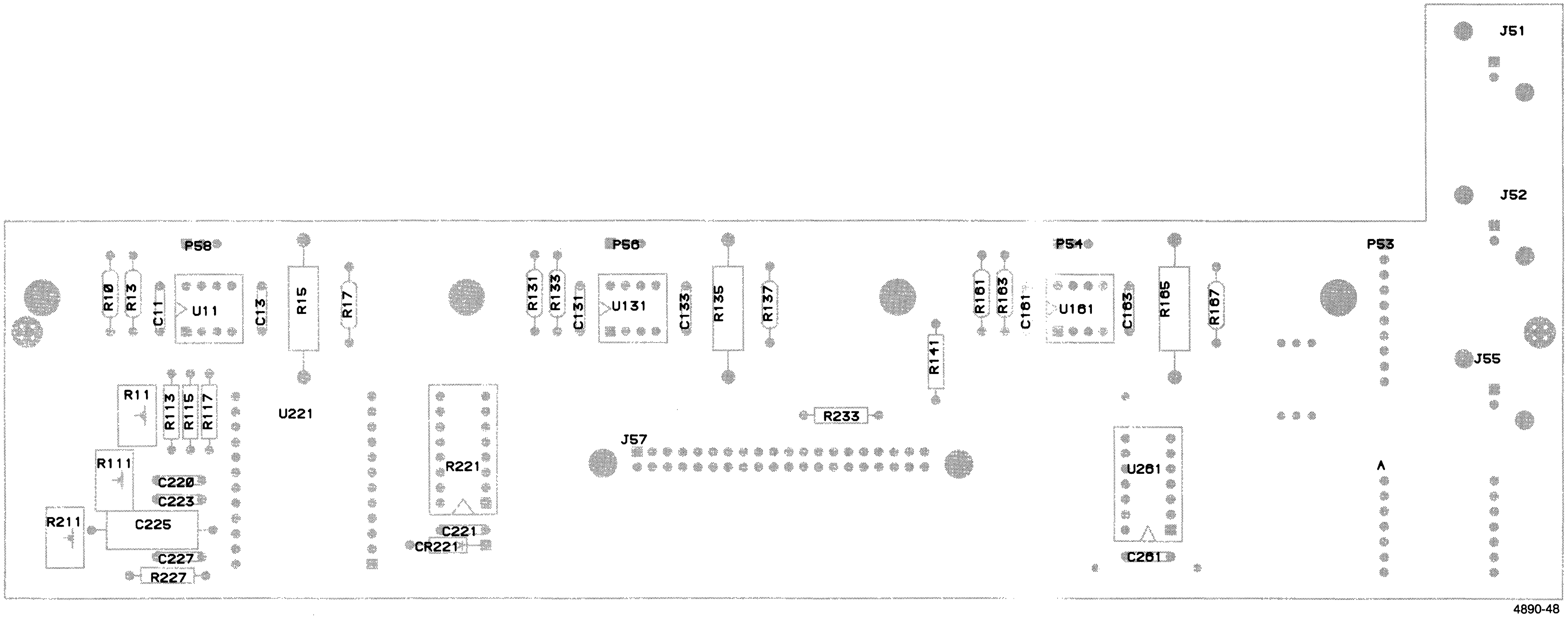
FIRST USE: 4107	OTHER USES: 4109 CX4107 CX4109 4106	NOTES:	TITLE: 670-8233-00,02,03,15,16 670-8815-00	Tektronix®	ASSEMBLY: -9
DATE: REV, 29 JUNE 1984			DISPLAY CONTROL BOARD		
CONTROL NO.: SDA003.000		TEKTRONIX, INC. © 1984			SHEET: 9 OF 10



IC SUPPLIES

DEVICE TYPE	PIN +5V	PIN GND
ALL 14 PIN IC'S	14	7
ALL 16 PIN IC'S	16	8
TMS4416	9	18
ALL 20 PIN IC'S	20	10
CRT9006	13	24
OTHER 24 PIN IC'S	24	12
2732A	28	14
9007	21	40

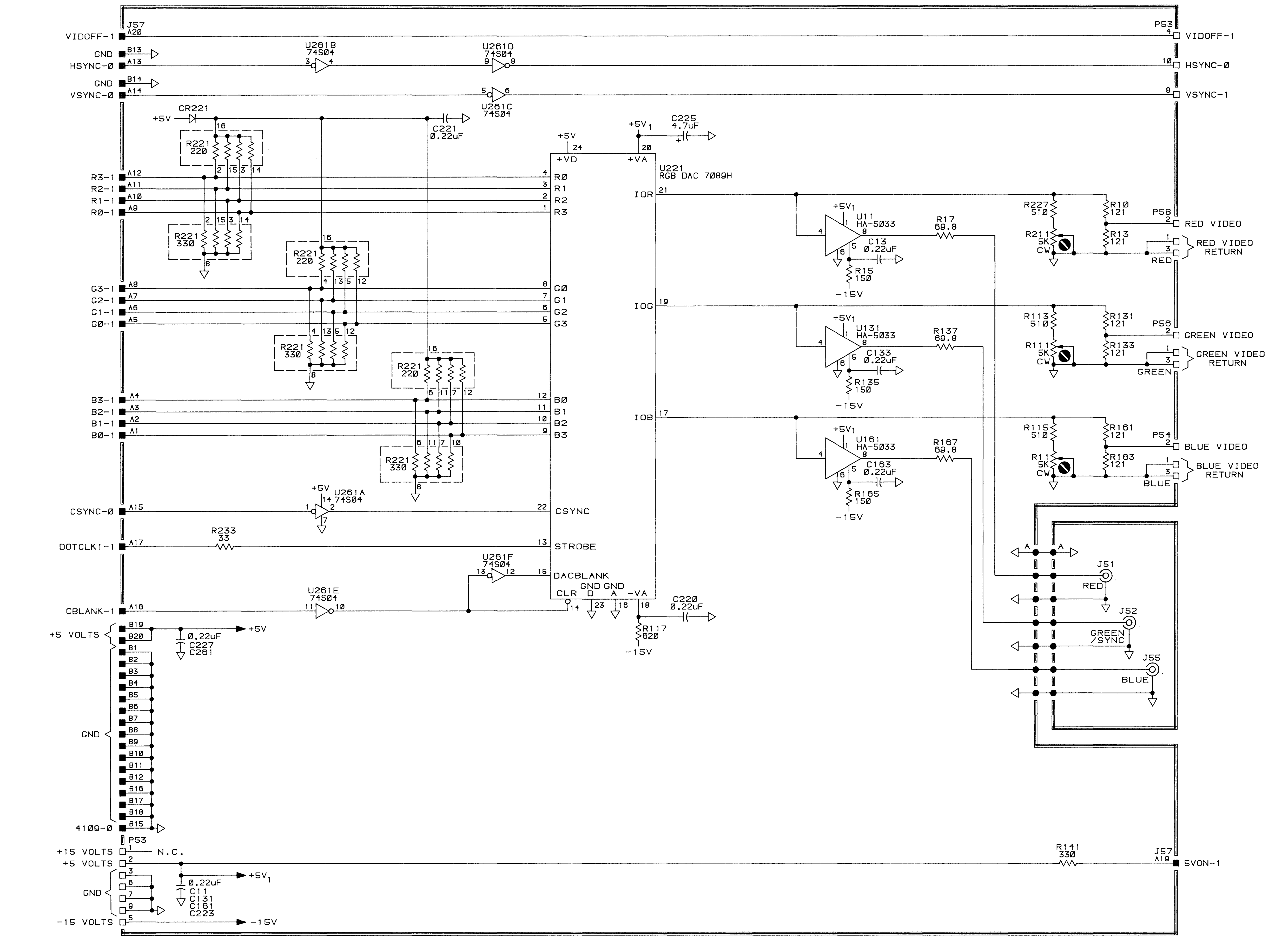
FIRST USE: 4107 DATE: REV, 29 JUNE 1984 CONTROL NO.: SDA003.000	OTHER USES: 4109 CX4107 CX4109 4106	NOTES: TEKTRONIX, INC. © 1984	TITLE: 670-8233-00,02,03,15,16 670-8815-00 DISPLAY CONTROL BOARD	Tektronix®	ASSEMBLY: -10 SHEET: 10 OF 10



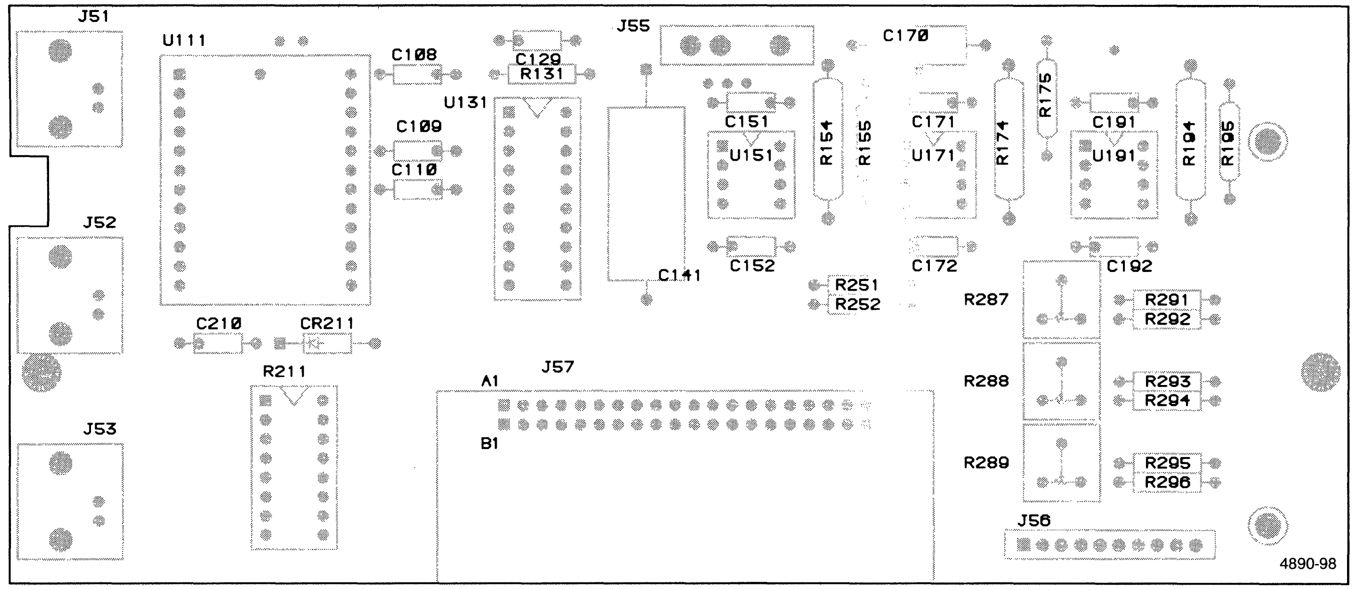
Digital Piggyback (670-8151-00) Component Locations.

DIGITAL PIGGYBACK
670-8151-00

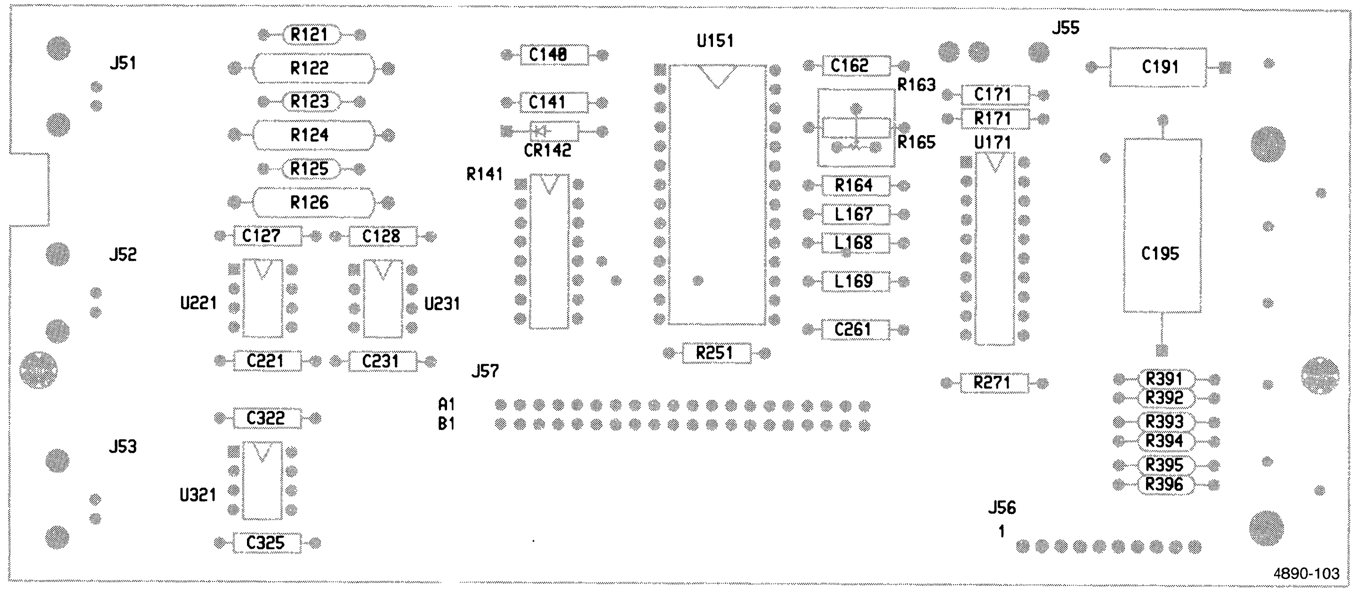
A4A



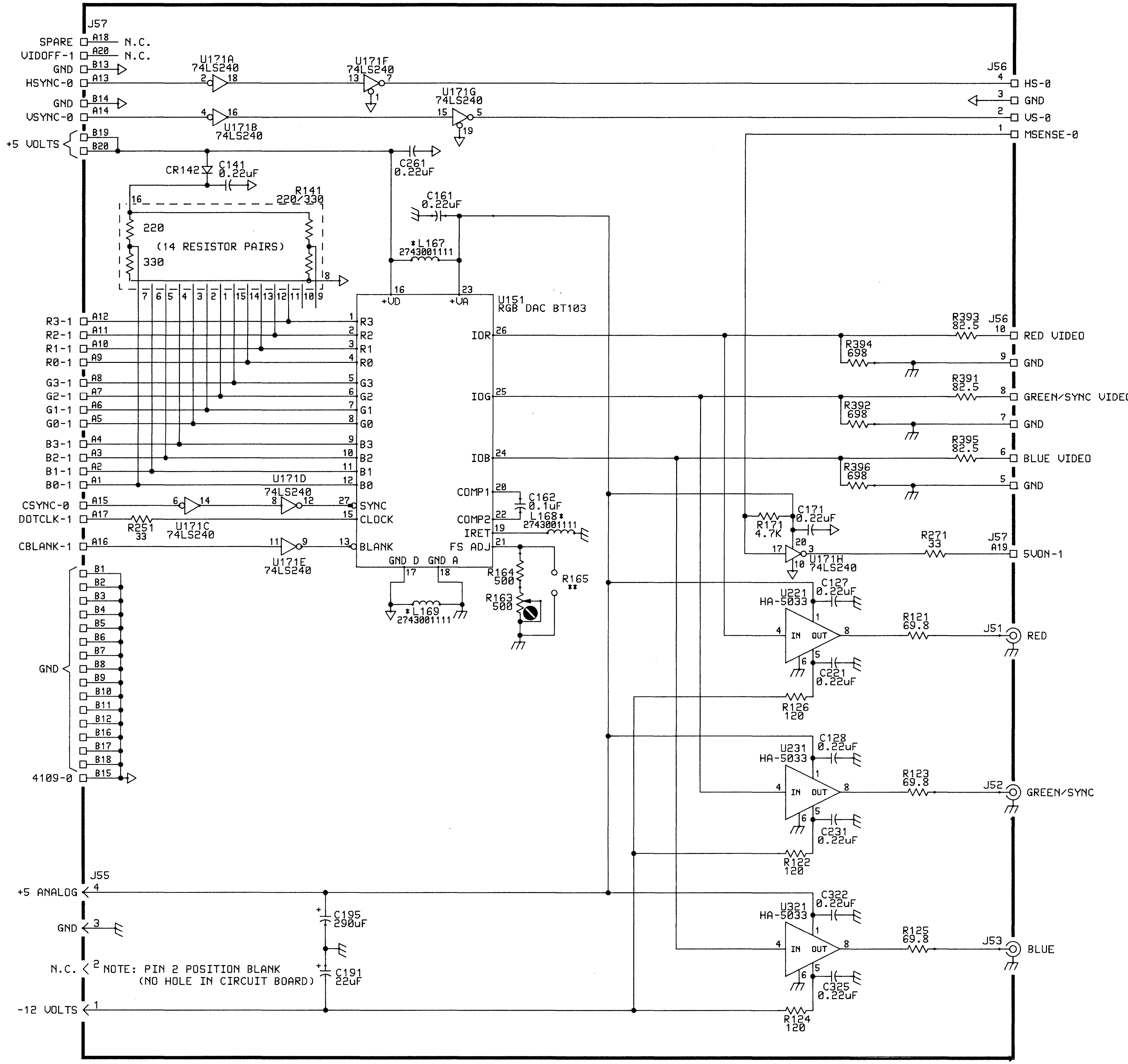
FIRST USE: 4109	OTHER USES:	NOTES:	TITLE: 67Ø-8151-ØØ ,15	Tektronix®	ASSEMBLY:
DATE: REV, 29 JUNE 1984	CX41Ø9		REAR		-1
CONTROL NO.: SDAØØ4.ØØØ		TEKTRONIX, INC. © 1984	DIGITAL PIGGYBACK BOARD		SHEET: 1 OF 1



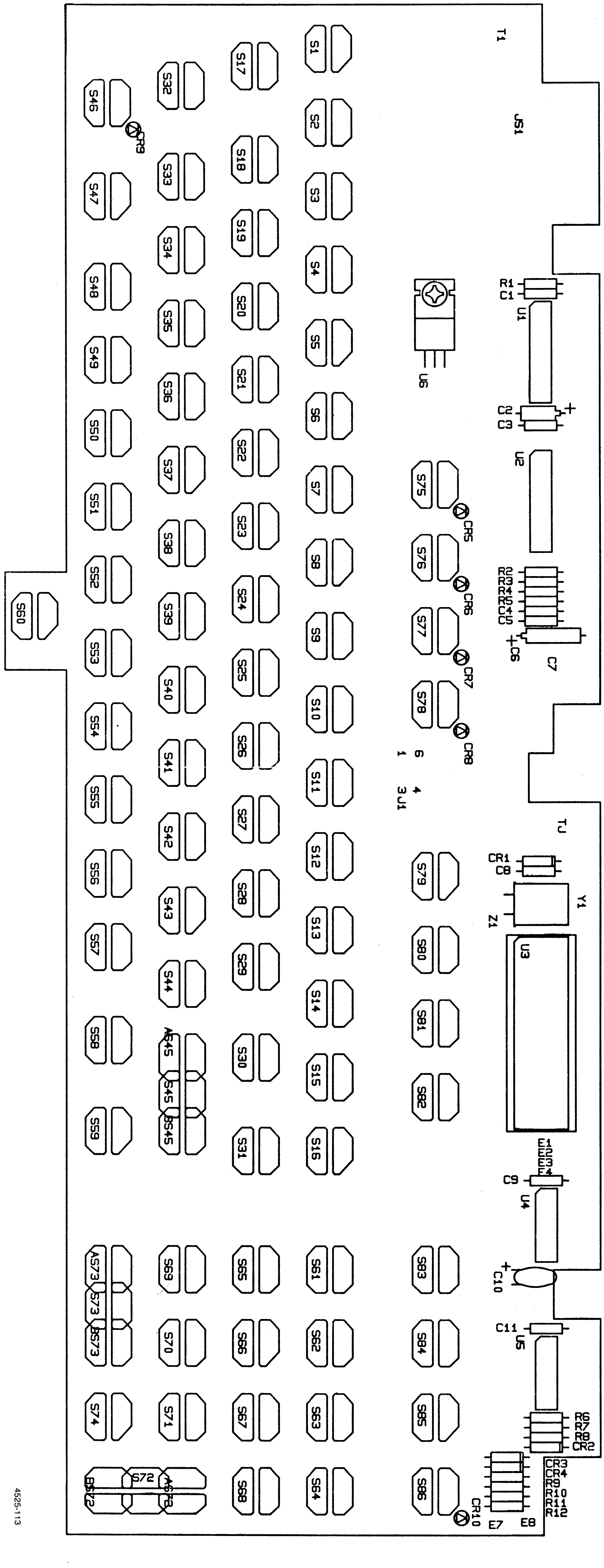
Video Interface (670-9045-00) Component Locations.



Later Video Interface (670-9045-02) Component Locations.

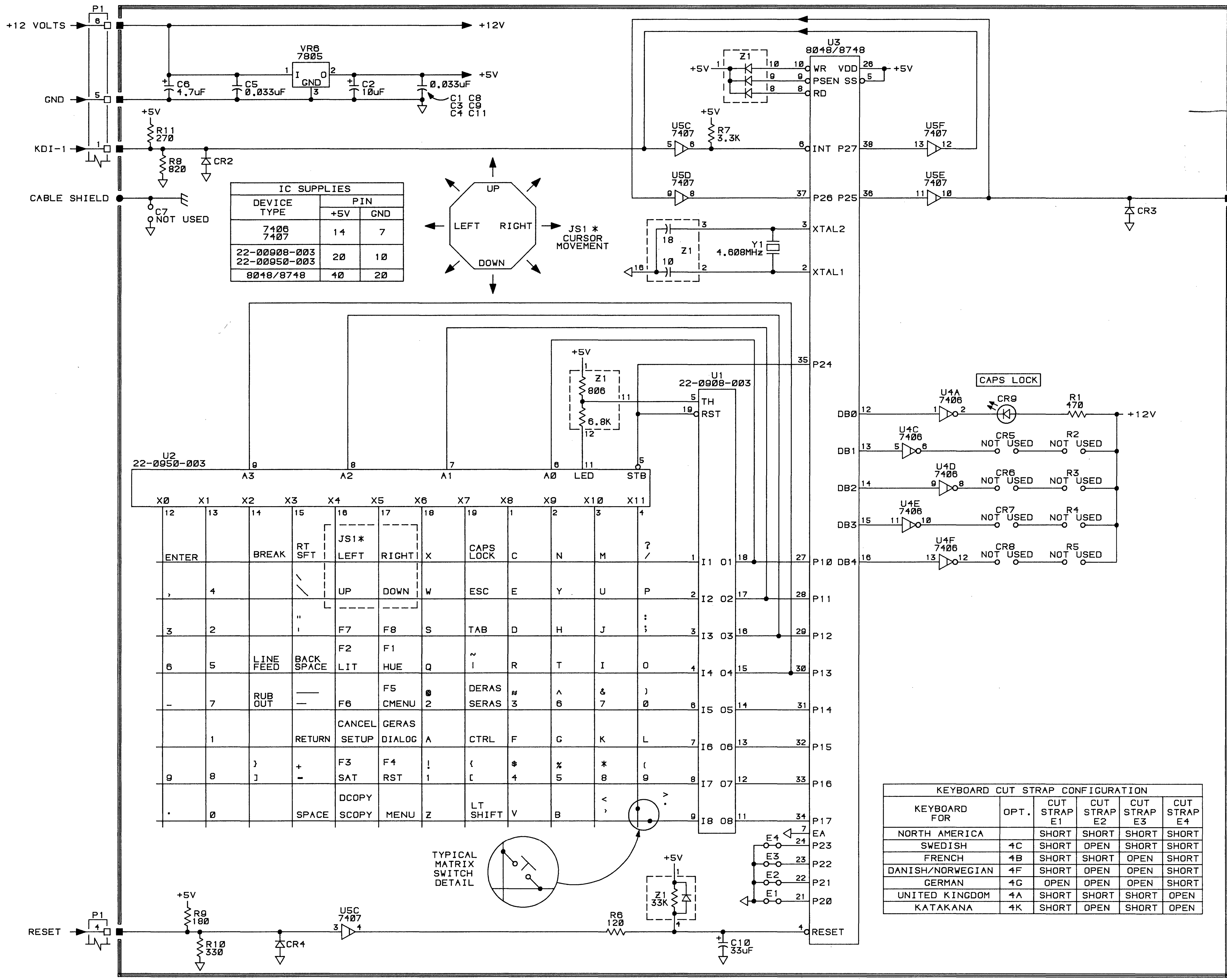


FIRST USE: 4109A	OTHER USES:	NOTES: * THESE ARE 'FERRITE' PART NUMBERS, SEE ALSO TEKTRONIX PART NUMBER 276-0752-00.	TITLE: 670-9045-02,03,04	Tektronix®	ASSEMBLY:
DATE: REV, 6 MAY 1986	CX4109A	** IF R165 IS INSTALLED R163 & R164 ARE REMOVED.	VIDEO INTERFACE BOARD		VIDIF
CONTROL NO.:		TEKTRONIX, INC. © 1985			SHEET: 1 OF 1



4525-113

Standard Keyboard (119-1592-01) Component Locations.



IC SUPPLIES		
DEVICE TYPE	PIN +5V	PIN GND
7406 7407	14	7
22-00908-003 22-00950-003	20	10
8048/8748	40	20

KEYBOARD CUT STRAP CONFIGURATION					
KEYBOARD FOR	OPT.	CUT STRAP E1	CUT STRAP E2	CUT STRAP E3	CUT STRAP E4
NORTH AMERICA		SHORT	SHORT	SHORT	SHORT
SWEDISH	4C	SHORT	OPEN	SHORT	SHORT
FRENCH	4B	SHORT	SHORT	OPEN	SHORT
DANISH/NORWEGIAN	4F	SHORT	OPEN	OPEN	SHORT
GERMAN	4G	OPEN	OPEN	OPEN	SHORT
UNITED KINGDOM	4A	SHORT	SHORT	SHORT	OPEN
KATAKANA	4K	SHORT	OPEN	SHORT	OPEN

3 2 1
o o o
o o o
4 5 6
compent side

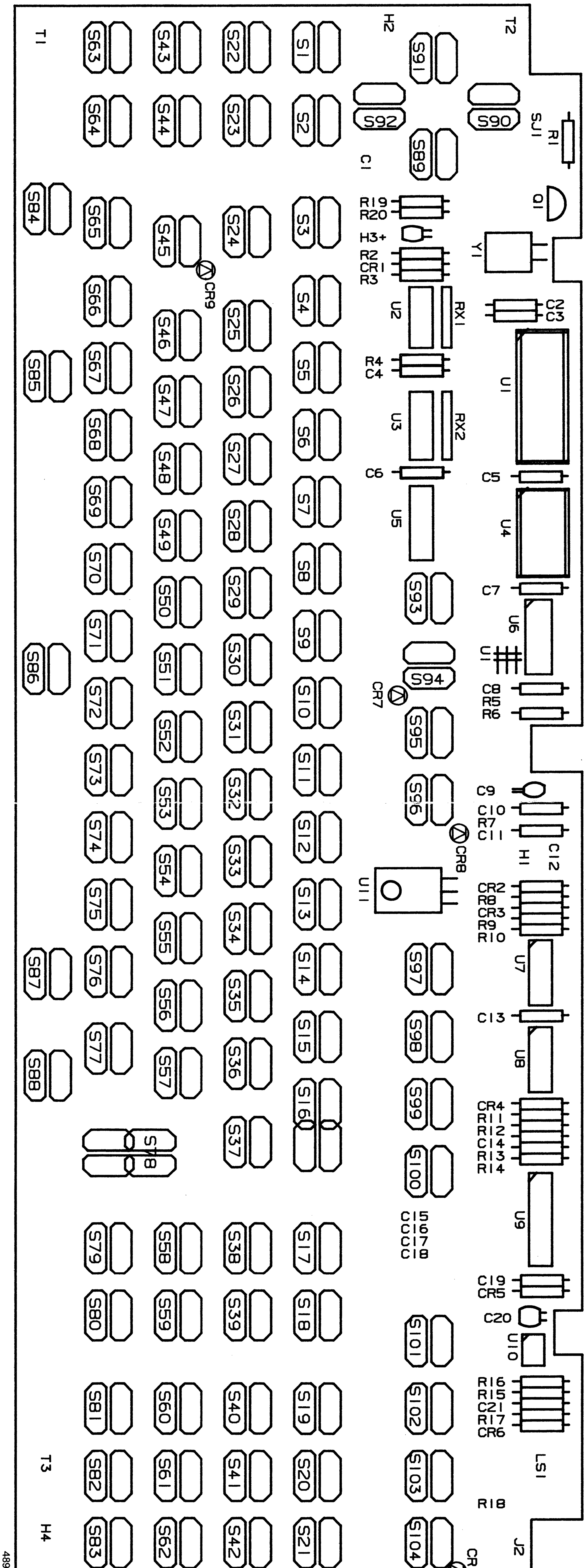
Board edge
Top & back

1 KDI-1 Red
2 KDO-1 Brown
3 –
4 RESET ORANGE
5 GND YELLOW
6 +12 CLEAR

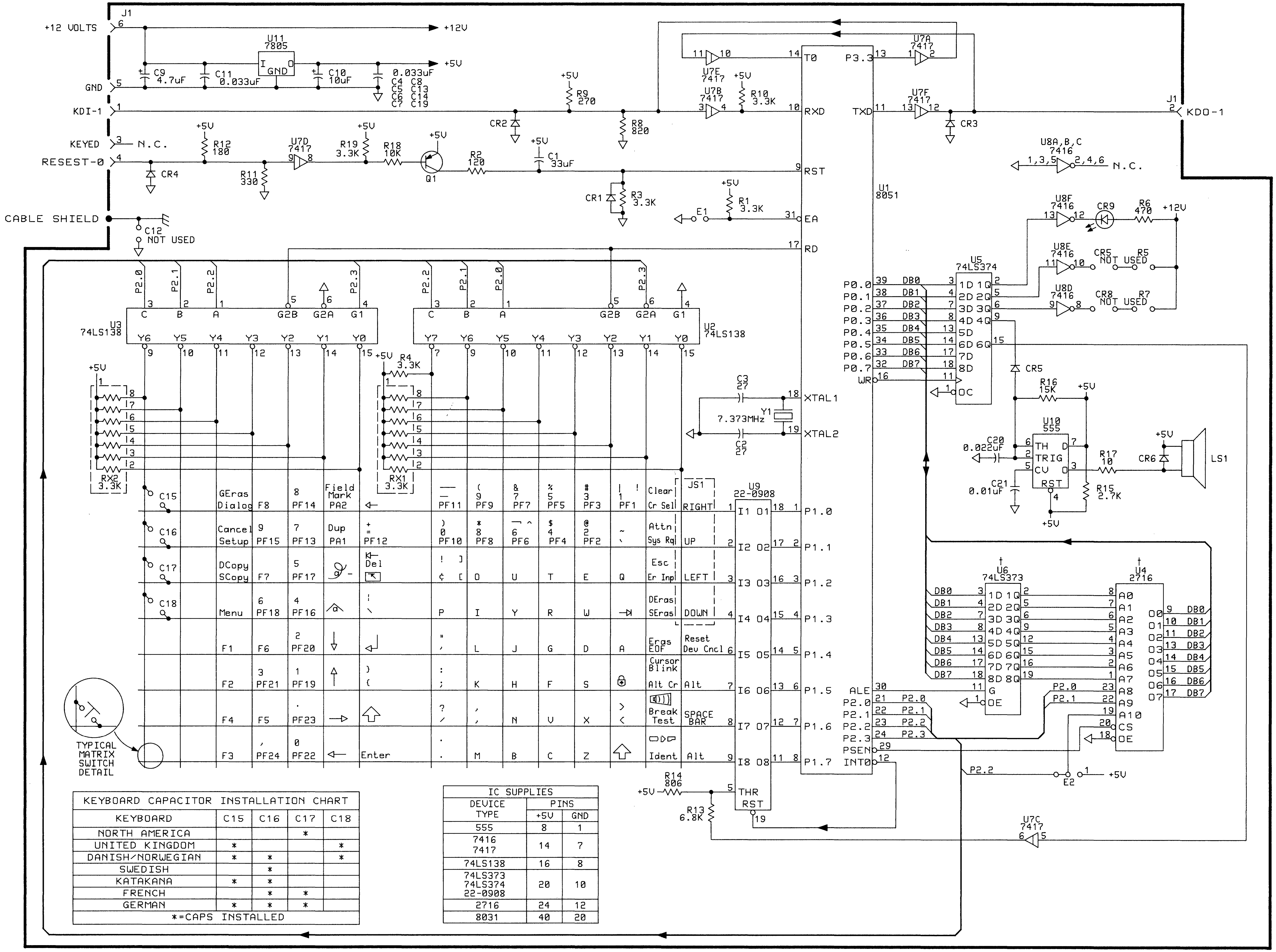
KEYBOARD
119-1592-01

A5A

FIRST USE: 4105 DATE: JAN 1984 CONTROL NO.: SDA005.000	OTHER USES: 4106 4107 4109	NOTES: KEYTRONIC CORPORATION	TITLE: 119-1592-01,15 KEYBOARD	Tektronix®	ASSEMBLY: A -1 SHEET: 1 OF 1



CX Keyboard (119-1860-00) Component Locations.



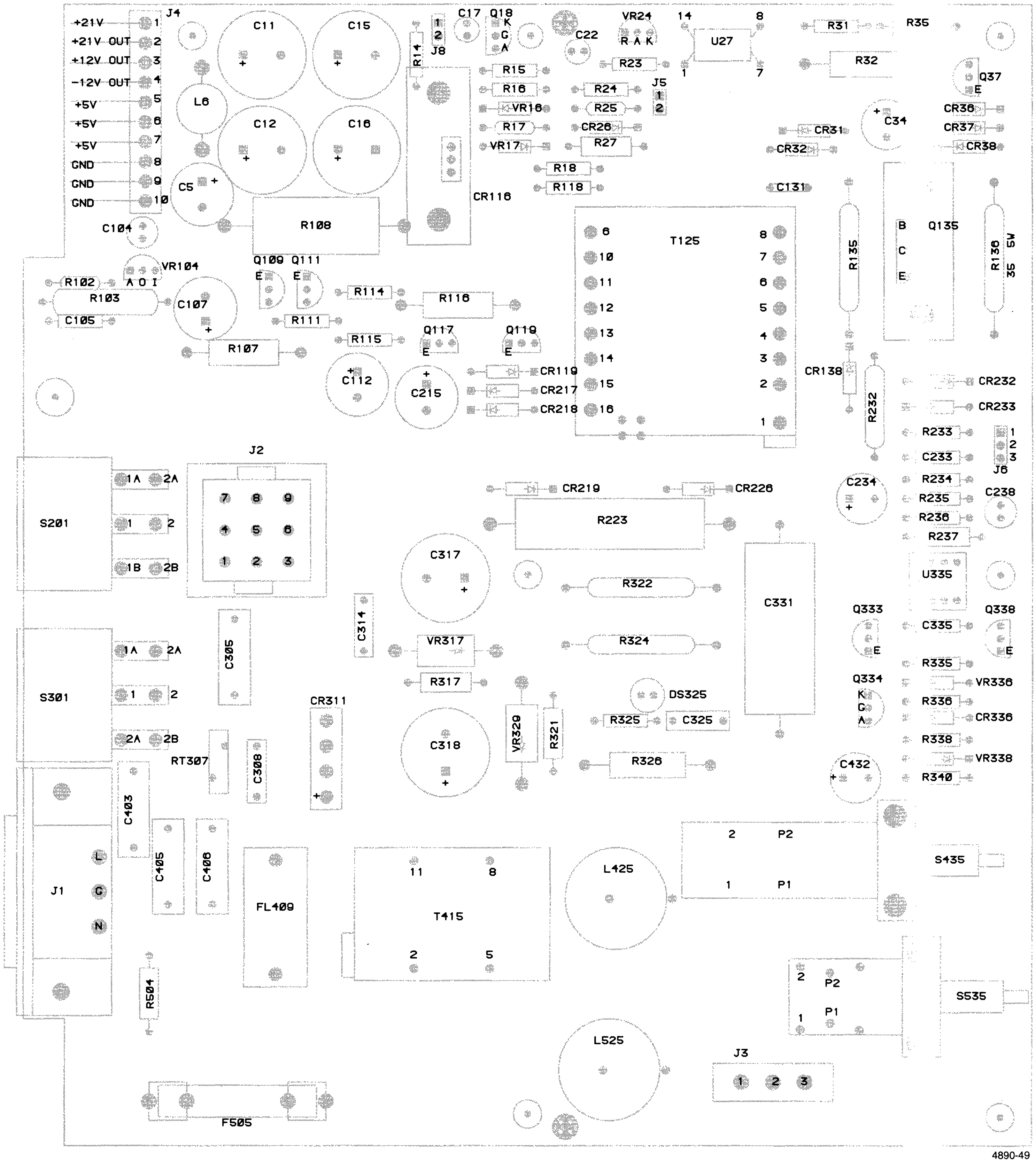
KEYBOARD CAPACITOR INSTALLATION CHART				
KEYBOARD	C15	C16	C17	C18
NORTH AMERICA			*	
UNITED KINGDOM	*			*
DANISH/NORWEGIAN	*	*		*
SWEDISH		*		
KATAKANA	*	*		
FRENCH		*	*	
GERMAN	*	*	*	
*=CAPS INSTALLED				

IC SUPPLIES		
DEVICE TYPE	PINS +5V	PINS GND
555	8	1
7416 7417	14	7
74LS138	16	8
74LS373 74LS374 22-0908	20	10
2716	24	12
8031	40	20

FIRST USE: CX4107	OTHER USES: CX4109	NOTES: DEPRESSING ANY KEYBOARD SWITCH CREATES A CAPACITIVE COUPLING. † MAY NOT BE INSTALLED. KEYTRONIC CORPORATION	TITLE: 119-1860-00 CX KEYBOARD	Tektronix®	ASSEMBLY: -1
DATE: 16 JULY 1984					
CONTROL NO.: SDA018.000					SHEET: 1 OF 1

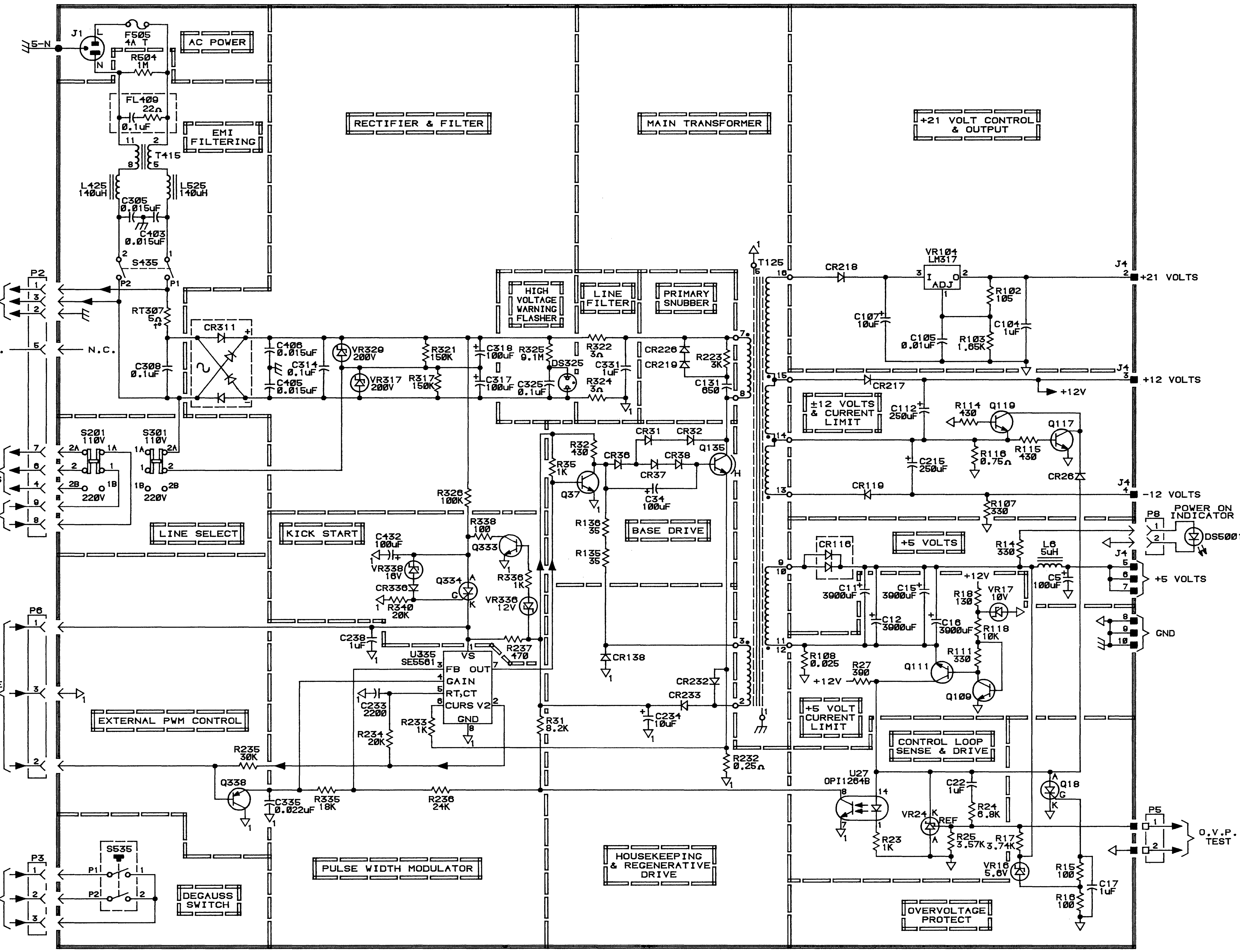
CX KEYBOARD
119-1860-00

A5B

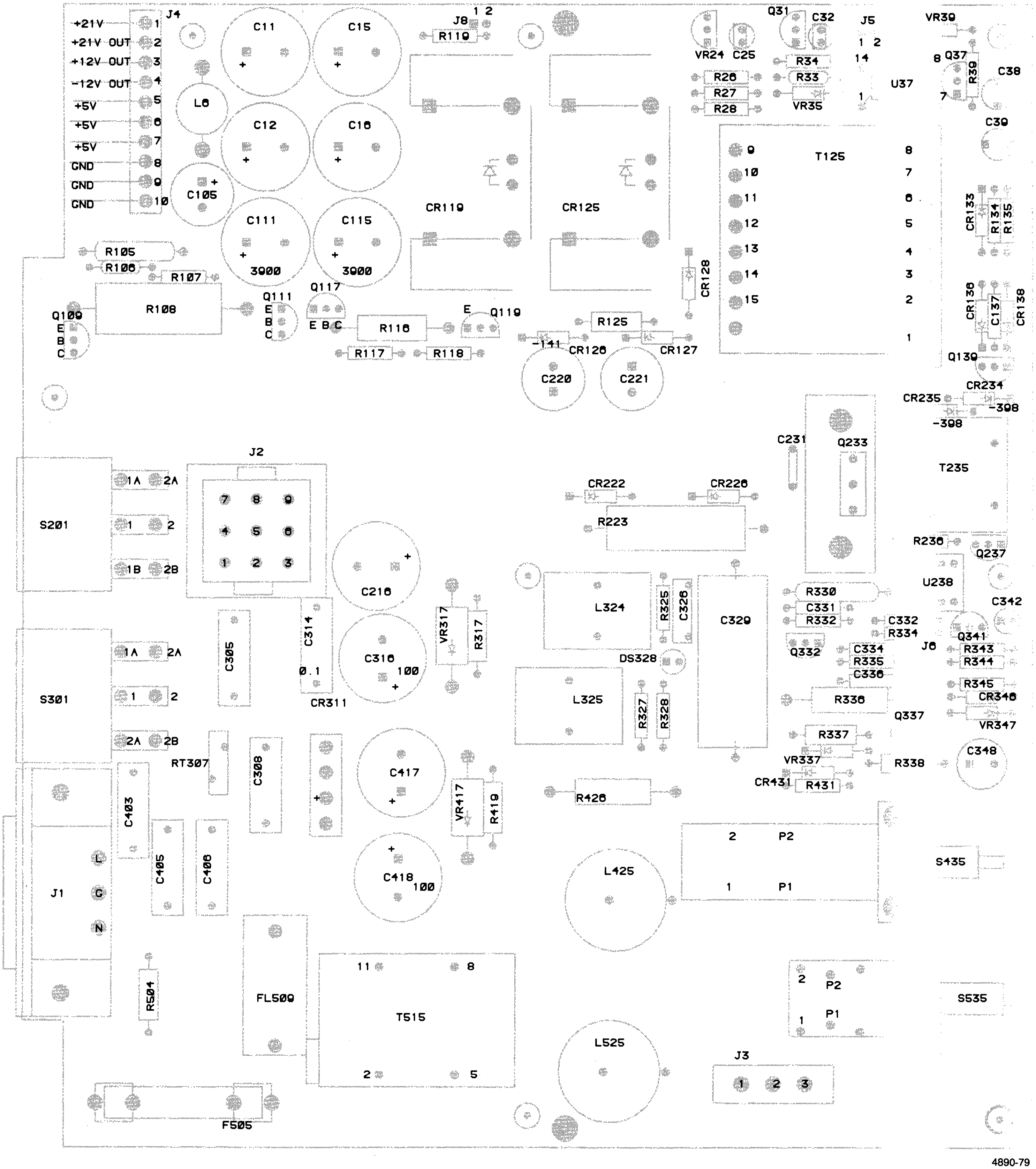


Power Supply (620-0003-00,15) Component Locations.

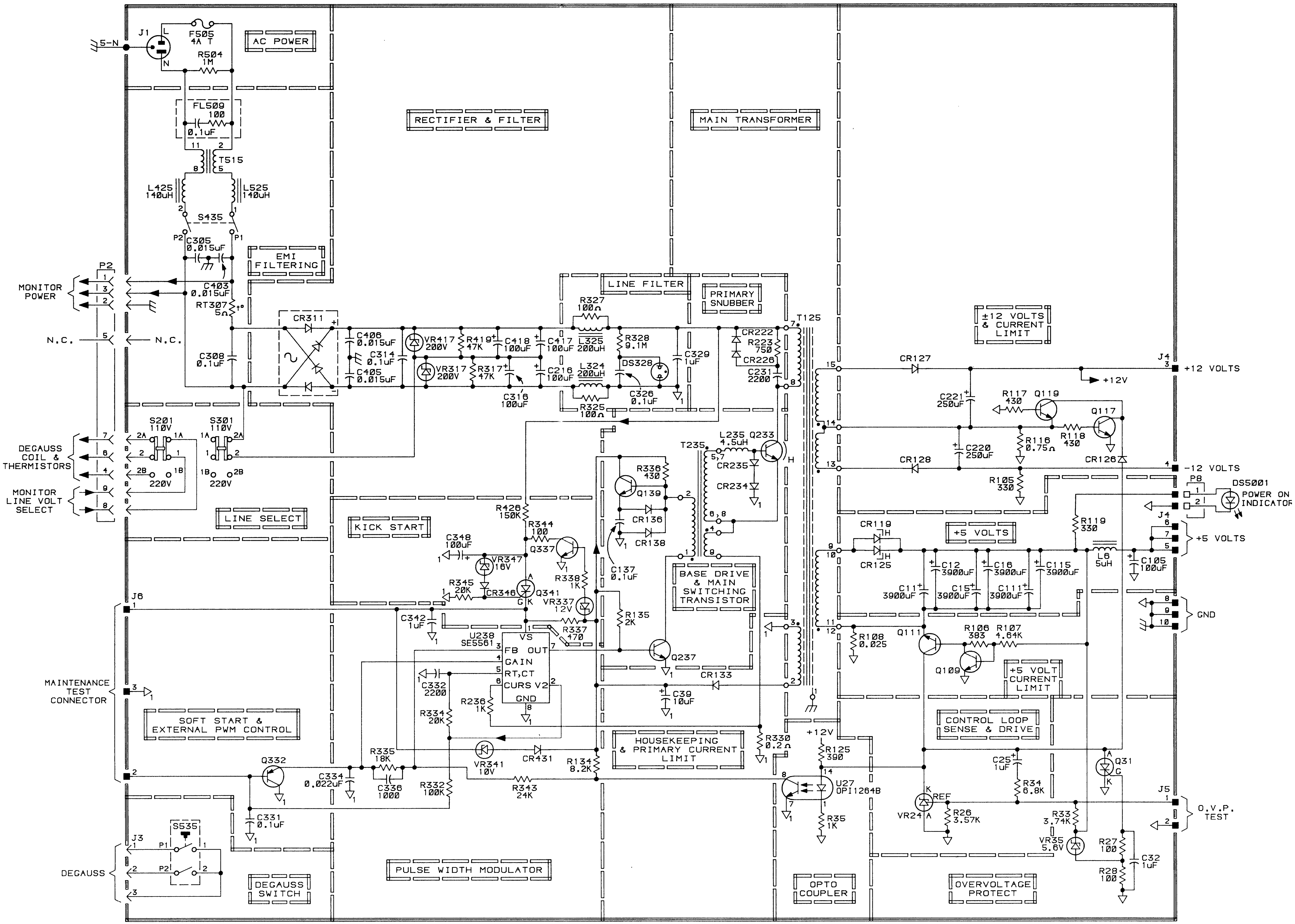
LOGIC POWER SUPPLY
(620-0003-00,15) COMP.LOC.



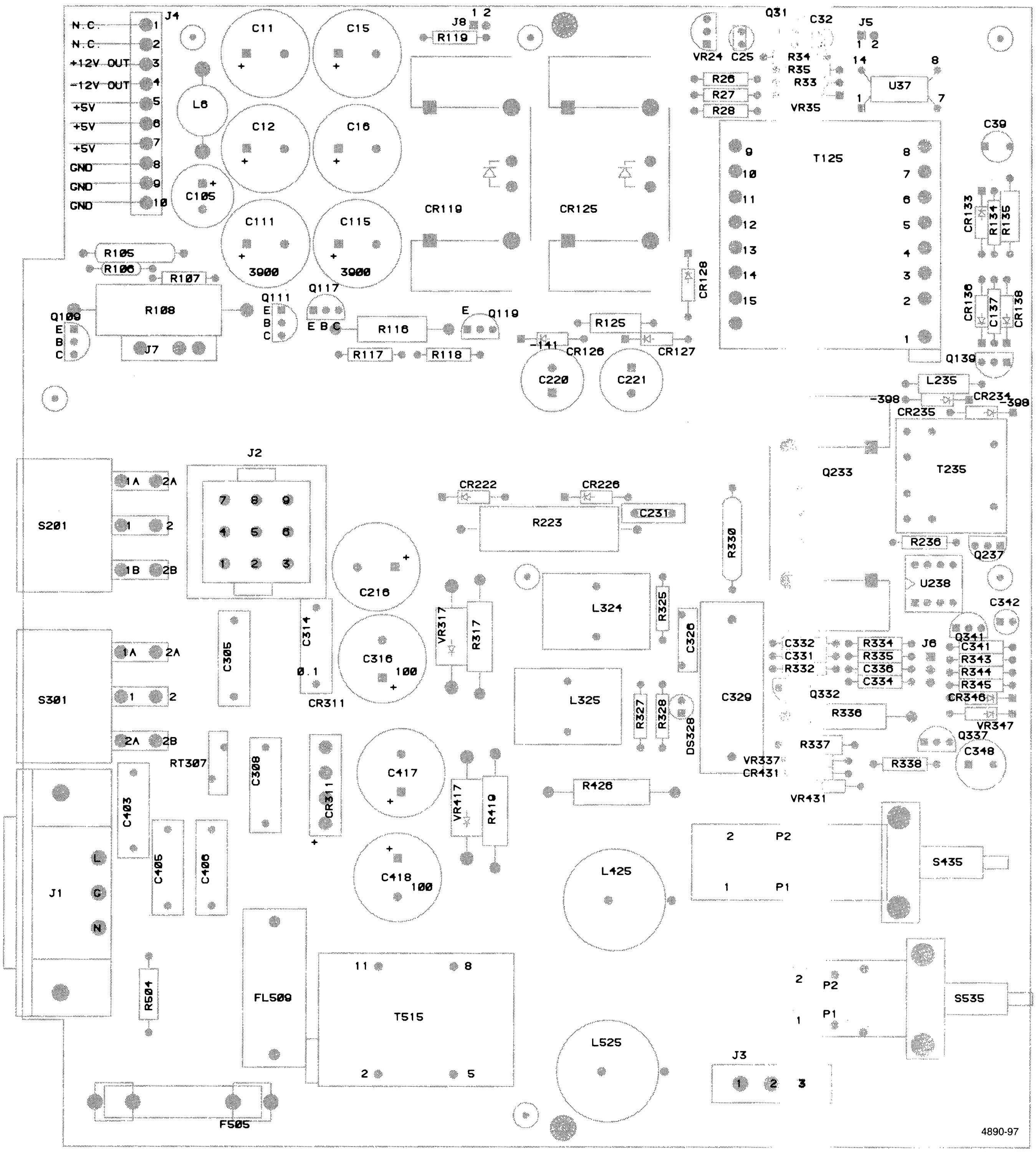
FIRST USE: 4109	OTHER USES:	NOTES:	TITLE: 670-8247-00	ASSEMBLY:
DATE: JAN 1984			LOGIC POWER SUPPLY BOARD	A6-1
CONTROL NO.: SDA006.000		TEKTRONIX, INC. © 1984	Tektronix	SHEET: 1 OF 1



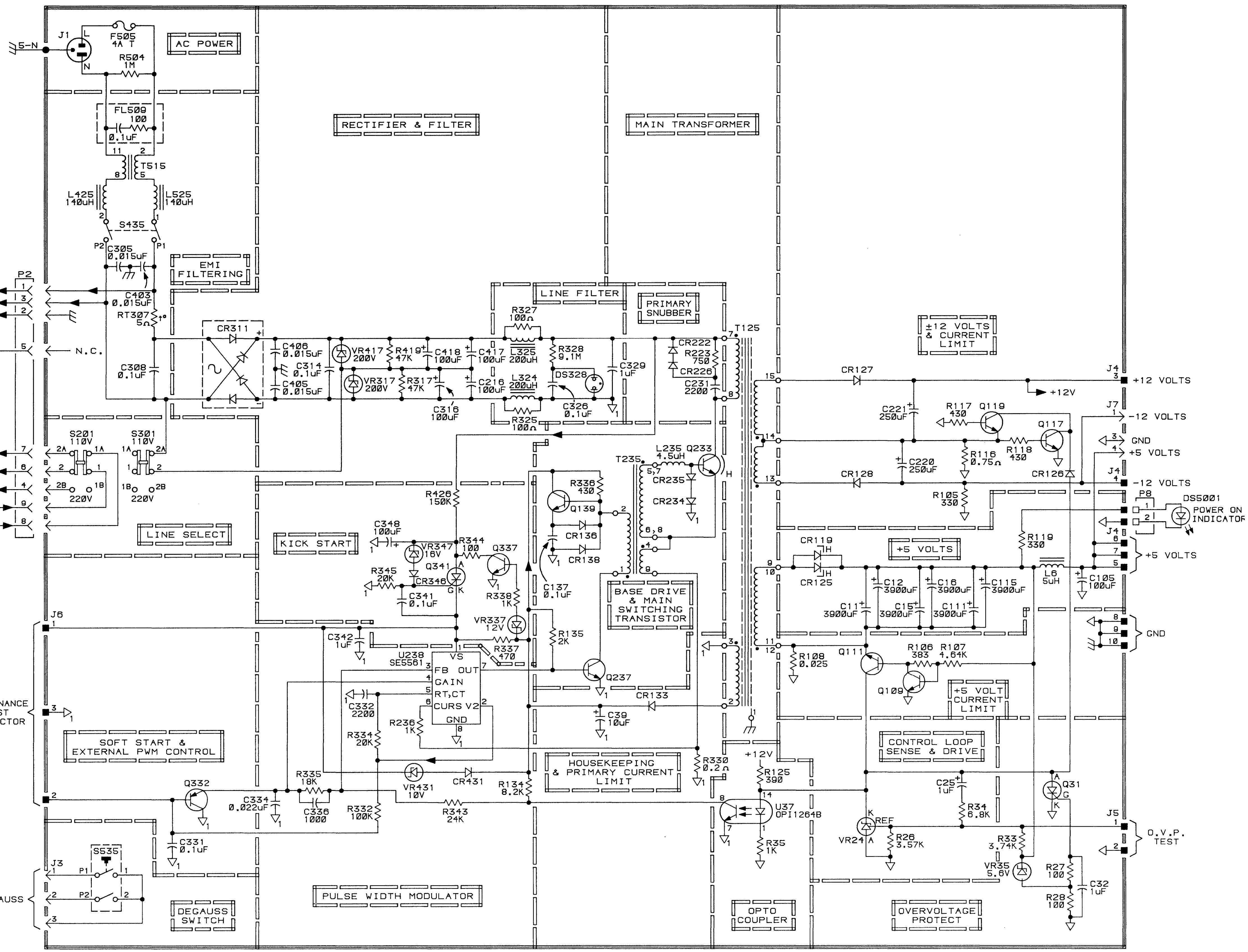
Power Supply (620-0019-00) Component Locations.



FIRST USE: CX4109	OTHER USES: 4109	NOTES:	TITLE: 620-0019-00	Tektronix®	ASSEMBLY: A6B-1
DATE: 11 DECEMBER 1984			LOGIC POWER SUPPLY BOARD		
CONTROL NO.: SDA023.000		TEKTRONIX, INC. © 1984			SHEET: 1 OF 1



Power Supply (620-0019-01) Component Locations.

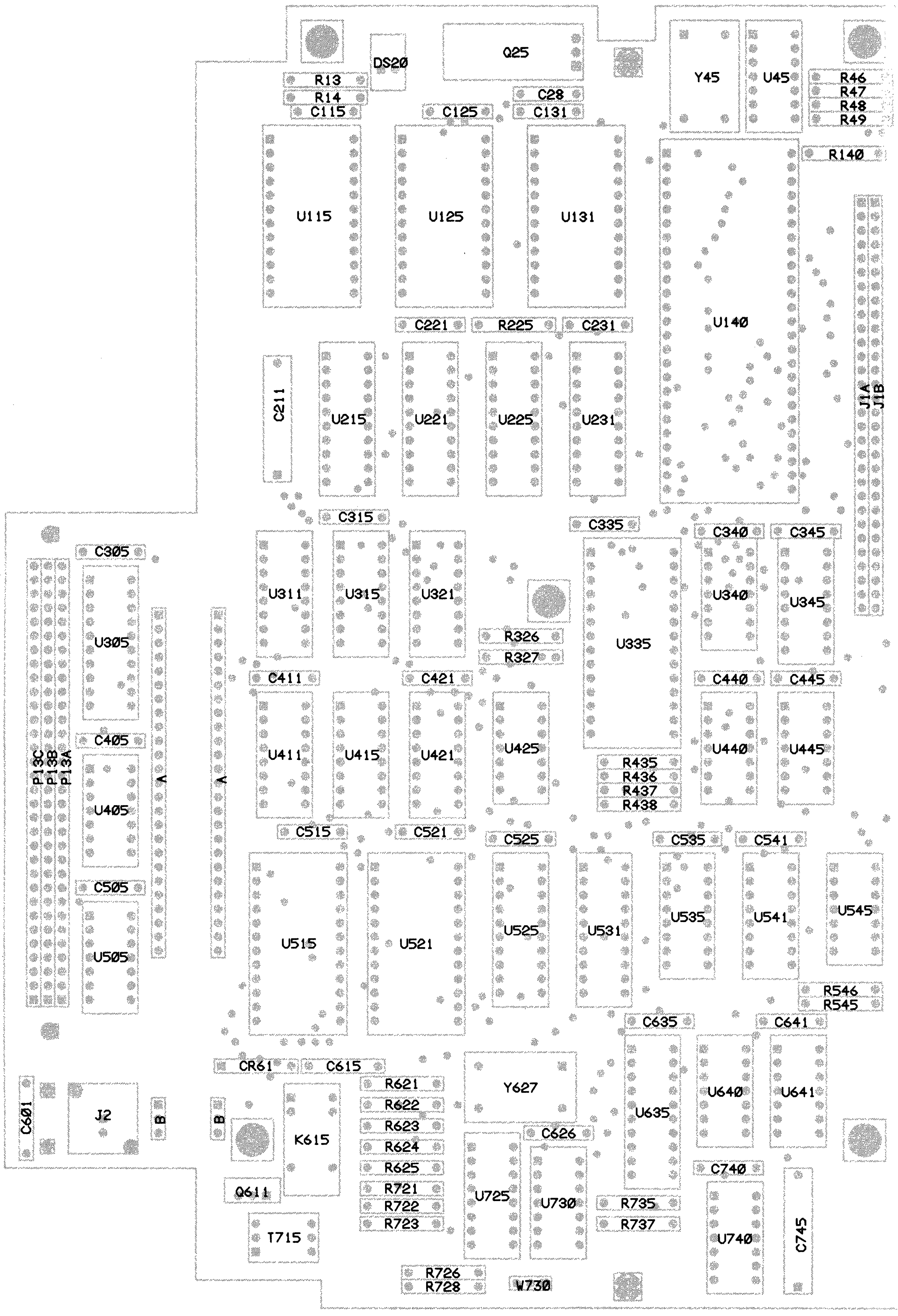


FIRST USE: CX4109	OTHER USES:	NOTES:	TITLE: 620-0019-01		ASSEMBLY:
DATE: REV. 15 APRIL 1985	4109		LOGIC POWER SUPPLY BOARD	Tektronix®	A6C-1
CONTROL NO.: SDA023.A01		TEKTRONIX, INC. © 1984			SHEET: 1 OF 1

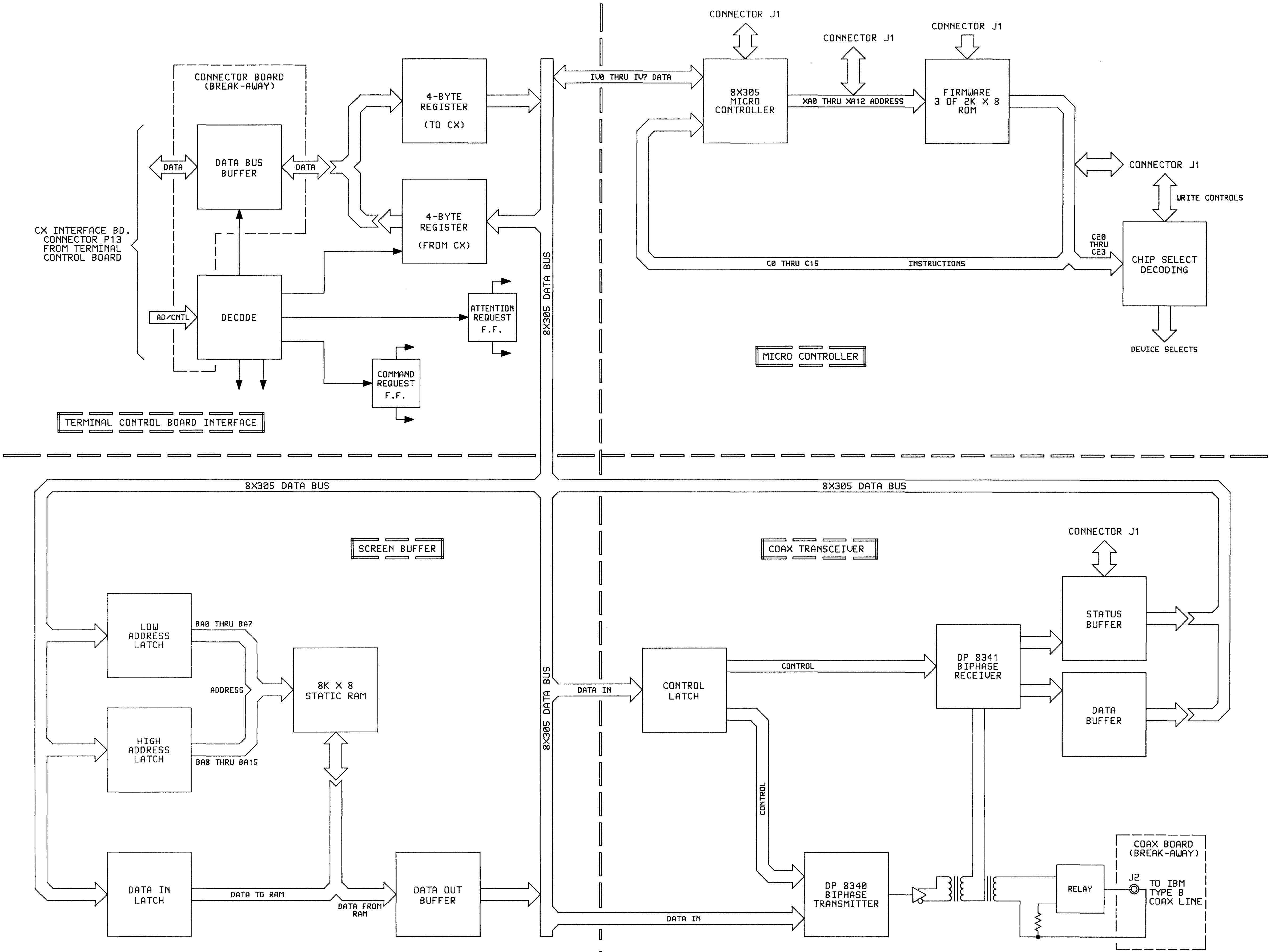
LOGIC POWER SUPPLY
620-0019-01

A6C

COMPONENT LOCATIONS



CX Interface (670-8721-00) Component Locations.



FIRST USE: CX4107	OTHER USES: CX4109	NOTES:	TITLE:			ASSEMBLY: −1
DATE: 24 JULY 1984			CX INTERFACE BOARD FUNCTIONAL BLOCK DIAGRAM		Tektronix®	
CONTROL NO.: BDA001.000		TEKTRONIX, INC. © 1984				SHEET: 1 OF 1

Section 12
REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
\- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
\- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
\- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01536	TEXTRON INC CAMCAR DIV SEMS PRODUCTS UNIT	1818 CHRISTINA ST	ROCKFORD IL 61108
02768	ILLINOIS TOOL WORKS INC FASTEX DIVISION	195 ALGONQUIN ROAD	DES PLAINES IL 60016
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
06915	RICHCO PLASTIC CO	5825 N TRIPP AVE	CHICAGO IL 60646
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
11897	PLASTIGLIDE MFG CORP	2701 W EL SEGUNDO BLVD	HAWTHORNE CA 90250
13103	THERMALLOY CO INC	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS TX 75234
16428	BELDEN CORP ELECTRONIC DIV	2200 US HWY 27 SOUTH P O BOX 1980	RICHMOND IN 47374
19613	MINNESOTA MINING AND MFG CO TEXTOOL PRODUCTS DEPT ELECTRONIC PRODUCT DIV	1410 E PIONEER DR	IRVING TX 75061
24931	SPECIALTY CONNECTOR CO INC	2620 ENDRESS PLACE P O BOX D	GREENWOOD IN 46142
30874	INTERNATIONAL BUSINESS MACHINES CORP	OLD ORCHARD ROAD	ARMONK NY 10504
31223	MICRO PLASTICS INC	20821 DEARBORN ST	CHATSWORTH CA 91311
46384	PENN ENGINEERING AND MFG CORP	P O BOX 311	DOYLESTOWN PA 18901
51181	KEYTRONICS INC	707 NORTH ST	ENDICOTT NY 13760
58361	GENERAL INSTRUMENT CORP OPTOELECTRONICS DIV	3400 HILLVIEW AVE	PALO ALTO CA 94304
70903	BELDEN CORP	2000 S BATAVIA AVE	GENEVA IL 60134
73743	FISCHER SPECIAL MFG CO	446 MORGAN ST	CINCINNATI OH 45206
75915	LITTELFUSE INC	800 E NORTHWEST HWY	DES PLAINES IL 60016
77250	ALLIED PRODUCTS CORP PHEOLL MFG CO DIV	5700 W ROOSEVELT RD	CHICAGO IL 60650
77900	SHAKEPROOF DIV OF ILLINOIS TOOL WORKS	SAINT CHARLES RD	ELGIN IL 60120
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIVISION	ST CHARLES ROAD	ELGIN IL 60120
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
86928	SEASTROM MFG CO INC	701 SONORA AVE	GLENDALE CA 91201
89663	REESE, J. RAMSEY, INC.	71 MURRAY STREET	NEW YORK, NY 10007
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
S3109	FELLER ASA ADOLF AG C/O PANEL COMPONENTS CORP	355 TESCONI CIRCLE	SANTA ROSA CA 95401
TK0435	LEWIS SCREW CO	4114 S PEORIA	CHICAGO IL 60609
TK0510	PANASONIC COMPANY DIV OF MATSUSHITA ELECTRIC CORP	ONE PANASONIC WAY	SECAUCUS NJ 07094
TK0648	PRECISION SPRING AND STAMPING	22617 85TH PL SO	KEN WA 98031
TK1099	INSTRUMENT SPECIALTIES CO	BOX A 1	DELAWARE WATERGAP PA 18327
TK1373	PATELEC-CEM (ITALY)	10156 TORINO	VAICENTALLO 62/45S ITALY
TK6020	DAINICHI-NIPPON CABLES	NEW KOKUSAI BLDG 4-1 MARUNOUCHI 3-CHOME CHIYODA-KU	TOKYO 100 JAPAN

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	200-2955-02			1	COVER,TERMINAL:TOP	80009	200-2955-02
					(ATTACHING PARTS)		
-2	212-0122-00			6	SCR,ASSEM WSHR:8-32 X 0.5,PNH,STL POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
-3	386-5139-02			1	PANEL,SIDE:RIGHT	80009	386-5139-02
					(ATTACHING PARTS)		
-4	212-0674-00			1	SCR,ASSEM WSHR:10-32 X 0.875,PNH,STL	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
-5	386-5138-02			1	PANEL,SIDE:LEFT	80009	386-5138-02
					(ATTACHING PARTS)		
-6	212-0674-00			1	SCR,ASSEM WSHR:10-32 X 0.875,PNH,STL	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
-7	348-0836-00			6	SHLD GSKT,ELEK:4.5 L	80009	348-0836-00
-8	334-5429-00			1	MARKER,IDENT:MKD 4109	80009	334-5429-00
-9	366-1833-00			1	KNOB:GRAY,0.25 ID X 0.392 OD X 0.466 H	80009	366-1833-00
-10	377-0512-00	B010100	B022798	1	INSERT,KNOB:0.125 ID X 0.247 OD X 0.663,AL	80009	377-0512-00
					(4109 ONLY)		
	377-0512-01	B022799		1	INSERT,KNOB:0.172 ID X 0.28 OD X 0.64,NYL	80009	377-0512-01
					(4109 ONLY)		
	377-0512-00	B010100	B020206	1	INSERT,KNOB:0.125 ID X 0.247 OD X 0.663,AL	80009	377-0512-00
					(CX4109 ONLY)		
	377-0512-01	B020207		1	INSERT,KNOB:0.172 ID X 0.28 OD X 0.64,NYL	80009	377-0512-01
					(CX4109 ONLY)		
-11	----- -----			1	WIRE SET,ELEC:(PART OF DISPLAY ASSY)		
					(SEE 070-4899-00)		
-12	334-5430-00			1	MARKER,IDENT:MKD POWER OFF/ON	80009	334-5430-00
-13	198-5372-00			1	WIRE SET,ELEC:LED POWER INDICATOR	80009	198-5372-00
					(4109,CX4109 ONLY)		
	198-5372-00	B010100	B010455	1	WIRE SET,ELEC:LED POWER INDICATOR	80009	198-5372-00
					(4109A ONLY)		
	198-5372-01	B010456		1	WIRE SET,ELEC:LED POWER INDICATOR,22.0 L	80009	198-5372-01
					(4109A ONLY)		
	198-5372-00	B010100	B010115	1	WIRE SET,ELEC:LED POWER INDICATOR	80009	198-5372-00
					(CX4109A ONLY)		
	198-5372-01	B010116		1	WIRE SET,ELEC:LED POWER INDICATOR,22.0 L	80009	198-5372-01
					(CX4109A ONLY)		
-14	----- -----			1	.LT EMITTING DIO:(SEE CHASSIS PARTS		
					.DS5001 REPL)		
	352-0700-00			1	.HOLDER,LED:PLASTIC,2 PIECE	58361	CMP52
-15	204-0739-00			1	.CONN BODY,PLUG:2 CONTACTS,SGL ROW,LKG CLIP	00779	87175-6
	131-1810-00			2	.CONTACT,ELEC:WIRE TO PIN,PH BRZ GOLD PL	00779	87124-1
-16	333-3106-02			1	PANEL,FRONT:	80009	333-3106-02
					(ATTACHING PARTS)		
-17	212-0122-00			4	SCR,ASSEM WSHR:8-32 X 0.5,PNH,STL POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
-18	331-0383-00	B010100	B011857	1	MASK,CRT:OUTER	80009	331-0383-00
-19	331-0382-00	B010100	B011857	1	MASK,CRT:INNER	80009	331-0382-00
	331-0384-12	B011858		1	MASKS,CRT ASSY:COMBINED INNER & OUTER MASK	80009	331-0384-12
-20	366-0554-00			2	PUSH BUTTON:SMOKE TAN,0.326 X 0.253 X 0.43	80009	366-0554-00
-21	384-0991-00			2	EXTENSION SHAFT:13.271 L X 0.244 OD,GREY PC	80009	384-0991-00
	----- -----			1	POWER SUPPLY:LOGIC(SEE A6 REPL)		
					(4109 ONLY)		
					(ATTACHING PARTS)		
-22	212-0114-00	B010100	B010375	2	SCR,ASSEM WSHR:8-32 X 0.375,PNH,STL	01536	ORDER BY DESCR
	212-0122-00	B010376		2	SCR,ASSEM WSHR:8-32 X 0.5,PNH,STL POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
					POWER SUPPLY ASSY INCLUDES:		
-23	----- -----			1	.CKT BD ASSY:(NOT REPLACEABLE,SEE A6 REPL)		
-24	348-0056-00			1	..GROMMET,PLASTIC:GRAY,ROUND,0.332 ID	80009	348-0056-00
-25	255-0334-00			1	..PLASTIC CHANNEL:12.75 X 0.175 X 0.155	11897	122-37-2500
-26	380-0723-00	B010100	B022634	1	..HSG HALF,CKT BD:TOP,ALUMINUM	80009	380-0723-00
	380-0723-01	B022635		1	..HSG HALF,CKT BD:TOP,ALUMINUM	80009	380-0723-01
					..(ATTACHING PARTS)		
-27	213-0931-00			1	..SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL	01536	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-28	214-1815-00	B010100	B022634	2	..HEAT SINK,XSTR:TO-220,ALUMINUM	13103	6034B-TT

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-	214-3745-00	B022635		3	..HEAT SINK,XSTR:TO-220,ALUMINUM W/4-40 STUD	13103	7023B-MT-SF-1
					..(ATTACHING PARTS)		
-29	211-0008-00	B010100	B022634	2	..SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-30	210-0586-00	B010100	B022634	2	..NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
	210-0586-00	B022635		3	..NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					..(END ATTACHING PARTS)		
-31	----- -----			1	..CONN,RCPT,ELEC:(SEE A6J1 REPL)		
					..(ATTACHING PARTS)		
-32	211-0121-00			1	..SCR,ASSEM WSHR:4-40 X 0.438,PNH,BRS	TK0435	ORDER BY DESCR
-33	210-3100-00			3	..RIVET,SOLID:0.26 L X 0.136 OD,RND,PLSTC	02768	201090751002056
-34	210-0457-00			1	..NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					..(END ATTACHING PARTS)		
-35	----- -----			1	..(PART OF A6J1)		
-36	344-0326-00			2	..CLIP,ELECTRICAL:FUSE,BRASS	75915	102071
-37	----- -----			1	..SWITCH,POWER:(SEE A6S435 REPL)		
					..(ATTACHING PARTS)		
-38	211-0008-00			2	..SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-39	210-0586-00			2	..NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					..(END ATTACHING PARTS)		
-40	----- -----			1	..SWITCH,PUSH:(SEE A6S535 REPL)		
					..(ATTACHING PARTS)		
-41	211-0008-00			2	..SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-42	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-43	210-0053-00			2	..WASHER,LOCK:#2 SPLIT,0.02 THK STL	78189	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-44	334-3379-01			1	..MARKER,IDENT:MARKED GROUND SYMBOL	80009	334-3379-01
-45	334-5212-00			1	..MARKER,IDENT:MKD CAUTION	80009	334-5212-00
-46	361-0067-00			8	..SPACER,CKT BD:0.187,NYLON	06915	LCBS3M
-47	380-0724-00			1	..HSG HALF,CKT BD:BOTTOM,ALUMINUM	80009	380-0724-00
-47.1	361-1305-00	B022635		5	..SPACER,CKT BD:1.0 SPACING,LOCKING,NYLON	06915	LCBS-16M
-47.2	175-9839-00	B020000		1	CA ASSY,SP,ELEC:3,26 AWG,24.0 L	80009	175-9839-00
-48	----- -----			1	DISPLAY ASSY:		
					(SEE 070-4899-00)		
	----- -----			1	COLOR MONITOR:19 IN COLOR CRT,LP PHOSPHOR		
					(SEE 070-5656-00)		
					(ATTACHING PARTS)		
-49	212-0674-00			4	SCR,ASSEM WSHR:10-32 X 0.875,PNH,STL	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
-50	337-3183-00			1	SHIELD,ELEC:EMI,TOP	80009	337-3183-00
					(4109,CX4109)		
	337-3183-00	B010100	B034883	1	SHIELD,ELEC:EMI,TOP	80009	337-3183-00
	337-3183-01	B034884		1	SHIELD,ELEC:EMI,TOP	80009	337-3183-01
					(4109A)		
	337-3183-00	B010100	B030311	1	SHIELD,ELEC:EMI,TOP	80009	337-3183-00
	337-3183-01	B030312		1	SHIELD,ELEC:EMI,TOP	80009	337-3183-01
					(CX4109A)		
					(ATTACHING PARTS)		
-51	212-0114-00	B010100	B010375	2	SCR,ASSEM WSHR:8-32 X 0.375,PNH,STL	01536	ORDER BY DESCR
	212-0122-00	B010376		2	SCR,ASSEM WSHR:8-32 X 0.5,PNH,STL POZ	01536	ORDER BY DESCR
					(4109,CX4109)		
	212-0122-00	B010100	B034883	2	SCR,ASSEM WSHR:8-32 X 0.5,PNH,STL POZ	01536	ORDER BY DESCR
	212-0001-00	B034884		2	SCREW,MACHINE:8-32 X 0.25,PNH,STL	77250	ORDER BY DESCR
					(4109A)		
	212-0122-00	B010100	B030311	1	SCR,ASSEM WSHR:8-32 X 0.5,PNH,STL POZ	01536	ORDER BY DESCR
	212-0001-00	B030312		1	SCREW,MACHINE:8-32 X 0.25,PNH,STL	77250	ORDER BY DESCR
					(CX4109A)		
-51.1	210-0007-00	B034884		2	WASHER,LOCK:#8 EXT,0.02 THK,STL	78189	1108-00-00-0541C
					(4109A)		
	210-0007-00	B030312		1	WASHER,LOCK:#8 EXT,0.02 THK,STL	78189	1108-00-00-0541C
					(CX4109A)		
					(END ATTACHING PARTS)		
-52	200-2956-02			1	COVER,CKT BD:	80009	200-2956-02
-53	333-3105-02			1	PANEL,REAR:	80009	333-3105-02
					(ATTACHING PARTS)		
-54	212-0115-00			5	SCR,ASSEM WSHR:8-32 X 0.75,PNH,STL,POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-55	131-0132-00			2	CONTACT,ELEC:FINGER STRIP	TK1099	97135X3.75INCH
-56	----- -----			1	CKT BD ASSY:TERMINAL CONTROL(SEE A1 REPL)		
-57	386-5104-00			1	.PLATE,CONN MTG:ALUMINUM .(ATTACHING PARTS)	80009	386-5104-00
-58	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-59	131-0890-01	B010100	B011676	6	.LOCK,CONNECTOR:4-40 X 0.312 L,HEX HD,STL (4109A ONLY)	00779	205818-2
	214-3903-00	B011677		6	.SCREW,JACK:4-40 X 0.312 LONG,HEX HEAD .(4109A ONLY)	80009	214-3903-00
	131-0890-01	B010100	B010276	6	.LOCK,CONNECTOR:4-40 X 0.312 L,HEX HD,STL .(CX4109A ONLY)	00779	205818-2
	214-3903-00	B010277		6	.SCREW,JACK:4-40 X 0.312 LONG,HEX HEAD .(CX4109A ONLY)	80009	214-3903-00
-60	210-0054-00	B010100	B011676	6	.WASHER,LOCK:#4 SPLIT,0.025 THK STL .(4109A ONLY)	78189	ORDER BY DESCR
	210-0054-00	B010100	B010276	6	.WASHER,LOCK:#4 SPLIT,0.025 THK STL .(CX4109A ONLY) .(END ATTACHING PARTS)	78189	ORDER BY DESCR
-61	131-1369-00			1	.TERM,QIK DISC.:0.615 L X 0.25 W BLADE .(ATTACHING PARTS)	00779	42506-2
-61.1	210-0004-00	B011625		1	.WASHER,LOCK:#4 INTL,0.015 THK,STL .(4109 ONLY)	77900	1204-00-00-0541C
	210-0004-00			1	.WASHER,LOCK:#4 INTL,0.015 THK,STL .(CX4109 ONLY)	77900	1204-00-00-0541C
-62	210-0406-00			1	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL .(END ATTACHING PARTS)	73743	12161-50
-63	131-3090-00			1	.CONTACT,ELEC:FINGER STRIP,CU-BE	TK0648	ORDER BY DESCR
-64	366-1559-01			2	.PUSH BUTTON:GRAY,0.18 SQ X 0.43	80009	366-1559-01
-65	136-0797-01			8	.SKT,PL-IN ELEK:MICROCKT,28 CONTACT	80009	136-0797-01
-66	129-1017-00			8	.SPACER,POST:0.219 L,4-40 INT ONE END,BRS,0. .22 OD	46384	KFB3-440-7
-67	136-0813-00	B010100	B010974	1	.SKT,PL-IN ELEK:CHIP CARRIER,68 CONTACTS .(4109A ONLY)	19613	268-5400-00-1102
	136-0813-00	B010100	B010189	1	.SKT,PL-IN ELEK:CHIP CARRIER,68 CONTACTS .(CX4109A ONLY)	19613	268-5400-00-1102
-68	----- -----			2	.CONN,RCPT,ELEC:(SEE A1J13,J28 REPL) .(ATTACHING PARTS)		
-69	211-0340-00			4	.SCREW,MACHINE:2-56 X 0.375,ROUND,NYLON	31223	RHNY-005NA
-70	210-0405-00			4	.NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL .(END ATTACHING PARTS)	73743	12157-50
-71	----- -----			1	CKT BOARD ASSY:RAM 3(SEE A2 REPL)		
-72	----- -----			2	.CONN,RCPT,ELEC:(SEE A2J49,P48 REPL) .(ATTACHING PARTS)		
-73	211-0340-00			4	.SCREW,MACHINE:2-56 X 0.375,ROUND,NYLON	31223	RHNY-005NA
-74	210-0405-00			4	.NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL .(END ATTACHING PARTS)	73743	12157-50
-75	----- -----			1	CKT BD ASSY:DIGITAL PIGGY BACK(SEE A4 REPL) (ATTACHING PARTS)		
-76	211-0018-00	B010100	B019999	3	SCREW,MACHINE:4-40 X 0.875,PNH,STL	TK0435	ORDER BY DESCR
-77	210-1002-00	B010100	B019999	3	WASHER,FLAT:0.125 ID X 0.25 OD X 0.022	86928	5714-147-20N
-78	220-0497-00			3	NUT,PLAIN,HEX:0.5-28 X 0.562 HEX,BRS CD PL	80009	220-0497-00
-79	210-0845-00			3	WASHER,FLAT:0.5 ID X 0.625 OD X 0.02,STL (END ATTACHING PARTS) CKT BOARD ASSY INCLUDES:	89663	634-R
-80	361-1090-00	B010100	B019999	4	.SPACER,SLEEVE:0.62 L X 0.14 ID,BRS	80009	361-1090-00
-81	175-9258-00	B010100	B019999	1	.CA ASSY,SP,ELEC:7 COND,6.0 L	80009	175-9258-00
-82	----- -----			3	.CONN,RCPT,ELEC:(SEE A4J51,J52,J55 REPL)		
-83	175-9247-00	B010100	B019999	1	CA ASSY,SP,ELEC:40,28 AWG,6.0 L,RIBBON	80009	175-9247-00
	175-9869-00	B020000		1	CA ASSY,SP,ELEC:40,28 AWG,11.0 L	80009	175-9869-00
-83.1	175-2559-00	B020000	B023234	1	CA ASSY,SP,ELEC:10,26 AWG,5.0 L,RIBBON (4109 ONLY)	80009	175-2559-00
	175-2559-01	B023235		1	CA ASSY,SP,ELEC:10,26 AWG,5.0 L,RIBBON (4109 ONLY)	80009	175-2559-01
	175-2559-00	B020000	B020242	1	CA ASSY,SP,ELEC:10,26 AWG,5.0 L,RIBBON (CX4109 ONLY)	80009	175-2559-00
	175-2559-01	B020243		1	CA ASSY,SP,ELEC:10,26 AWG,5.0 L,RIBBON	80009	175-2559-01

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-					(CX4109 ONLY)		
-83.2	175-9823-00	B020000		1	CA ASSY,SP,ELEC:3,22 AWG,25.75 L,RIBBON	80009	175-9823-00
-83.3	175-9838-00	B020000		1	CA ASSY,SP,ELEC:3,22 AWG,30.0 L	80009	175-9838-00
-83.4	344-0386-00	B023235		1	SPRING,CLIP:	80009	344-0386-00
					(4109 ONLY)		
	344-0386-00	B020243		1	SPRING,CLIP:	80009	344-0386-00
					(CX4109 ONLY)		
-84	----- -----			1	CKT BOARD ASSY:DISPLAY CONTROL(SEE A3 REPL)		
-85	136-0755-00			1	.SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
-86	386-5031-00			1	.STIF,CIRCUIT BD:9.1 L,ALUMINUM	80009	386-5031-00
					.(ATTACHING PARTS)		
-87	210-3099-00			3	.RIVET,SOLID:0.187 L X 0.116 OD,DOME HD	19738	75021-0406
					.(END ATTACHING PARTS)		
-88	----- -----			2	.CONN,RCPT,ELEC:(SEE A3P35,P39 REPL)		
					.(ATTACHING PARTS)		
-89	210-3102-00	B010100	B012210	4	.RIVET,SOLID:0.25 L X 0.156 OD,AL	19738	1131-0308
					.(4109 ONLY)		
					.(END ATTACHING PARTS)		
-90	348-0513-00			2	FOOT,CABINET:BLACK POLYURETHANE	80009	348-0513-00
-91	200-2957-02	B010100	B010891	1	COVER,TERMINAL:BOTTOM	80009	200-2957-02
	200-2957-05	B010892		1	COVER,TERMINAL:BOTTOM	80009	200-2957-05
-92	134-0180-00	B010892		1	.PLUG,BUTTON:0.812 X 0.328	80009	134-0180-00

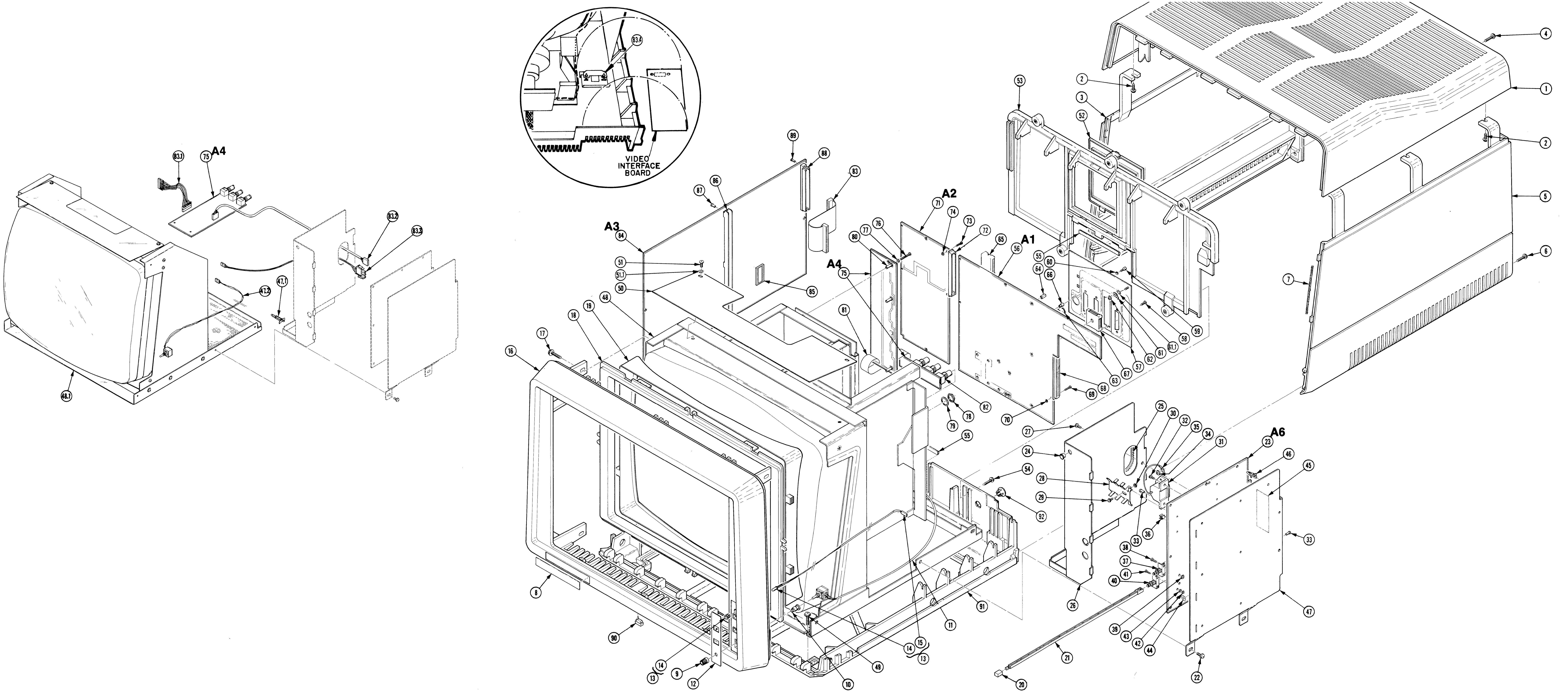


FIG. 14109

FIG. 2 KEYBOARD

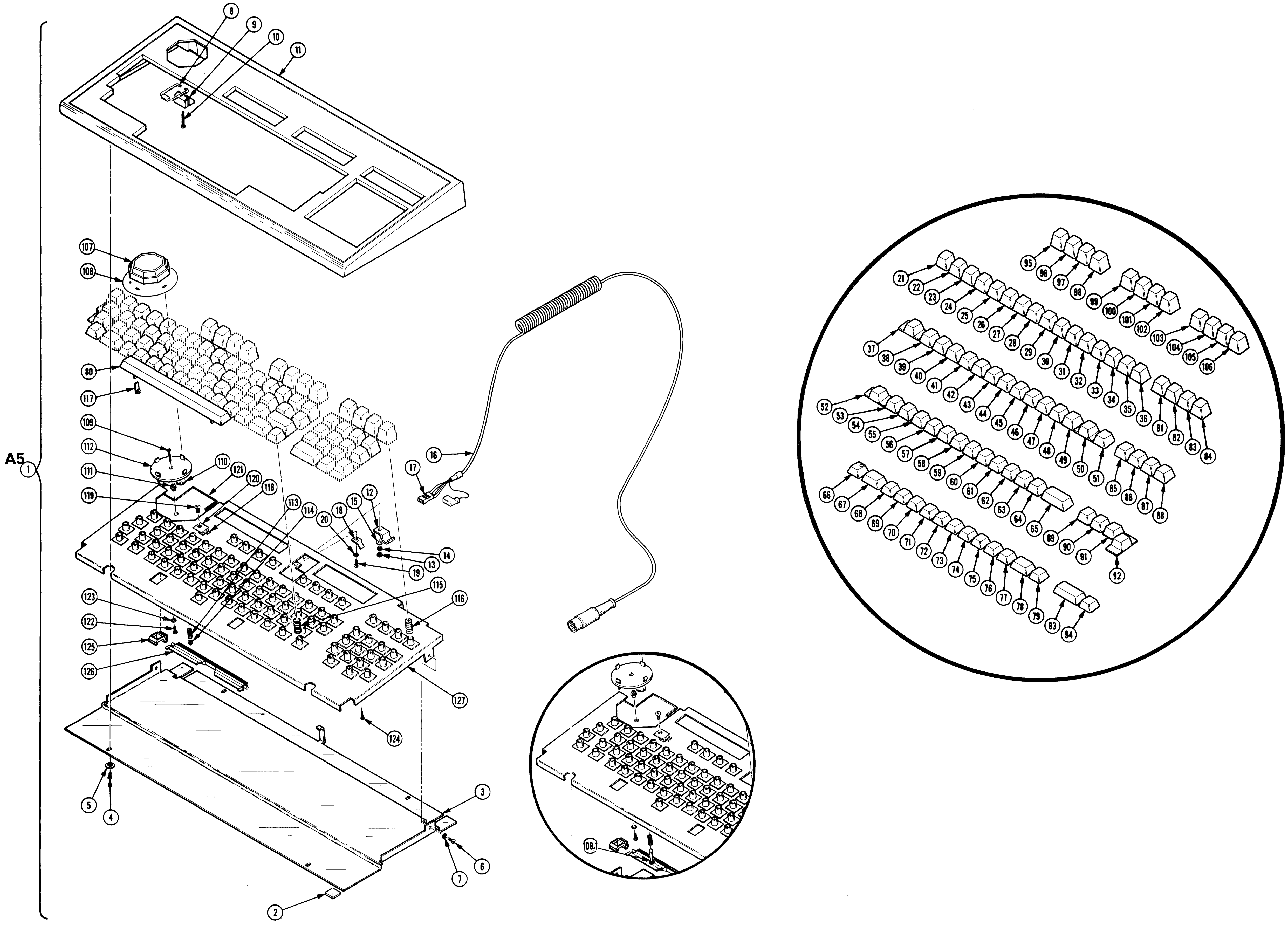


Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-1	----- -----			1	KEYBOARD ASSY:(SEE A5 REPL)		
-2	118-3014-00			4	.FOOT,RUBBER:	51181	48-00559-000
-3	118-3013-00			1	.PLATE,BASE:	51181	49-01307-000
					.(ATTACHING PARTS)		
-4	211-0101-00			4	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	TK0435	ORDER BY DESCR
-5	118-3190-00			4	.WASHER:SHOULDER	51181	47-00408-000
-6	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-7	210-0004-00			2	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
					.(END ATTACHING PARTS)		
-8	118-3020-00			2	.LEG:	51181	45-00057-002
-9	118-3021-00			2	.BLOCK,BAIL:	51181	44-00193-000
					.(ATTACHING PARTS)		
-10	118-3022-00			2	.SCREW:	51181	47-00290-000
					.(END ATTACHING PARTS)		
-11	118-3023-00			1	.HOUSING,KYBD:	51181	44-00205-001
-12	118-3006-00			1	.STRAP,TIEDOWN,E:	51181	48-00646-000
					.(ATTACHING PARTS)		
-13	210-0551-00			1	.NUT,PLAIN,HEX:4-40 X 0.25,ST CD PL	TK0435	ORDER BY DESCR
-14	210-0004-00			1	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
-15	210-0994-00			1	.WASHER,FLAT:0.125ID X 0.250D X 0.022	86928	A371-283-20
					.(END ATTACHING PARTS)		
-16	118-3026-00			1	.CA ASSY,SP,ELEC:	51181	48-00626-000
					.(OPTION 4B,4K ONLY)		
	118-3026-00	B010100	B022884	1	.CA ASSY,SP,ELEC:	51181	48-00626-000
					.(STANDARD ONLY)		
	118-3026-01	B022885		1	.CA ASSY,SP,ELEC: KEYTRONICS	80009	118-3026-01
					.(STANDARD ONLY)		
	118-3026-00	B010100	B022940	1	.CA ASSY,SP,ELEC:	51181	48-00626-000
					.(OPTION 4A ONLY)		
	118-3026-01	B022941		1	.CA ASSY,SP,ELEC: KEYTRONICS	80009	118-3026-01
					.(OPTION 4A ONLY)		
	118-3026-00	B010100	B022781	1	.CA ASSY,SP,ELEC:	51181	48-00626-000
					.(OPTION 4C ONLY)		
	118-3026-01	B022782		1	.CA ASSY,SP,ELEC: KEYTRONICS	80009	118-3026-01
					.(OPTION 4C ONLY)		
	118-3026-00	B010100	B022300	1	.CA ASSY,SP,ELEC:	51181	48-00626-000
					.(OPTION 4F ONLY)		
	118-3026-01	B022301		1	.CA ASSY,SP,ELEC: KEYTRONICS	80009	118-3026-01
					.(OPTION 4F ONLY)		
	118-3026-00	B010100	B022902	1	.CA ASSY,SP,ELEC:	51181	48-00626-000
					.(OPTION 4G ONLY)		
	118-3026-01	B022903		1	.CA ASSY,SP,ELEC: KEYTRONICS	80009	118-3026-01
					.(OPTION 4G ONLY)		
-17	118-3025-00			1	.CONN,PLUG,ELEC:	51181	48-00501-000
-18	118-3032-00			1	.STANDOFF:	51181	61-04302-001
					.(ATTACHING PARTS)		
-19	211-0008-00			1	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-20	210-0004-00			1	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
					.(END ATTACHING PARTS)		
-21	118-3173-00			1	.PUSH BUTTON:DERAS/SERAS	51181	HIBB401Z771D6947
					.(STANDARD AND OPTIONS 4A,4B,4C,4F,4K ONLY)		
	118-3291-00			1	.PUSH BUTTON:DL DIRSOO/BL DIRSO	51181	HIBB401Z782D6947
					.(OPTION 4G ONLY)		
-22	118-3245-00			1	.PUSH BUTTON:LEFT BRACE/LEFT BRACKET	51181	CYBB401Z10854534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3143-00			1	.PUSH BUTTON:ASTERISK/$	51181	CYBB401Z14424534
					.(OPTION 4B ONLY)		
	118-3260-00			1	.PUSH BUTTON:CARET/OVERLINE	51181	CYBB401Z48376206
					.(OPTIONS 4C, 4F ONLY)		
	118-3285-00			1	.PUSH BUTTON:CARET/#	51181	CYBB401Z27994534
					.(OPTION 4G ONLY)		
	118-3392-00			1	.PUSH BUTTON:LEFT BRACKET/LEFT BRACE	80009	118-3392-00
					.(OPTION 4K ONLY)		
-23	118-3249-00			1	.PUSH BUTTON:]/1	51181	CYBB401Z37014534
					.(STANDARD AND OPTIONS 4A,4C,4F,4G ONLY)		
	118-3133-00			1	.PUSH BUTTON:1/&	51181	CYBB401Z29914534

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					.(OPTION 4B ONLY)		
	118-3396-00			1	.PUSH BUTTON:1/]	51181	CYBB401Z94467652
					.(OPTION 4K ONLY)		
-24	118-3254-00			1	.PUSH BUTTON:@/2	51181	CYBB401Z37224534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3152-00			1	.PUSH BUTTON:2/ACUT ACNT/E	51181	CYBB401Z13504534
					.(OPTION 4B ONLY)		
	118-3256-00			1	.PUSH BUTTON:QUOTES/2	51181	CYBB401Z37024534
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3402-00			1	.PUSH BUTTON:2/@	51181	CYBB401Z41367370
					(OPTION 4K ONLY)		
-25	118-3250-00			1	.PUSH BUTTON:#/3	51181	CYBB401Z37034534
					.(STANDARD AND OPTIONS 4C,4F ONLY)		
	118-3144-00			1	.PUSH BUTTON:3/VER QUOTES	51181	CYBB401Z21174534
					.(OPTION 4B ONLY)		
	366-0536-00			1	.PUSH BUTTON:SMOKE TAN,POUNDS OVER 3,UK	80009	366-0536-00
					.(OPTION 4A ONLY)		
	118-3286-00			1	.PUSH BUTTON:SECTION/3	51181	CYBB401Z30234534
					.(OPTION 4G ONLY)		
	118-3393-00			1	.PUSH BUTTON:3/#	51181	CYBB401Z27637371
					.(OPTION 4K ONLY)		
-26	118-3251-00			1	.PUSH BUTTON:$/4	51181	CYBB401Z37044534
					.(STANDARD AND OPTIONS 4A,4F,4G ONLY)		
	118-3141-00			1	.PUSH BUTTON:4/FWD SLASH	51181	CYBB401Z13524534
					.(OPTION 4B ONLY)		
	118-3851-00			1	.PUSH BUTTON:"SUN" OVER 4	80009	118-3851-00
					.(OPTION 4C ONLY)		
	118-3394-00			1	.PUSH BUTTON:4/$	51181	CYBB401Z27647372
					.(OPTION 4K ONLY)		
-27	118-3252-00			1	.PUSH BUTTON:%/5	51181	CYBB401Z37054534
					.(STANDARD AND OPT 4A,4C,4F,4G ONLY)		
	118-3145-00			1	.PUSH BUTTON:5/(	51181	CYBB401Z21194534
					.(OPTION 4B ONLY)		
	118-3395-00			1	.PUSH BUTTON:5/%	80009	118-3395-00
					.(OPTION 4K ONLY)		
-28	118-3248-00			1	.PUSH BUTTON:CARET/6	51181	CYBB401Z36164534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3257-00			1	.PUSH BUTTON:&/6	51181	CYBB401Z37064534
					.(OPTIONS 4C, 4F, 4G ONLY)		
	118-3136-00			1	.PUSH BUTTON:6/SECTION	51181	CYBB401Z44594534
					.(OPTION 4B ONLY)		
	118-3401-00			1	.PUSH BUTTON:6/CARET	51181	CYBB401Z41357374
					.OPTION 4K ONLY)		
-29	118-3188-00			1	.PUSH BUTTON:&/7	51181	CYBB401Z37274534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3135-00			1	.PUSH BUTTON:7/GRV APOST E	51181	CYBB401Z33574534
					.(OPTION 4B ONLY)		
	118-3255-00			1	.PUSH BUTTON://7	51181	CYBB401Z36074534
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3400-00			1	.PUSH BUTTON:7/&	51181	CYBB401Z41347375
					.(OPTION 4K ONLY)		
-30	118-3253-00			1	.PUSH BUTTON:ASTERISK/8	51181	CYBB401Z37184534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3146-00			1	.PUSH BUTTON:8/]	51181	CYBB401Z21514534
					.(OPTION 4B ONLY)		
	118-3258-00			1	.PUSH BUTTON:(/8	51181	CYBB401Z37084534
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3399-00			1	.PUSH BUTTON:8/*	51181	CYBB401Z41337376
					.(OPTION 4K ONLY)		
-31	118-3183-00			1	.PUSH BUTTON:(/9	51181	CYBB401Z37294534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3142-00			1	.PUSH BUTTON:9/CEDILLIA	51181	CYBB401Z13574534
					.(OPTION 4B ONLY)		
	118-3259-00			1	.PUSH BUTTON:)/9	51181	CYBB401Z37094534
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3398-00			1	.PUSH BUTTON:9/(	51181	CYBB401Z41327327

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					.(OPTION 4K ONLY)		
-32	118-3184-00			1	.PUSH BUTTON:)/PHASE	51181	CYBB401Z37904534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3572-00			1	.PUSH BUTTON:0/GRV ACNT/LOWER CASE A	51181	CYBB401Z21234534
					.(OPTION 4B ONLY)		
	118-3265-00			1	.PUSH BUTTON:=/BULLSEYE	51181	CYBB401Z24234534
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3403-00			1	.PUSH BUTTON:0/)	51181	CYBB401Z41387378
					.(OPTION 4K ONLY)		
-33	118-3185-00			1	.PUSH BUTTON:HORIZONTAL/HYPHEN	51181	CYBB401Z30956204
					.(STANDARD AND OPTIONS 4A)		
	118-3134-00			1	.PUSH BUTTON:DEGREE/)	51181	CYBB401Z30414534
					.(OPTION 4B ONLY)		
	118-3263-00			1	.PUSH BUTTON:?/+	51181	CYBB401Z20944534
					.(OPTIONS 4C, 4F ONLY)		
	118-3288-00			1	.PUSH BUTTON:?/SHARPS	51181	CYBB401Z48574534
					.(OPTION 4G ONLY)		
	118-3405-00			1	.PUSH BUTTON:-/UNDERSCORE	51181	CYBB401Z41447379
					.(OPTION 4K ONLY)		
-34	118-3247-00			1	.PUSH BUTTON:+/=	51181	CYBB401Z11274534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3185-00			1	.PUSH BUTTON:HORIZONTAL/HYPHEN	51181	CYBB401Z30956204
					.(OPTION 4B ONLY)		
	118-3266-00			1	.PUSH BUTTON:GRV ACNT/ACUT ACNT	51181	CYBB401Z27764534
					.(OPTIONS 4C, 4F, 4G ONLY)		
	118-3284-00			1	.PUSH BUTTON:GRV APOST/ACUT APOST	51181	CYBB401Z14934534
					.(OPTION 4G ONLY)		
	118-3404-00			1	.PUSH BUTTON:=/+	51181	CYBB401Z41437380
					.(OPTION 4K ONLY)		
-35	118-3246-00			1	.PUSH BUTTON:RIGHT BRACE/RIGHT BRACKET	51181	CYBB401Z10864534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3573-00			1	.PUSH BUTTON:MICRON/ENGLISH POUND	51181	CYBB401Z48554534
					.(OPTION 4B ONLY)		
	118-3264-00			1	.PUSH BUTTON:>/<	51181	CYBB401Z20954534
					.(OPTION 4C, 4F ONLY)		
	118-3149-00			1	.PUSH BUTTON:>/<	51181	CYBB301Z20954534
					.(OPTION 4B, 4G ONLY)		
	118-3283-00			1	.PUSH BUTTON:ASTERISK/+	51181	CYBB401Z14334534
					.(OPTION 4G ONLY)		
	118-3397-00			1	.PUSH BUTTON:RIGHT BRACKET/RIGHT BRACE	51181	CYBB401Z00357378
					.(OPTION 4K ONLY)		
-36	118-3172-00			1	.PUSH BUTTON:RUB/OUT	51181	HIBB401Z468R4529
					.(STANDARD AND OPTIONS 4A,4C,4F,4K ONLY)		
	118-3574-00			1	.PUSH BUTTON:RUBOUT/BACKSPACE	51181	HIBB401Z85125150
					.(OPTIONS 4B,4G ONLY)		
-37	118-3182-00			1	.PUSH BUTTON:ESC	51181	HIBB302Z303E4527
					.(STANDARD & OPTIONS 4A,4C,4F,4G,4K)		
	118-3179-00			1	.PUSH BUTTON:TAB	51181	HIBB202ZT9294527
					.(OPTION 4B)		
-38	118-3228-00			1	.PUSH BUTTON:TILDE/VERT LINE	51181	CYBB301Z72914534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3149-00			1	.PUSH BUTTON:>/<	51181	CYBB301Z20954534
					.(OPTION 4B, 4G ONLY)		
	118-3262-00			1	.PUSH BUTTON:ASTERISK/@	51181	CYBB301Z91264534
					.(OPTIONS 4C, 4F ONLY)		
	118-3390-00			1	.PUSH BUTTON:VERT BAR	51181	CYBB301Z41317382
					.(OPTION 4K ONLY)		
-39	118-3234-00			1	.PUSH BUTTON:Q	51181	CYBB301ZQ0014531
					.(STANDARD AND OPTIONS 4A,4C,4F,4G ONLY)		
	118-3151-00			1	.PUSH BUTTON:A	51181	CYBB301ZA0014531
					.(OPTION 4B ONLY)		
	118-3384-00			1	.PUSH BUTTON:Q	51181	CYBB301ZQ1517383
					.(OPTION 4K ONLY)		
-40	118-3238-00			1	.PUSH BUTTON:W	51181	CYBB301ZW0014531
					.(STANDARD AND OPTIONS 4A,4C,4F,4G ONLY)		
	118-3191-00			1	.PUSH BUTTON:Z	51181	CYBB301ZZ0014531

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					.(OPTION 4B ONLY)		
	118-3388-00			1	.PUSH BUTTON:W	51181	CYBB301ZW5887653
					.(OPTION 4K ONLY)		
-41	118-3230-00			1	.PUSH BUTTON:E	51181	CYBB301ZE0014531
	118-3382-00			1	.PUSH BUTTON:E	51181	CYBB301ZE0157384
					.(OPTION 4K ONLY)		
-42	118-3235-00			1	.PUSH BUTTON:R	51181	CYBB301ZR0014531
	118-3385-00			1	.PUSH BUTTON:R	51181	CYBB301ZR2687647
					.(OPTION 4K ONLY)		
-43	118-3236-00			1	.PUSH BUTTON:T	51181	CYBB301ZT0014531
	118-3386-00			1	.PUSH BUTTON:T	51181	CYBB301ZT3507386
					.(OPTION 4K ONLY)		
-44	118-3239-00			1	.PUSH BUTTON:Y	51181	CYBB301ZY0014531
					.(STANDARD AND OPTIONS 4A,4B,4C,4F ONLY)		
	118-3191-00			1	.PUSH BUTTON:Z	51181	CYBB301ZZ0014531
					.(OPTION 4B, 4G ONLY)		
	118-3389-00			1	.PUSH BUTTON:Y	51181	CYBB301Z70157387
					.(OPTION 4K ONLY)		
-45	118-3237-00			1	.PUSH BUTTON:U	51181	CYBB301ZU0014531
	118-3387-00			1	.PUSH BUTTON:U	51181	CYBB301ZU5557651
					.(OPTION 4K ONLY)		
-46	118-3231-00			1	.PUSH BUTTON:I	51181	CYBB301ZI0014531
	118-3383-00			1	.PUSH BUTTON:I	51181	CYBB301ZI5797389
					.(OPTION 4K ONLY)		
-47	118-3232-00			1	.PUSH BUTTON:O	51181	CYBB301ZO0014531
	118-3380-00			1	.PUSH BUTTON:O	51181	CYBB301Z57407390
					.(OPTION 4K ONLY)		
-48	118-3233-00			1	.PUSH BUTTON:P	51181	CYBB301ZP0014531
	118-3381-00			1	.PUSH BUTTON:P	51181	CYBB301Z574P7391
					.(OPTION 4K ONLY)		
-49	118-3229-00			1	.PUSH BUTTON:GRAVE ACCENT/\	51181	CYBB301Z82864534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3150-00			1	.PUSH BUTTON:DIRS/CARET	51181	CYBB301Z39394534
					.(OPTION 4B ONLY)		
	118-3261-00			1	.PUSH BUTTON:DEGREE/A	51181	CYBB301Z575A6951
					.(OPTIONS 4C,4F ONLY)		
	118-3282-00			1	.PUSH BUTTON:DIRESIS/U	51181	CYBB301Z580U6864
					.(OPTION 4G)		
	118-3391-00			1	.PUSH BUTTON:'/"	51181	CYBB301Z41377392
					.(OPTION 4K ONLY)		
-50	118-3171-00			1	.PUSH BUTTON:BACK/SPACE	51181	HIBB302ZB6344529
					.(STANDARD AND OPTIONS 4A,4C,4F,4K ONLY)		
	118-3182-00			1	.PUSH BUTTON:ESC	51181	HIBB302Z303E4527
					.(OPTION 4B)		
	118-3140-00			1	.PUSH BUTTON:LEFT ARROW	51181	HIBB301Z10185535
					.(OPTION 4G ONLY)		
-51	118-3181-00			1	.PUSH BUTTON:LINE/FEED	51181	HIBB301Z027L4529
					.(STANDARD AND OPTIONS 4A,4C,4F,4K ONLY)		
	118-3140-00			1	.PUSH BUTTON:LEFT ARROW	51181	HIBB301Z10185535
					.(OPTION 4B ONLY)		
	118-3290-00			1	.PUSH BUTTON:DOWN ARROW	51181	HIBB301Z10205535
					.(OPTION 4G ONLY)		
-52	118-3179-00			1	.PUSH BUTTON:TAB	51181	HIBB202ZT9294527
					.(STANDARD & OPTIONS 4A,4C,4F,4G,4K)		
	118-3138-00			1	.PUSH BUTTON:DWN OPEN FAT ARW	51181	HIBB202Z15104535
					.(OPTION 4B ONLY)		
-53	118-3178-00			1	.PUSH BUTTON:CTRL	51181	HIBB201Z3C204527
-54	118-3215-00			1	.PUSH BUTTON:A	51181	CYBB201ZA0014531
					.(STANDARD AND OPTIONS 4A,4C,4F,4G ONLY)		
	118-3148-00			1	.PUSH BUTTON:Q	51181	CYBB201ZQ0014531
					.(OPTION 4B ONLY)		
	118-3363-00			1	.PUSH BUTTON:A	51181	CYBB201Z555A7648
					.(OPTION 4K ONLY)		
-55	118-3223-00			1	.PUSH BUTTON:S	51181	CYBB201ZS0014531
	118-3377-00			1	.PUSH BUTTON:S	51181	CYBB201ZS1147649
					.(OPTION 4K ONLY		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-56	118-3216-00			1	.PUSH BUTTON:D	51181	CYBB201ZD0014531
	118-3373-00			1	.PUSH BUTTON:D .(OPTION 4K ONLY)	51181	CYBB201ZD1537394
-57	118-3217-00			1	.PUSH BUTTON:F	51181	CYBB222ZF0014531
	118-3370-00			1	.PUSH BUTTON:F .(OPTION 4K ONLY)	51181	CYBB201Z574F7395
-58	118-3218-00			1	.PUSH BUTTON:G	51181	CYBB201ZG0014531
	118-3374-00			1	.PUSH BUTTON:G .(OPTION 4K ONLY)	51181	CYBB201ZG3437388
-59	118-3219-00			1	.PUSH BUTTON:H	51181	CYBB201ZH0014531
	118-3375-00			1	.PUSH BUTTON:H .(OPTION 4K ONLY)	51181	CYBB201ZH2567650
-60	118-3220-00			1	.PUSH BUTTON:J	51181	CYBB222ZJ0014531
	118-3371-00			1	.PUSH BUTTON:J .(OPTION 4K ONLY)	51181	CYBB201Z574J7396
-61	118-3221-00			1	.PUSH BUTTON:K	51181	CYBB201ZK0014531
	118-3376-00			1	.PUSH BUTTON:K .(OPTION 4K ONLY)	51181	CYBB201ZK4317646
-62	118-3222-00			1	.PUSH BUTTON:L	51181	CYBB201ZL0014531
	118-3372-00			1	.PUSH BUTTON:L .(OPTION 4K ONLY)	51181	CYBB201Z574L7397
-63	118-3214-00			1	.PUSH BUTTON::/; .(STANDARD AND OPTION 4A ONLY)	51181	CYBB201Z11294534
	118-3147-00			1	.PUSH BUTTON:M .(OPTION 4B ONLY)	51181	CYBB201ZM0014531
	118-3271-00			1	.PUSH BUTTON:DIRESIS O .(OPTION 4C,4G ONLY)	51181	CYBB201Z57506864
	366-0537-00			1	.PUSH BUTTON:SMOKE TAN,NULL .(OPTION 4F ONLY)	80009	366-0537-00
	118-3379-00			1	.PUSH BUTTON:;/: .(OPTION 4K ONLY)	51181	CYBB201Z41407398
-64	118-3224-00			1	.PUSH BUTTON:QUOTES/ACUTE ACNT .(STANDARD AND OPTION 4A ONLY)	51181	CYBB201Z24524534
	118-3158-00			1	.PUSH BUTTON:%/GRV ACNT U .(OPTION 4B ONLY)	51181	CYBB201Z21264534
	118-3272-00			1	.PUSH BUTTON:DIRESIS A .(OPTION 4C, 4G ONLY)	51181	CYBB201Z579A6864
	366-0538-00			1	.PUSH BUTTON:SMOKE TAN,AE RUN TOGETHER .(OPTION 4F ONLY)	80009	366-0538-00
	118-3378-00			1	.PUSH BUTTON:'/" .(OPTION 4K ONLY)	51181	CYBB201Z41397399
-65	118-3180-00			1	.PUSH BUTTON:RETURN .(STANDARD AND OPT 4A,4C,4F,4K ONLY)	51181	HIBB205YR9846944
	118-3139-00			1	.PUSH BUTTON:RETURN ARROW .(OPTION 4B,4G ONLY)	51181	HIBB205Y13217314
-66	118-3164-00			1	.PUSH BUTTON:CAPS/LOCK .(STANDARD AND OPT 4A,4B,4C,4F ONLY)	51181	HITB100Z3C214529
	118-3431-00			1	.PUSH BUTTON:SPERR .(OPTION 4G ONLY)	51181	HITB100Z8S364527
	118-3571-00			1	.PUSH BUTTON:ENGLISH/KATAKANA .(OPTION 4K ONLY)	80009	118-3571-00
-67	118-3177-00			1	.PUSH BUTTON:SHIFT .(STANDARD AND OPT 4A,4C,4F,4K ONLY)	51181	HIBB102Y719S6948
	118-3137-00			1	.PUSH BUTTON:MAJ/UNDRLN MIN .(OPTION 4B ONLY)	51181	HIBB102Y643M7351
	118-3289-00			1	.PUSH BUTTON:UP OPEN FAT ARROW .(OPTION 4G ONLY)	51181	HIBB102Y15097313
-68	118-3209-00			1	.PUSH BUTTON:Z .(STANDARD AND OPT 4A,4C,4F ONLY)	51181	CYBB101ZZ0014531
	118-3157-00			1	.PUSH BUTTON:W .(OPTION 4B ONLY)	51181	CYBB101ZW0014531
	118-3430-00			1	.PUSH BUTTON:Y .(OPTION 4G ONLY)	51181	CYBB101ZY0014531
	118-3361-00			1	.PUSH BUTTON:Z .(OPTION 4K ONLY)	51181	CYBB101ZZ6717645
-69	118-3208-00			1	.PUSH BUTTON:X	51181	CYBB101ZX0014531

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-	118-3360-00			1	.PUSH BUTTON:X	51181	CYBB101ZX6257393
					.(OPTION 4K ONLY)		
-70	118-3204-00			1	.PUSH BUTTON:C	51181	CYBB101ZC0014531
	118-3368-00			1	.PUSH BUTTON:C	51181	CYBB101ZC5227401
					.(OPTION 4K ONLY)		
-71	118-3207-00			1	.PUSH BUTTON:V	51181	CYBB101ZV0014531
	118-3359-00			1	.PUSH BUTTON:V	80009	118-3359-00
					.(OPTION 4K ONLY)		
-72	118-3203-00			1	.PUSH BUTTON:B	51181	CYBB101ZB0014531
	118-3367-00			1	.PUSH BUTTON:B	51181	CYBB101ZB1797403
					.(OPTION 4K ONLY)		
-73	118-3206-00			1	.PUSH BUTTON:N	51181	CYBB101ZN0014531
	118-3358-00			1	.PUSH BUTTON:N	51181	CYBB101ZN3657404
					.(OPTION 4K ONLY)		
-74	118-3205-00			1	.PUSH BUTTON:M	51181	CYBB101ZM0014531
					.(STANDARD AND OPT 4A,4C,4F,4G ONLY)		
	118-3154-00			1	.PUSH BUTTON:?/,	51181	CYBB101Z13934534
					.(OPTION 4B ONLY)		
	118-3369-00			1	.PUSH BUTTON:M	51181	CYBB101ZM2127385
					.(OPTION 4K ONLY)		
-75	118-3200-00			1	.PUSH BUTTON:</,	51181	CYBB101Z10344534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3155-00			1	.PUSH BUTTON:PERIOD/;	51181	CYBB101Z14444534
					.(OPTION 4B ONLY)		
	118-3268-00			1	.PUSH BUTTON:;/,	51181	CYBB101Z14394534
					.(OPTIONS 4C, 4F, 4G ONLY)		
	118-3362-00			1	.PUSH BUTTON:,/</,	51181	CYBB101Z41427405
					.(OPTION 4K ONLY)		
-76	118-3201-00			1	.PUSH BUTTON:>/PERIOD	51181	CYBB101Z10354534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3156-00			1	.PUSH BUTTON://:	51181	CYBB101Z14454534
					.(OPTION 4B ONLY)		
	118-3267-00			1	.PUSH BUTTON::/PERIOD	51181	CYBB101Z11644534
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3366-00			1	.PUSH BUTTON:./>	51181	CYBB101Z22277406
					.(OPTION 4K ONLY)		
-77	118-3202-00			1	.PUSH BUTTON:?//	51181	CYBB101Z18564534
					.(STANDARD AND OPTION 4A ONLY)		
	118-3153-00			1	.PUSH BUTTON:+/=	51181	CYBB101Z11274534
					.(OPTION 4B ONLY)		
	118-3269-00			1	.PUSH BUTTON:HORIZONTAL/HYPHEN	51181	CYBB101Z30956204
					.(OPTIONS 4C,4F,4G ONLY)		
	118-3365-00			1	.PUSH BUTTON://?/.	51181	CYBB101Z19077407
					.(OPTION 4K ONLY)		
-78	118-3177-00			1	.PUSH BUTTON:SHIFT	51181	HIBB102Y719S6948
					.(STANDARD AND OPT 4A,4C,4F,4K ONLY)		
	118-3137-00			1	.PUSH BUTTON:MAJ/UNDRLN MIN	51181	HIBB102Y643M7351
					.(OPTION 4B ONLY)		
	118-3289-00			1	.PUSH BUTTON:UP OPEN FAT ARROW	51181	HIBB102Y15097313
					.(OPTION 4G ONLY)		
-79	118-3187-00			1	.PUSH BUTTON:BREAK	51181	HIBB101Z634B4527
-80	118-3186-00			1	.PUSH BUTTON:SPACE BAR	51181	CYCY012Z10902602
-81	118-3241-00			1	.PUSH BUTTON:7	51181	CYBB401Z10074536
-82	118-3242-00			1	.PUSH BUTTON:8	51181	CYBB401Z10084536
-83	118-3243-00			1	.PUSH BUTTON:9	51181	CYBB401Z10094536
-84	118-3244-00			1	.PUSH BUTTON:MINUS	51181	CYBB401Z10404536
-85	118-3225-00			1	.PUSH BUTTON:4	51181	CYBB301Z10044536
-86	118-3240-00			1	.PUSH BUTTON:5	51181	CYBB324Z10054536
-87	118-3226-00			1	.PUSH BUTTON:6	51181	CYBB301Z10064536
-88	118-3227-00			1	.PUSH BUTTON:COMMA	51181	CYBB301Z10234536
-89	118-3211-00			1	.PUSH BUTTON:1	51181	CYBB201Z10014536
-90	118-3212-00			1	.PUSH BUTTON:2	51181	CYBB201Z10024536
-91	118-3213-00			1	.PUSH BUTTON:3	51181	CYBB201Z10034536
-92	118-3161-00			1	.PUSH BUTTON:ENTER	51181	HIBB606Z350E4527
-93	118-3210-00			1	.PUSH BUTTON:PHASE	51181	CYBB105Y10106942
					.(STANDARD AND OPTIONS 4A,4B,4K ONLY)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-	118-3270-00			1	.PUSH BUTTON:BULLSEYE	51181	CYBB105Y34796942
					.(OPTIONS 4C, 4F ONLY)		
	118-3287-00			1	.PUSH BUTTON:=/PHASE	51181	CYBB401Z36804534
					.(OPTION 4G ONLY)		
-94	118-3199-00			1	.PUSH BUTTON:PERIOD	51181	CYBB101Z10224536
-95	118-3160-00			1	.PUSH BUTTON:GERAS/DIALOG	51181	HIBB501ZG5256945
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3300-00			1	.PUSH BUTTON:GL DIRS O/DIALOG	80009	118-3300-00
					.(OPTION 4G ONLY)		
-96	118-3174-00			1	.PUSH BUTTON:CANCEL/SETUP	51181	HIBB501Z5C475510
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3299-00			1	.PUSH BUTTON:STOP/PARAM	51181	HIBB501Z85356609
					.(OPTION 4G ONLY)		
-97	118-3167-00			1	.PUSH BUTTON:DCOPY/SCOPY	51181	HIBB501Z686D6947
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3298-00			1	.PUSH BUTTON:DKOP/BKOP	51181	HIBB501Z783D6947
					.(OPTION 4G ONLY)		
-98	118-3163-00			1	.PUSH BUTTON:MENU	51181	HIBB501Z052M4527
					.(STANDARD AND OPT 4A,4B,4C,4F ONLY)		
	118-3295-00			1	.PUSH BUTTON:MENU	51181	HIBB501Z060M4527
					.(OPTION 4G ONLY)		
	118-3621-00			1	.PUSH BUTTON:MENU CAP LOCK	51181	HITB500Z061M6559
					.(OPTION 4K ONLY)		
-99	118-3175-00			1	.PUSH BUTTON:F1	51181	HIBB501ZF4014527
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3293-00			1	.PUSH BUTTON:F1/FWERT	80009	118-3293-00
					.(OPTION 4G ONLY)		
-100	118-3176-00			1	.PUSH BUTTON:F2	51181	HIBB501ZF4024527
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3292-00			1	.PUSH BUTTON:F2/FHELL	80009	118-3292-00
					.(OPTION 4G ONLY)		
-101	118-3165-00			1	.PUSH BUTTON:F3	51181	HIBB501ZF4034527
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3294-00			1	.PUSH BUTTON:F3/FS DIRS A TT	80009	118-3294-00
					.(OPTION 4G ONLY)		
-102	118-3166-00			1	.PUSH BUTTON:F4	51181	HIBB501ZF4044527
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3296-00			1	.PUSH BUTTON:F4/FORIG	80009	118-3296-00
					.(OPTION 4G ONLY)		
-103	118-3168-00			1	.PUSH BUTTON:F5	51181	HIBB501ZF4054527
					.(STANDARD AND OPT 4A,4B,4C,4F,4K ONLY)		
	118-3297-00			1	.PUSH BUTTON:FS/FMEN DIRS U	51181	HIBB501Z783D6947
					.(OPTION 4G ONLY)		
-104	118-3169-00			1	.PUSH BUTTON:F6	51181	HIBB501ZF4064527
-105	118-3170-00			1	.PUSH BUTTON:F7	51181	HIBB501ZF4074527
-106	118-3159-00			1	.PUSH BUTTON:F8	51181	HIBB501ZF4084527
-107	118-3162-00			1	.PUSH BUTTON:JOY SWITCH/CAP	51181	HIHI059Z00000000
					.JOYSTICK:(SEE A5A1JS1 REPL)		
-108	118-3192-00			1	..SHIELD,DUST:JOY SWITCH	51181	48-00631-000
-109	----- -----		B010100	1	..SCREW:BINDER HEAD,0-80		
-109.1	118-3198-00	B010100		1	..SCREW:BINDER HEAD,0-80	51181	47-00395-000
-110	118-3193-00			4	..CARRIER,PAD:JOY SWITCH	51181	44-00204-000
-111	118-3197-00			1	..PIVOT:BRASS,JOY SWITCH	51181	47-00394-001
-112	118-3194-00			1	..CAP,DISC:JOY SWITCH	51181	44-00207-000
-113	118-3195-00			1	..SPRING:JOY SWITCH	51181	45-00064-000
-114	----- -----		B010100	1	..RETAINER,SPRING:JOY SWITCH		
-115	118-3017-00			1	.SPRING:	51181	45-00053-060
					.(S59 ONLY)		
	118-3007-00			2	.SPRING:	51181	45-00053-030
					.(S46 AND S60 ONLY)		
	118-3007-00			3	.SPRING:	51181	45-00053-030
					.(S46,60,78 OPTION 4K ONLY)		
-116	118-3016-00			83	.SPRING:	51181	45-00053-015
					.(S1 THRU S45,S47 THRU S58,S61 THRU S86)		
					.(OPTION 4B,4K ONLY)		
	118-3016-00	B010100	B022884	83	.SPRING:	51181	45-00053-015

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					.(S1 THRU S45,S47 THRU S58,S61 THRU S86)		
					.(STANDARD ONLY)		
	118-4030-00	B022885		81	.SPRING:2 OZ	51181	45-00053-020
					.(S1-S44,S47-S58,S61-S72,S74-S86)		
					.(STANDARD ONLY)		
	118-4199-00	B022885		4	.SPRING:	51181	45-00053-010
					.(S45,S73)		
					.(STANDARD ONLY)		
	118-3016-00	B010100	B022940	83	.SPRING:	51181	45-00053-015
					.(S1 THRU S45,S47 THRU S58,S61 THRU S86)		
					.(OPTION 4A ONLY)		
	118-4030-00	B022941		81	.SPRING:2 OZ	51181	45-00053-020
					.(S1-S44,S47-S58,S61-S72,S74-S86)		
					.(OPTION 4A ONLY)		
	118-4199-00	B022941		4	.SPRING:	51181	45-00053-010
					.(S45,S73)		
					.(OPTION 4A ONLY)		
	118-3016-00	B010100	B022781	83	.SPRING:	51181	45-00053-015
					.(S1 THRU S45,S47 THRU S58,S61 THRU S86)		
					.(OPTION 4C ONLY)		
	118-4030-00	B022782		81	.SPRING:2 OZ	51181	45-00053-020
					.(S1-S44,S47-S58,S61-S72,S74-S86)		
					.(OPTION 4C ONLY)		
	118-4199-00	B022782		4	.SPRING:	51181	45-00053-010
					.(S45,S73)		
					.(OPTION 4C ONLY)		
	118-3016-00	B010100	B022300	83	.SPRING:	51181	45-00053-015
					.(S1 THRU S45,S47 THRU S58,S61 THRU S86)		
					.(OPTION 4F ONLY)		
	118-4030-00	B022301		81	.SPRING:2 OZ	51181	45-00053-020
					.(S1-S44,S47-S58,S61-S72,S74-S86)		
					.(OPTION 4F ONLY)		
	118-4199-00	B022301		4	.SPRING:	51181	45-00053-010
					.(S45,S73)		
					.(OPTION 4F ONLY)		
	118-3016-00	B010100	B022902	83	.SPRING:	51181	45-00053-015
					.(S1 THRU S45,S47 THRU S58,S61 THRU S86)		
					.(OPTION 4G ONLY)		
	118-4030-00	B022903		81	.SPRING:2 OZ	51181	45-00053-020
					.(S1-S44,S47-S58,S61-S72,S74-S86)		
					.(OPTION 4G ONLY)		
	118-4199-00	B022903		4	.SPRING:	51181	45-00053-010
					.(S45,S73)		
					.(OPTION 4G ONLY)		
-117	118-3009-00			2	.LEG:	30874	44-00174-000
-118	----- -----			1	.MICROCIRCUIT:(SEE A5A1VR6 REPL)		
					.(ATTACHING PARTS)		
-119	118-3031-00			1	.SCREW:	51181	47-00402-001
-120	118-3030-00			1	.INSULATOR:	51181	48-00651-000
					.(END ATTACHING PARTS)		
-121	----- -----			1	.CKT BOARD ASSY:(NOT REPLACEABLE SEE A5A1)		
					.(ATTACHING PARTS)		
-122	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-123	210-0004-00			2	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
-124	118-3015-00			13	.SCREW:	51181	47-00368-000
					.(END ATTACHING PARTS)		
-125	118-3010-00			2	.BRACKET,MTG:SPACER BAR	51181	44-00102-000
-126	118-3008-00			1	.SPACER,BAR:	51181	44-00173-000
-127	118-3028-00			1	.PLATE,MOUNTING:	51181	49-01306-001

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
3-1	----- -----			1	CKT BOARD ASSY:I/O(SEE A7 REPL)		
					(ATTACHING PARTS)		
-2	220-0497-00			1	NUT,PLAIN,HEX:0.5-28 X 0.562 HEX,BRS CD PL	80009	220-0497-00
-3	210-0845-00			1	WASHER,FLAT:0.5 ID X 0.625 OD X 0.02,STL	89663	634-R
-4	210-1039-00			1	WASHER,LOCK:0.521 ID,INT,0.025 THK,SST	24931	ORDER BY DESCR
					(END ATTACHING PARTS)		
					I/O CIRCUIT BOARD INCLUDES:		
-5	210-0364-00			1	.TERMINAL,LUG:0.51 ID,STL,TIN PLATED	80009	210-0364-00
-6	----- -----			1	.BNC CONNECTOR:(SEE A7J2 REPL)		
-7	136-0751-00			5	.SKT,PL-IN ELEK:MICROCKT,24 PIN	09922	DILB24P108
-8	136-0836-00			1	.SKT,PL-IN ELEK:MICROCIRCUIT,50 DIP	09922	DILBQ50P-101
-9	----- -----			1	POWER SUPPLY:(SEE A6 REPL)		
					(CX4109 ONLY)		
					(ATTACHING PARTS)		
-10	212-0114-00			2	SCR,ASSEM WSHR:8-32 X 0.375,PNH,STL	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
					POWER SUPPLY INCLUDES:		
-11	380-0723-01			1	.HSG HALF,CKT BD:TOP,ALUMINUM	80009	380-0723-01
					.(ATTACHING PARTS)		
-12	213-0931-00			1	.SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL	01536	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-13	255-0334-00			1	.PLASTIC CHANNEL:12.75 X 0.175 X 0.155	11897	122-37-2500
-14	----- -----			1	.CKT BOARD ASSY:(NOT REPLACEABLE SEE A6)		
					.(ATTACHING PARTS)		
-15	361-0067-00			8	.SPACER,CKT BD:0.187,NYLON	06915	LCBS3M
					.(END ATTACHING PARTS)		
-16	334-3379-01			1	.MARKER,IDENT:MARKED GROUND SYMBOL	80009	334-3379-01
-17	334-5212-00			1	.MARKER,IDENT:MKD CAUTION	80009	334-5212-00
-18	----- -----			1	.SWITCH:(SEE A6S535 REPL)		
					.(ATTACHING PARTS)		
-19	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-20	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-21	----- -----			1	.SWITCH:(SEE A6S435 REPL)		
					.(ATTACHING PARTS)		
-22	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-23	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-24	344-0326-00			2	.CLIP,ELECTRICAL:FUSE,BRASS	75915	102071
-25	214-1815-00	B010100	B010249	1	.HEAT SINK,XSTR:TO-220,ALUMINUM	13103	6034B-TT
	214-3745-00	B010250	B020199	1	.HEAT SINK,XSTR:TO-220,ALUMINUM W/4-40 STUD	13103	7023B-MT-SF-1
	214-3745-00	B020200		2	.HEAT SINK,XSTR:TO-220,ALUMINUM W/4-40 STUD	13103	7023B-MT-SF-1
					.(ATTACHING PARTS)		
-26	211-0008-00	B010100	B020199	1	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-27	210-0586-00	B010100	B020199	1	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
	210-0586-00	B020200		2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					.(END ATTACHING PARTS)		
-28	----- -----			1	.CONNECTOR LINE CORD:(SEE A6J1 REPL)		
					.(ATTACHING PARTS)		
-29	211-0121-00			1	.SCR,ASSEM WSHR:4-40 X 0.438,PNH,BRS	TK0435	ORDER BY DESCR
-30	210-3100-00			1	.RIVET,SOLID:0.26 L X 0.136 OD,RND,PLSTC	02768	201090751002056
-31	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					.(END ATTACHING PARTS)		
-32	214-3745-00			1	.HEAT SINK,XSTR:TO-220,ALUMINUM W/4-40 STUD	13103	7023B-MT-SF-1
					.(ATTACHING PARTS)		
-33	210-0586-00			1	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-34	211-0008-00	B010100	B020199	1	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-35	348-0056-00			1	.GROMMET,PLASTIC:GRAY,ROUND,0.332 ID	80009	348-0056-00
-36	380-0724-00			1	.HSG HALF,CKT BD:BOTTOM,ALUMINUM	80009	380-0724-00
-37	361-1305-00			1	.SPACER,CKT BD:1.0 SPACING,LOCKING,NYLON	06915	LCBS-16M
-38	334-6023-00			1	MARKER,IDENT:MKD CX4109	80009	334-6023-00

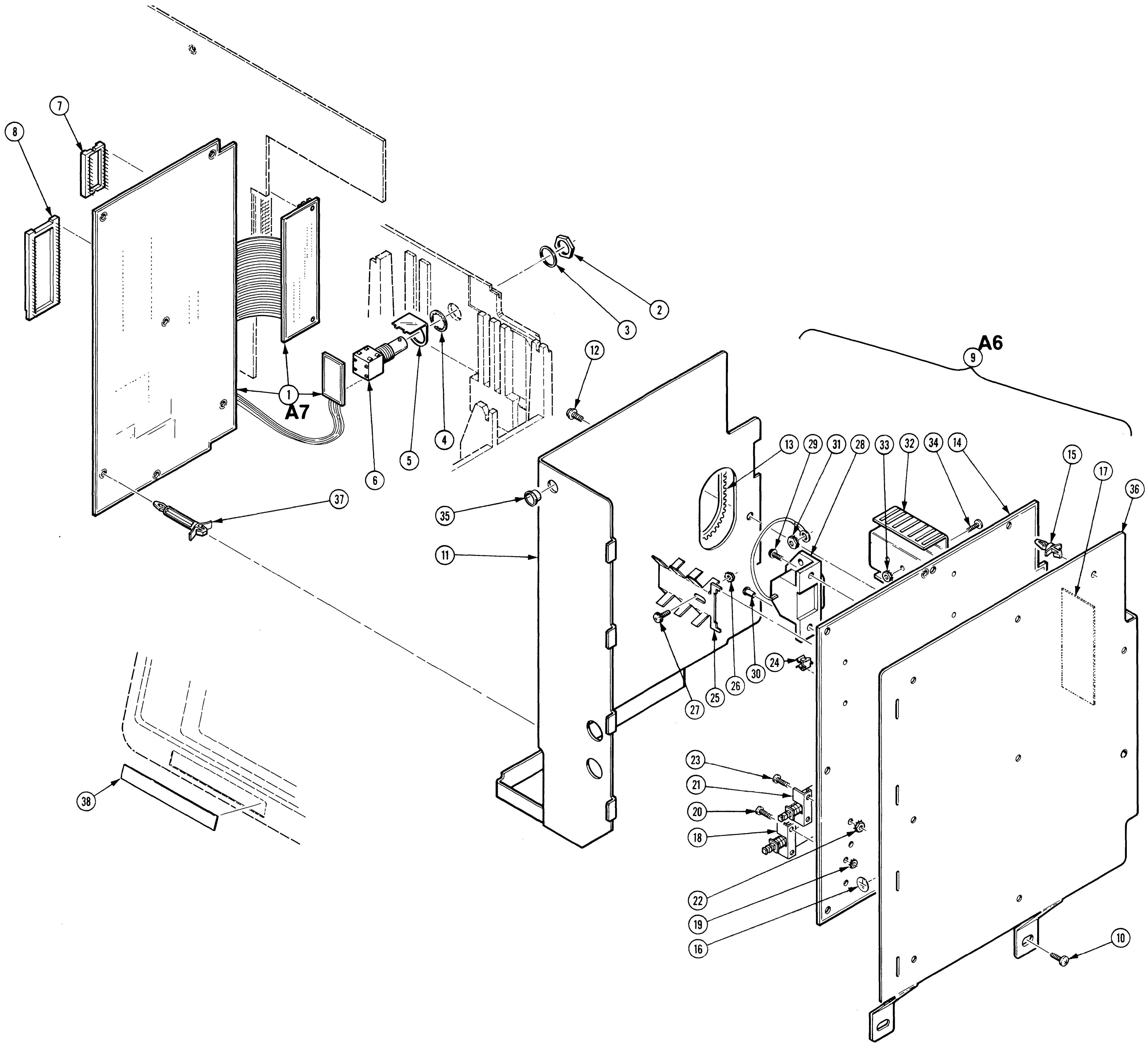

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FIG. 3 CX4109

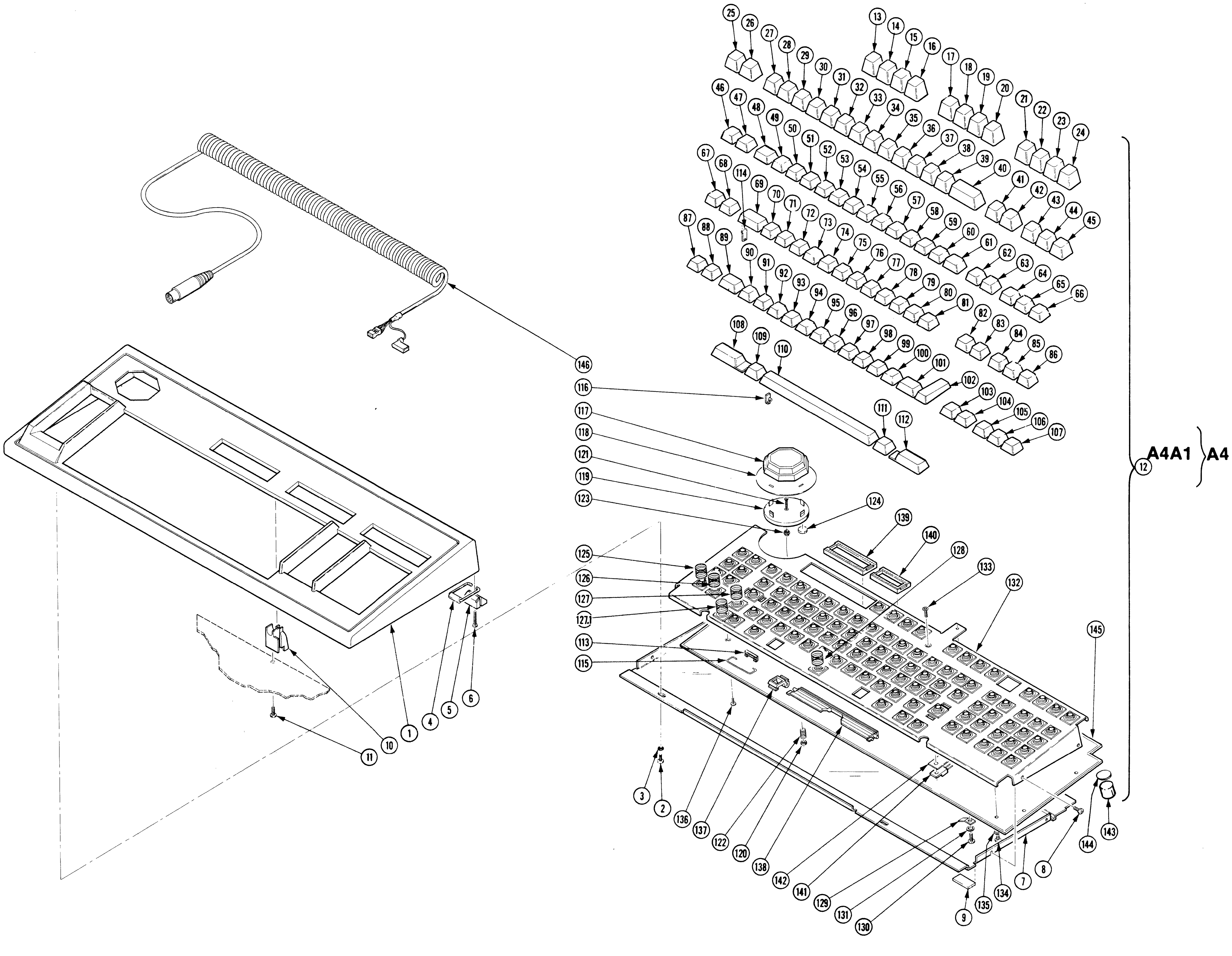


FIG. 4 4109 CX KEYBOARD

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-1	118-4023-00			1	HSG,KEYBOARD:	51181	44-00263-001
					(ATTACHING PARTS)		
-2	211-0008-00			4	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-3	118-4025-00			4	BUSHING:	51181	47-00381-004
					(END OF ATTACHING PARTS)		
-4	118-3020-00			2	LEG:	51181	45-00057-002
					(ATTACHING PARTS)		
-5	118-3021-00			2	BLOCK,BAIL:	51181	44-00193-000
-6	118-3022-00			2	SCREW:	51181	47-00290-000
					(END OF ATTACHING PARTS)		
-7	118-4027-00			1	PLATE,BASE:	30874	49-01785-000
					(ATTACHING PARTS)		
-8	213-0034-00			4	SCREW,TPG,TC:4-40 X 0.312,TYPE T,PNH,STL	77250	ORDER BY DESCR
					(END OF ATTACHING PARTS)		
-9	118-4100-00			4	FOOT:RUBBER,RETANGULAR	51181	48-00738-000
-10	118-4024-00			1	STRAIN RELIEF:	51181	44-00264-000
					(ATTACHING PARTS)		
-11	118-4026-00			1	SCREW:6-19	30874	ORDER BY DESCR
					(END OF ATTACHING PARTS)		
-12	----- -----			1	KEYBOARD ASSEMBLIES;(SEE A5A1 REPL)		
-13	118-3160-00			1	.PUSH BUTTON:GERAS/DIALOG	51181	HIBB501ZG5256945
-14	118-4084-00			1	.PUSH BUTTON:CANCEL,SETUP	51181	HIBB501Z5C475510
					.(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)		
	118-4547-00			1	.PUSH BUTTON:STOP PARAM	51181	HIBB501Z8S355510
					.(CX4109 OPTION 4G ONLY)		
-15	118-3167-00			1	.PUSH BUTTON:DCOPY/SCOPY	51181	HIBB501Z686D6947
-16	118-3163-00			1	.PUSH BUTTON:MENU	51181	HIBB501Z052M4527
-17	118-3175-00			1	.PUSH BUTTON:F1	51181	HIBB501ZF4014527
-18	118-3176-00			1	.PUSH BUTTON:F2	51181	HIBB501ZF4024527
-19	118-3165-00			1	.PUSH BUTTON:F3	51181	HIBB501ZF4034527
-20	118-3166-00			1	.PUSH BUTTON:F4	51181	HIBB501ZF4044527
-21	118-3168-00			1	.PUSH BUTTON:F5	51181	HIBB501ZF4054527
-22	118-3169-00			1	.PUSH BUTTON:F6	51181	HIBB501ZF4064527
-23	118-3170-00			1	.PUSH BUTTON:F7	51181	HIBB501ZF4074527
-24	118-3159-00			1	.PUSH BUTTON:F8	51181	HIBB501ZF4084527
-25	118-4098-00			1	.PUSH BUTTON:ATTN SYS REQ	51181	HIXD401Z931AA023
					.(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)		
	118-4571-00			1	.PUSH BUTTON:ABRUF SYS AB	51181	HIXD401Z0A04A023
					.(CX4109 OPTION 4G ONLY)		
-26	118-4099-00			1	.PUSH BUTTON:CURSR SEL,CLEAR	51181	HIXD401Z2C30A023
					.(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)		
	118-4572-00			1	.PUSH BUTTON:L "DIRESIS" O SCH POS AU	51181	HIXD401Z342LA023
					.(CX4109 OPTION 4G ONLY)		
-27	118-4048-00			1	.PUSH BUTTON:TILDE GRAVE ACCENT	51181	CYBB401Z44364534
					.(STANDARD CX4109 ONLY)		
	118-4526-00			1	.PUSH BUTTON:VERTICAL LINE BACK SLASH	51181	CYBB401Z10744534
					.(CX4109 OPTION 4A ONLY)		
	118-4549-00			1	.PUSH BUTTON:BLANK (NO LEGEND)	51181	CYCY401Z10900000
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-28	118-4049-00			1	.PUSH BUTTON:VERT LINE,EXCLAMATION,1,PF1	51181	CYPZ401Z64119093
					.(STANDARD CX4109 ONLY)		
	118-4527-00			1	.PUSH BUTTON:] 1 PF1	51181	CYXD401Z92215558
					.(CX4109 OPTIONS 4A,4B,4C,4F,4G ONLY)		
-29	118-4054-00			1	.PUSH BUTTON:@,2,PF2	51181	CYPZ401Z54249093
					.(STANDARD CX4109 ONLY)		
	118-4528-00			1	.PUSH BUTTON:QUOTES 2 PF2	51181	CYXD401Z97245558
					.(CX4109 OPTIONS 4A,4B,4C,4F,4G ONLY)		
-30	118-4055-00			1	.PUSH BUTTON:#,3,PF3	51181	CYXD401Z73325558
					.(STANDARD CX4109 ONLY)		
	118-4529-00			1	.PUSH BUTTON:ENGLISH POUND 3 PF3	51181	CYXD401Z97015558
					.(CX4109 OPTION 4A ONLY)		
	118-4550-00			1	.PUSH BUTTON:SECTION 3 PF3	51181	CYXD401Z97325558
					.(CX4109 OPTION 4B ONLY)		
	118-4543-00			1	.PUSH BUTTON:SECTION # 3 PF3	51181	CYPZ401Z74159093
					.(CX4109 OPTION 4C ONLY)		
	118-4578-00			1	.PUSH BUTTON:# 3 PF3	51181	CYXD401Z73325558

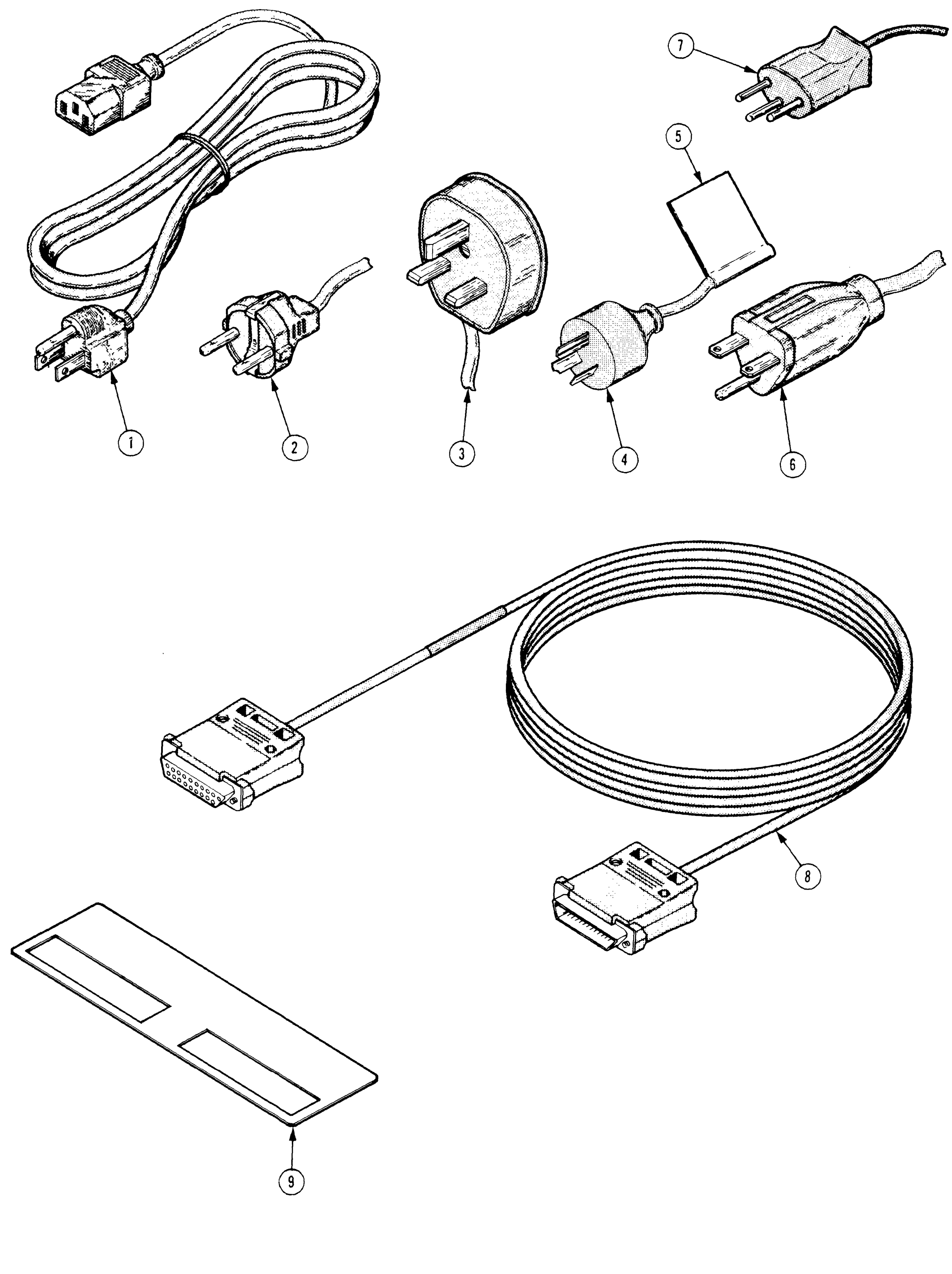
Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-					.(CX4109 OPTIONS 4F,4G ONLY)		
-31	118-4056-00			1	.PUSH BUTTON:$,4,PF4	51181	CYXD401Z73335558
					.(CX4109 STANDARD AND OPTIONS 4A,4B ONLY)		
	118-4544-00			1	.PUSH BUTTON:SUN 4 PF4	51181	CYXD401Z22835558
					.(CX4109 OPTION 4C ONLY)		
	118-4579-00			1	.PUSH BUTTON:SUN $ 4 PF4	51181	CYPZ401Z73879093
					.(CX4109 OPTIONS 4F,4G ONLY)		
-32	118-4057-00			1	.PUSH BUTTON:%,5,PF5	51181	CYXD401Z73345558
-33	118-4050-00			1	.PUSH BUTTON:NEGTN,CARET,6,PF6	51181	CYPZ401Z54249093
					.(STANDARD CX4109 ONLY)		
	118-4530-00			1	.PUSH BUTTON:& 6 PF6	51181	CYXD401Z97025558
					.(CX4109 OPTION 4A ONLY)		
	118-4551-00			1	.PUSH BUTTON:+ 6 PF6	51181	CYXD401Z99905558
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-34	118-4058-00			1	.PUSH BUTTON:&,7,PF7	51181	CYXD401Z73365558
					.(STANDARD CX4109 ONLY)		
	118-4531-00			1	.PUSH BUTTON:VERTICAL APOSTROPHE 7 PF7	51181	CYXD401Z61685558
					.(CX4109 OPTION 4A ONLY)		
	118-4552-00			1	.PUSH BUTTON:/ 7 PF7	51181	CYXD401Z97255558
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-35	118-4059-00			1	.PUSH BUTTON:*,8,PF8	51181	CYXD401Z73375558
					.(STANDARD CX4109 ONLY)		
	118-4532-00			1	.PUSH BUTTON:(8 PF8	51181	CYXD401Z97045558
					.(CX4109 OPTIONS 4A,4B,4C,4F,4G ONLY)		
-36	118-4060-00			1	.PUSH BUTTON:LEFT PARENTHESIS,9,PF9	51181	CYXD401Z73385558
					.(STANDARD CX4109 ONLY)		
	118-4533-00			1	.PUSH BUTTON:) 9 PF9	51181	CYXD401Z97055558
					.(CX4109 OPTIONS 4A,4B,4C,4F,4G ONLY)		
-37	118-4052-00			1	.PUSH BUTTON:RIGHT PARENTHESIS,PHASE,PF10	51181	CYXD401Z54655528
					.(STANDARD CX4109 ONLY)		
	118-4534-00			1	.PUSH BUTTON:# CIRCUMFLEX 0 PF10	51181	CYPZ401Z74199093
					.(CX4109 OPTION 4A ONLY)		
	118-4553-00			1	.PUSH BUTTON:= 0 PF10	51181	CYXD401Z73525558
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-38	118-4053-00			1	.PUSH BUTTON:HORIZONTAL LINE,HYPHEN,PF11	51181	CYXD401Z64105558
					.(STANDARD CX4109 ONLY)		
	118-4535-00			1	.PUSH BUTTON:= MINUS PF11	51181	CYXD401Z97075558
					.(CX4109 OPTION 4A ONLY)		
	118-4554-00			1	.PUSH BUTTON:? VERTICAL APOSTROPHE PF11	51181	CYXD401Z99925558
					.(CX4109 OPTION 4B ONLY)		
	118-4545-00			1	.PUSH BUTTON:? + PF11	51181	CYXD401Z00085558
					.(CX4109 OPTIONS 4C,4F ONLY)		
	118-4573-00			1	.PUSH BUTTON:? SHARPS S PF11	51181	CYXD401Z03325558
					.(CX4109 OPTION 4G ONLY)		
-39	118-4061-00			1	.PUSH BUTTON:PLUS,EQUALS,PF12	51181	CYXD401Z73415558
					.(STANDARD CX4109 ONLY)		
	118-4536-00			1	.PUSH BUTTON:UNDSCR NEGTN UNDSCR,PF12	51181	CYPZ401Z74177090
					.(CX4109 OPTION 4A ONLY)		
	118-4555-00			1	.PUSH BUTTON:DIRS CURCUMFLEX PF12	51181	CYXD401Z99935558
					.(CX4109 OPTION 4B ONLY)		
	118-4546-00			1	.PUSH BUTTON:GRAVE ACCENT + E ACUTE ACCENT @	51181	CYPZ401Z74827091
					. PF12		
					.(CX4109 OPTION 4C ONLY)		
	118-4580-00			1	.PUSH BUTTON:GRAVE APOSTROPHE \ @ PF12	51181	CYPZ401Z73897090
					.(CX4109 OPTION 4F ONLY)		
	118-4574-00			1	.PUSH BUTTON:GRAVE ACCENT VERTICAL APOSTROPH	51181	CYXD401Z97345558
					.E PF12		
					.(CX4109 OPTION 4G ONLY)		
-40	118-4083-00			1	.PUSH BUTTON:LEFT ARROW	51181	HIBB445Y10189217
-41	118-4097-00			1	.PUSH BUTTON:DUP,PA1	51181	HIBB401Z1D946306
-42	118-4090-00			1	.PUSH BUTTON:FIELD MARK,PA2,UNDERLINE	51181	HIBB401Z2F274566
					.(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)		
	118-4575-00			1	.PUSH BUTTON:FELD MARKE UNDLN PA2	51181	HIBB401Z4F504566
					.(CX4109 OPTION 4G ONLY)		
-43	118-4080-00			1	.PUSH BUTTON:7,PF13	51181	HIBB401Z4598A024
-44	118-4081-00			1	.PUSH BUTTON:8,PF14	51181	HIBB401Z4599A024

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-45	118-4082-00			1	.PUSH BUTTON:9,PF15	51181	HIBB401Z4600A024
-46	118-4075-00			1	.PUSH BUTTON:D ERASE,S ERASE .(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)	51181	HIAG301Z771D6947
	118-4576-00			1	.PUSH BUTTON:D L "DIRS O" B L "DIRS O" .(CX4109 OPTION 4G ONLY)	51181	HIAG301Z3D726947
-47	118-4096-00			1	.PUSH BUTTON:ESC,ERASE INPUT .(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)	51181	HIPY301Z950EA023
	118-4565-00			1	.PUSH BUTTON:ESC EIN L "DIRS O" .(CX4109 OPTION 4G ONLY)	51181	HIPY301Z1E37A023
-48	118-4078-00			1	.PUSH BUTTON:RIGHT STOP ARROW	51181	HIBB302Y16778451
-49	118-3234-00			1	.PUSH BUTTON:Q	51181	CYBB301ZQ0014531
-50	118-3238-00			1	.PUSH BUTTON:W	51181	CYBB301ZW0014531
-51	118-3230-00			1	.PUSH BUTTON:E	51181	CYBB301ZE0014531
-52	118-3235-00			1	.PUSH BUTTON:R	51181	CYBB301ZR0014531
-53	118-3236-00			1	.PUSH BUTTON:T	51181	CYBB301ZT0014531
-54	118-3239-00			1	.PUSH BUTTON:Y	51181	CYBB301ZY0014531
-55	118-3237-00			1	.PUSH BUTTON:U	51181	CYBB301ZU0014531
-56	118-3231-00			1	.PUSH BUTTON:I	51181	CYBB301ZI0014531
-57	118-3232-00			1	.PUSH BUTTON:O	51181	CYBB301ZO0014531
-58	118-3233-00			1	.PUSH BUTTON:P	51181	CYBB301ZP0014531
-59	118-4051-00			1	.PUSH BUTTON:EXCLAMATION,LEFT & RIGHT BRACKE .T,CENT .(STANDARD CX4109 ONLY)	51181	CYSY301Z64099089
	118-4537-00			1	.PUSH BUTTON:GRAVE ACCENT @ .(CX4109 OPTION 4A ONLY)	51181	CYBB301Z29814534
	118-4556-00			1	.PUSH BUTTON:C CEDILLA GRAVE ACCENT A .(CX4109 OPTION 4B ONLY)	51181	CYBB301Z44024534
	118-3261-00			1	.PUSH BUTTON:DEGREE/A .(CX4109 OPTIONS 4C,4F ONLY)	51181	CYBB301Z575A6951
	118-3282-00			1	.PUSH BUTTON:DIRESIS/U .(CX4109 OPTION 4G ONLY)	51181	CYBB301Z580U6864
-60	118-4047-00			1	.PUSH BUTTON:BROKEN VERT LINE,BACK SLASH .(STANDARD CX4109 ONLY)	51181	CYBB301Z10874534
	118-4538-00			1	.PUSH BUTTON:LEFT BRACE LEFT BRACKET .(CX4109 OPTION 4A ONLY)	51181	CYLZ301Z10854534
	118-4557-00			1	.PUSH BUTTON:* & .(CX4109 OPTION 4B ONLY)	51181	CYBB301Z14064534
	118-4548-00			1	.PUSH BUTTON:CIRCUMFLEX DIRS U HORIZ .(CX4109 OPTIONS 4C,4F ONLY)	51181	CYSY301Z73907043
	118-4566-00			1	.PUSH BUTTON:* + .(CX4109 OPTION 4G ONLY)	51181	CYBB301Z14334534
-61	118-4089-00			1	.PUSH BUTTON:LEFT STOP ARROW,DEL	51181	HIST325Y64079091
-62	118-4102-00			1	.PUSH BUTTON:INSERT,ALPHA	51181	HIBB301Z63304535
-63	118-4103-00			1	.PUSH BUTTON:DELETE,ALPHA	51181	HISY301Z61147078
-64	118-4076-00			1	.PUSH BUTTON:4,PF16	51181	HIBB301Z4601A024
-65	118-4079-00			1	.PUSH BUTTON:5,PF17	51181	HIBB324Z4602A024
-66	118-4077-00			1	.PUSH BUTTON:6,PF18	51181	HIBB301Z4603A024
-67	118-4095-00			1	.PUSH BUTTON:CURSR BLINK,ALT CURSR .(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)	51181	HIXD201Z2C32A025
	118-4567-00			1	.PUSH BUTTON:POS BLINK POS UM .(CX4109 OPTION 4G ONLY)	51181	HIXD201Z0P36A025
-68	118-4071-00			1	.PUSH BUTTON:ERASE EOF .(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)	51181	HIBB201Z951E4529
	118-4568-00			1	.PUSH BUTTON:L "DIRS O" SCH FELD .(CX4109 OPTION 4G ONLY)	51181	HIBB201Z341L4529
-69	118-4087-00			1	.PUSH BUTTON:CAPS LOCK	51181	HIKU244Y83429216
-70	118-3215-00			1	.PUSH BUTTON:A	51181	CYBB201ZA0014531
-71	118-3223-00			1	.PUSH BUTTON:S	51181	CYBB201ZS0014531
-72	118-3216-00			1	.PUSH BUTTON:D	51181	CYBB201ZD0014531
-73	118-3217-00			1	.PUSH BUTTON:F	51181	CYBB222ZF0014531
-74	118-3218-00			1	.PUSH BUTTON:G	51181	CYBB201ZG0014531
-75	118-3219-00			1	.PUSH BUTTON:H	51181	CYBB201ZH0014531
-76	118-3220-00			1	.PUSH BUTTON:J	51181	CYBB222ZJ0014531
-77	118-3221-00			1	.PUSH BUTTON:K	51181	CYBB201ZK0014531
-78	118-3222-00			1	.PUSH BUTTON:L	51181	CYBB201ZL0014531
-79	118-3214-00			1	.PUSH BUTTON::/;	51181	CYBB201Z11294534

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-					.(STANDARD CX4109 ONLY)		
	118-4539-00			1	.PUSH BUTTON:+ ;	51181	CYBB201Z10374534
					.(CX4106/7 OPTION 4A ONLY)		
	118-4558-00			1	.PUSH BUTTON:GRAVE ACCENT E ACUTE ACCENT E	51181	CYBB201Z40474534
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-80	118-4046-00			1	.PUSH BUTTON:QUOTES,VER A POST	51181	CYBB201Z11304534
					.(STANDARD CX4109 ONLY)		
	118-4540-00			1	.PUSH BUTTON:* :	51181	CYBB201Z10114534
					.(CX4109 OPTION 4A ONLY)		
	118-4559-00			1	.PUSH BUTTON:GRAVE ACCENT MICRON DEGREE	51181	CYBB201Z97594534
					.(CX4109 OPTIONS 4B,4C,4G ONLY)		
	118-3850-00			1	.PUSH BUTTON:A/E	51181	CYBB201Z14244531
					.(CX4109 OPTION 4F ONLY)		
-81	118-4104-00			1	.PUSH BUTTON:SEMICOLON/EQUAL	51181	CYBB201Z14674534
					.(STANDARD CX4109 ONLY)		
	118-4541-00			1	.PUSH BUTTON:RIGHT BRACE RIGHT BRACKET	51181	CYLZ201Z10864534
					.(CX4109 OPTION 4A ONLY)		
	118-4560-00			1	.PUSH BUTTON:ENGLISH POUND GRAVE ACCENT MU	51181	CYBB201Z74227043
					.(CX4109 OPTION 4B ONLY)		
	118-4563-00			1	.PUSH BUTTON:* VERTICAL APOSTROPHE	51181	CYBB201Z20974534
					.(CX4109 OPTIONS 4C,4F ONLY)		
	118-4569-00			1	.PUSH BUTTON:CIRCUMFLEX #	51181	CYBB201Z74404534
					.(CX4109 OPTION 4G ONLY)		
-82	118-4069-00			1	.PUSH BUTTON:UP ARROW	51181	HIBB201Z10195535
-83	118-4070-00			1	.PUSH BUTTON:DOWN ARROW	51181	HIBB201Z10205535
-84	118-4072-00			1	.PUSH BUTTON:1,PF19	51181	HIBB201Z4604A024
-85	118-4073-00			1	.PUSH BUTTON:2,PF20	51181	HIBB201Z4605A024
-86	118-4074-00			1	.PUSH BUTTON:3,PF21	51181	HIBB201Z4606A024
-87	118-4091-00			1	.PUSH BUTTON:IDENT	51181	HIXD101Z64069215
-88	118-4088-00			1	.PUSH BUTTON:BREAK,TEST	51181	HIST101Z64049087
-89	118-4067-00			1	.PUSH BUTTON:SMALL UP OPEN FAT ARROW	51181	HIBB125Y15096959
-90	118-4045-00			1	.PUSH BUTTON:LESS THAN,GREATER THAN	51181	CYBB101Z20954534
					.(STANDARD CX4109 ONLY)		
	118-4542-00			1	.PUSH BUTTON:HORIZ LINE BROKEN VERT LINE	51181	CYBB101Z61834534
					.(CX4109 OPTION 4A ONLY)		
	118-4561-00			1	.PUSH BUTTON:> <	51181	CYBB101Z20954534
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-91	118-3209-00			1	.PUSH BUTTON:Z	51181	CYBB101ZZ0014531
-92	118-3208-00			1	.PUSH BUTTON:X	51181	CYBB101ZX0014531
-93	118-3204-00			1	.PUSH BUTTON:C	51181	CYBB101ZC0014531
-94	118-3207-00			1	.PUSH BUTTON:V	51181	CYBB101ZV0014531
-95	118-3203-00			1	.PUSH BUTTON:B	51181	CYBB101ZB0014531
-96	118-3206-00			1	.PUSH BUTTON:N	51181	CYBB101ZN0014531
-97	118-3205-00			1	.PUSH BUTTON:M	51181	CYBB101ZM0014531
-98	118-4043-00			1	.PUSH BUTTON:COMMA	51181	CYBB101Z10214534
-99	118-4044-00			1	.PUSH BUTTON:PERIOD	51181	CYBB101Z10994534
-100	118-3202-00			1	.PUSH BUTTON:?//	51181	CYBB101Z18564534
					.(CX4109 STANDARD AND OPTION 4A ONLY)		
	118-4562-00			1	.PUSH BUTTON:HORIZONTAL LINE MINUS SIGN	51181	CYBB101Z10524534
					.(CX4109 OPTIONS 4B,4C,4F,4G ONLY)		
-101	118-4066-00			1	.PUSH BUTTON:LARGE UP OPEN FAT ARROW	51181	HIBB102Y15097313
-102	118-4085-00			1	.PUSH BUTTON:RETURN ARROW	51181	HIBB606Y28215557
-103	118-4092-00			1	.PUSH BUTTON:LEFT ARROW,LEFT DOUBLE ARROW	51181	HIXD101Z6433A022
-104	118-4093-00			1	.PUSH BUTTON:RIGHT ARROW,RIGHT DOUBLE ARROW	51181	HIXD101Z6436A022
-105	118-4065-00			1	.PUSH BUTTON:PHASE,PF22	51181	HIBB101Z6403A024
-106	118-4064-00			1	.PUSH BUTTON:PERIOD,PF23	51181	HIBB101Z6402A024
-107	118-4063-00			1	.PUSH BUTTON:COMMA,PF24	51181	HIBB101Z6401A024
-108	118-4094-00			1	.PUSH BUTTON:RESET,DEV CNCL	51181	HIXD174Y1R529218
					.(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)		
	118-4570-00			1	.PUSH BUTTON:GRDSTG EIN L "DIRS O" SCH	51181	HIXD174YG6499218
					.(CX4109 OPTION 4G ONLY)		
-109	118-4062-00			1	.PUSH BUTTON:ALT,CTRL	51181	HILZ101Z6401A024
-110	118-4086-00			1	.PUSH BUTTON:SPACE BAR	51181	HIHI012Z10902602
-111	118-4062-00			1	.PUSH BUTTON:ALT,CTRL	51181	HILZ101Z6401A024
-112	118-4068-00			1	.PUSH BUTTON:ENTER	51181	HIBB180Y350E6944
					.(CX4109 STANDARD & OPT 4A,4B,4C,4F ONLY)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-	118-4577-00			1	.PUSH BUTTON:DAT FREIG	51181	HIBB180Y3D718689
					.(CX4109 OPTION 4G ONLY)		
-113	118-4040-00			1	.LEVEL,MECH:PIVOT	51181	44-00233-000
-114	118-4039-00			1	.LEGS:	51181	44-00232-000
-115	118-4041-00			1	.LEVEL,BAR:	51181	49-01575-001
-116	118-3009-00			2	.LEG:	30874	44-00174-000
-117	118-3162-00			1	.PUSH BUTTON:JOY SWITCH/CAP	51181	HIHI059Z00000000
-118	118-3192-00			1	.SHIELD,DUST:JOY SWITCH	51181	48-00631-000
-119	118-3194-00			1	.CAP,DISC:JOY SWITCH	51181	44-00207-000
					.(ATTACHING PARTS)		
-120	118-3196-00			1	.RETAINER,SPRING:JOY SWITCH	51181	47-00393-000
-121	118-4042-00			1	.PIN,PIVOT:	51181	47-00422-000
					.(END OF ATTACHING PARTS)		
-122	118-3195-00			1	.SPRING:JOY SWITCH	51181	45-00064-000
-123	118-3197-00			1	.PIVOT:BRASS,JOY SWITCH	51181	47-00394-001
-124	118-3193-00			4	.CARRIER,PAD:JOY SWITCH	51181	44-00204-000
-125	118-4031-00			7	.SPRING:4 OZ	51181	45-00053-040
-126	118-4032-00			1	.SPRING:7 OZ	51181	45-00053-070
-127	118-4030-00			91	.SPRING:2 OZ	51181	45-00053-020
					.(CX4109 ONLY)		
	118-4030-00	B010100	B010106	91	.SPRING:2 OZ	51181	45-00053-020
					.(CX4109A ONLY)		
	118-4030-00	B010107		88	.SPRING:2 OZ	51181	45-00053-020
					.(CX4109A ONLY)		
-127.1	118-4199-00	B010107		6	.SPRING:	51181	45-00053-010
					.(CX4109A ONLY)		
-128	118-3007-00			1	.SPRING:	51181	45-00053-030
-129	118-3025-00			1	.CONN,PLUG,ELEC:	51181	48-00501-000
					.(ATTACHING PARTS)		
-130	211-0008-00			1	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-131	210-0004-00			1	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
					.(END OF ATTACHING PARTS)		
-132	118-4037-00			1	.PLATE ASSEMBLY:MOUNTING	51181	49-01802-000-A
					.(ATTACHING PARTS)		
-133	118-3031-00			1	.SCREW:	51181	47-00402-001
-134	211-0007-00			3	.SCREW,MACHINE:4-40 X 0.188,PNH,STL	TK0435	ORDER BY DESCR
-135	210-0004-00			3	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
-136	118-3015-00			16	.SCREW:	51181	47-00368-000
					.(END OF ATTACHING PARTS)		
-137	118-3010-00			2	.BRACKET,MTG:SPACER BAR	51181	44-00102-000
-138	118-4029-00			1	.BAR,SPACER:	51181	44-00173-001
-139	136-0757-00			1	.SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
-140	136-0751-00	B010100	B010100	1	.SKT,PL-IN ELEK:MICROCKT,24 PIN	09922	DILB24P108
-141	----- -----			1	.MICROCKT,LINEAR:POS VOLTAGE REG,BURN-IN		
					(SEE A4A1U11 REPL)		
-142	118-3030-00			1	.INSULATOR:	51181	48-00651-000
-143	----- -----			1	.SPEAKER:ALARM		
					.(SEE A5A1LS1 REPL)		
-144	118-4034-00			1	.INSULATOR:ALARM	51181	48-00125-001
-145	----- -----			1	.CIRCUIT BOARD ASSY;(SEE A5A1 REPL)		
-146	118-3026-01			1	.CA ASSY,SP,ELEC: KEYTRONICS	80009	118-3026-01

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
5-					STANDARD ACCESSORIES		
-1	161-0066-00			1	CABLE ASSY,PWR,:3,18AWG,115V,98.0 L	16428	CH8481, FH8481
-2	161-0066-09			1	CABLE ASSY,PWR,:3,0.75MM SQ,220V,99.0 L (OPTION A1 EUROPEAN ONLY)	S3109	86511000
-3	161-0066-10			1	CABLE ASSY,PWR,:3,0.75MM SQ,240V,96.0 L (OPTION A2 UNITED KINGDOM ONLY)	TK1373	24230
-4	161-0066-11			1	CABLE ASSY,PWR,:3,0.75MM,240V,96.0 L (OPTION A3 AUSTRALIAN ONLY)	S3109	ORDER BY DESCR
-5	334-3995-00			1	MARKER,IDENT:MARKED CAUTION (OPTION A3 AUSTRALIAN ONLY)	80009	334-3995-00
-6	161-0066-12			1	CABLE ASSY,PWR,:3,18 AWG,250V,99.0 L (OPTION A4 NORTH AMERICAN ONLY)	70903	CH-77893
-7	161-0154-00			1	CABLE ASSY,PWR,:3,0.75MM SQ,240V,6A,2.5M L (OPTION A5 SWISS ONLY)	S3109	86515000
-8	012-0911-00			1	CABLE,INTCON:144.0 L, RS 232	TK6020	ESF-85249
-9	334-5164-00	B010100	B011429	1	OVERLAY,KYBD:MKD USER DEFINABLE	80009	334-5164-00
	062-7235-00	B010100	B022700	1	MANUAL,TECH:USERS,IDD SURVEY CARD (4109 ONLY)	80009	062-7235-00
	062-7235-01	B022701		1	MANUAL,TECH:TO THE USER SURVEY CARD (4109 ONLY)	80009	062-7235-01
	062-7235-00	B010100	B020207	1	MANUAL,TECH:USERS,IDD SURVEY CARD (CX4109 ONLY)	80009	062-7235-00
	062-7235-01	B020208		1	MANUAL,TECH:TO THE USER SURVEY CARD (CX4109 ONLY)	80009	062-7235-01
	070-4893-00	B010100	B022670	1	MANUAL,TECH:REF,4107/4109 (4109 ONLY)	80009	070-4893-00
	070-4893-01	B022671		1	MANUAL,TECH:REF,4106/4107/4109/CX (4109 ONLY)	80009	070-4893-01
	070-4892-00	B010100	B022670	1	MANUAL,TECH:REF,4107/4109 COMPUTER (4109 ONLY)	80009	070-4892-00
	070-4892-01	B022671		1	MANUAL,TECH:REF,4106/4107/4109/CX (4109 ONLY)	80009	070-4892-01
	070-5689-00	B022671		1	MANUAL,TECH:INSTR,4106/4107/4109 (4109 ONLY)	80009	070-5689-00
	070-5256-00			1	MANUAL,TECH:OPERATORS,CX4100	80009	070-5256-00
	070-5257-00			1	MANUAL,TECH:CX4100 SERIES	80009	070-5257-00
	062-7235-00			1	MANUAL,TECH:USERS,IDD SURVEY CARD	80009	062-7235-00
					OPTIONAL ACCESSORIES		
	070-4890-01			1	MANUAL,TECH:SERVICE,4109/CX	80009	070-4890-01
	070-4899-00			1	MANUAL,TECH:SVCE,19"COLOR MONITOR	80009	070-4899-00
	013-0214-00			1	ADAPTER ASSY:COPIER LOOP BACK TEST FIXTURE	80009	013-0214-00
	067-1043-00			1	FIXTURE,CAL:HOST PORT LOOP BACK CONN	80009	067-1043-00
	070-4981-00			1	MANUAL,TECH:OPERATORS,4107/4109 (4109 ONLY)	80009	070-4981-00
	067-1181-00			1	FIXTURE,CAL:GRATICULE,TEST	80009	067-1181-00
	334-5164-00	B011430		1	OVERLAY,KYBD:MKD USER DEFINABLE	80009	334-5164-00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OPTIONS

OPTION	ORDER NO.	QTY. NAME & DESCRIPTION
A1		EUROPEAN:POWER OPTION
A2		UNITED KINGDOM:POWER OPTION
A3		AUSTRALIAN:POWER OPTION
A5		SWISS:POWER OPTION
4A		UNITED KINGDOM KEYBOARD
4B		FRENCH KEYBOARD
4C		SWEDISH KEYBOARD
4F		DANISH/NORWEGIAN KEYBOARD
4G		GERMAN KEYBOARD
4K		KATAKANA KEYBOARD

Appendix A

STRAP INFORMATION

The terminal has straps on the Terminal Control board and the Display Module. These straps provide flexibly in its operating parameters. The two general types of straps are: cut straps and jumper straps. In cases where a terminal was designed to function in one way, but provisions were made for future design enhancements, cut straps are often used. Jumper straps are used for most strap options, which allows:

- More than one kind of chip to be used in a given socket
- A change in timing or other operating parameters

TERMINAL CONTROL BOARD STRAPS

Table A-1 lists the straps on the Terminal Control board. Straps labeled "Jxxx" (on the circuit board) have square pins with movable jumpers. Straps labeled "Wxxx" are cut straps; they consist of circuit runs on layer 1 of the ECB (and no square pins).

Table A-1

TERMINAL CONTROL BOARD STRAPS

Strap Label	Definition and Function
EEPROM Type Straps: (W30 two straps)	These two straps are related to the type of EEPROM used (2817, or 2817A). One strap changes pin 1 (Vpp) for 2817, to READY/BUSY for a 2817A. The other strap changes the 2817 READY/BUSY to an extra address line for a 2817A.
Keyboard/Host-Port Timing (W295 & W294)	These straps allow clock input X2 to be used instead of X1. The appropriate components must be inserted, then cut both straps.
RS-232A vs. RS-232C (W493)	This cut strap provides a means for converting from RS-232A to RS-232C. This strap moves the driver for 'secondary request to send' from pin 11 to pin 19 (on output connection).
2PPI-related Straps: (see Special Clock Provisions)	
Processor Clock, W137	When connected, runs the processor on the Display Control Board's 14.7456 MHz clock.
DUART Clock, W280	When connected, runs the DUART's divide-by-four network on the 14.7456 MHz Display Control Board clock.
W294, W295	These cut-straps allow the DUARTs to run on 3.6864 MHz crystals.

SPECIAL CLOCK PROVISIONS

There are four possible clock sources, other than the normal source on the Terminal Control Board. The normal source (with no straps cut or oscillators on the TCB) is the 14.7456 MHz oscillator on the Display Control Board. In this mode, the DUARTs and 80186 all run on the same clock. If the processor or DUARTs are to be run on different clocks, then one or more of the following changes must be implemented:

- Run the DUARTs on their own oscillator module (14.7456 MHz). To do this, cut the strap in the DISP CLK line (W280) and let the oscillator chip, Y485, provide the 14.7456 MHz clock.
- Run the DUARTs on 3.6864 MHz crystals. To do this, cut the straps at both DUARTs: W294 and W295 for U290, and also the two cut-straps for U437. Then install the crystals and two 20 pF capacitors in the spaces marked "not used" (on the schematic).
- Run the processor on an oscillator module. To do this, cut the strap that connects the terminal clock to the processor (W137). Now insert an oscillator module of the desired frequency into the spot labeled "186 clock." The DUARTs can still be run on the display clock.
- Run the processor on a crystal. To do this, cut strap, W135, and install a crystal in the spot for Y135. Install 20 pF capacitors in the spaces marked "not used", and strap the other side of W135.

DISPLAY MODULE STRAPS

The separate *19" Color Monitor for GMA 301 and 4109 Service Manual* contains strap information for the terminal's Display Module. Also, some Display Module strap information is contained in Section 5 of this manual.

Appendix B

REPLACING ROMS

CAUTION

Before removing the ROM Access Door, or before touching any ROMs, read the following "Electrostatic Discharge Awarness" information.

ELECTROSTATIC DISCHARGE PRECAUTIONS

This product contains components that are highly sensitive to electrostatic discharge. To prevent damage to such components and to maintain product reliability, **do NOT** touch or remove the circuit boards or components from the terminal until the following conditions are met.

Handling of Static-Sensitive Components

Handle all static sensitive components (such as ROMs, EEROMs, custom logic arrays, etc.) in a static-safeguarded work area. A static-safe area is any area that is capable of controlling static charge on conductive materials, people, and non-conductive materials.

The following equipment is recommended to create a static-safe area:

- Conductive floor mats,
- Conductive table mat,
- Wrist strap (conducts acquired body charge to ground),
- Ground cord (to suitable ground connection),
- Ionized air blower (for certain applications where climate or other conditions create excessive static build-up).

Transportation of Static-Sensitive Components

Transport all static-sensitive components in static-shielded containers/packages.

A "static shield" container must be capable of protecting from static discharge as well as static fields. The following is a list of suitable static-shield containers:

- Plastic bags (10,000 ohms/sq-cm insulation value),
- Insulated tote boxes,
- Dip Tubes (constructed especially for transporting Dual In-line Package components: RAMs, ROMs, etc.).

ROM REPLACEMENT PROCEDURE

The terminal contains replacable ROMs (Read Only Memories, used to host programs that control the terminal, provide command-set instructions, etc.) This allows you to update firmware as new versions become available. The only tool required for this procedure is a small flat-bladed screwdriver.

Replace the ROMs by doing the following:

1. **Remove the ROM access door.** This door is located at the rear of the terminal (see Figure B-1) and may be removed by pulling it out from the top. Once the door is free, set it aside. The eight banks of ROMs are now exposed (see Figure B-2).

   NOTE

   If this is the first time a set of ROMs has been replaced, the ROM may be difficult to remove from the socket. With gentle pressure, however, the ROM should come free.

2. **Remove each ROM to be replaced.** Do this by using the screwdriver to pry the top and bottom of the ROM from its holder (see Figure B-2). Place the old ROMs in a safe location until operation of the new ROMs has been verified. Then you may wish to discard the old ROMs.

   CAUTION

   Make sure that the new ROMs are installed in the proper sockets. If the ROMs are installed in the wrong locations, the terminal will not operate properly. If this happens, remove the ROM and install it in its proper socket.

3. **Install the new ROMs.** Place each ROM into the proper socket (each ROM is labeled by a component number; match this number to the number on the circuit board). The ROMs are keyed so they cannot be installed upside down. Lock each ROM in place by pushing firmly in.

4. **Reinstall the ROM access door.** Hook the bottom of the door in the back-panel opening, then lock it in place by pressing in firmly on the top of the door.

This completes the ROM replacement procedure. Your terminal is now ready for use with its new firmware.

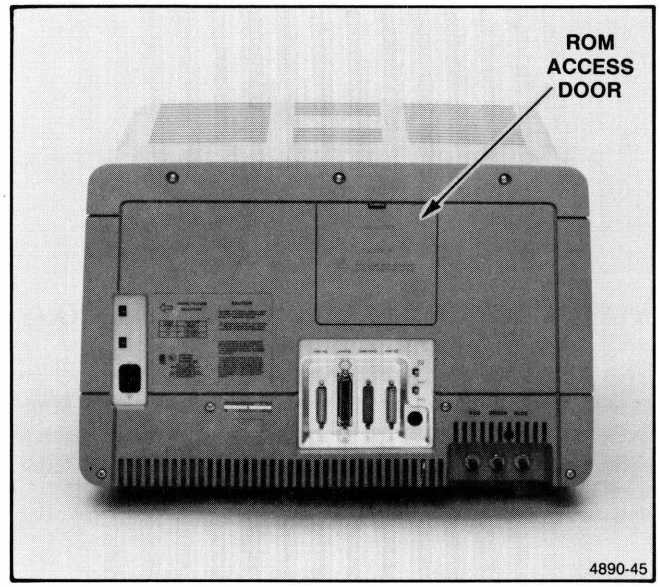


Figure B-1. ROM Access Door.

Figure B-2. Replacing the ROMs.

Appendix C

SELF TEST DIAGNOSTIC PROGRAM

INTRODUCTION

The primary troubleshooting aid for the terminal is the Self Test diagnostic program. This program resides in firmware and is arranged to test most of the hardware of the terminal (see NOTE 1). For the most part, Self Test does not depend on any portion of the hardware until it has tested it; it may then use this hardware to aid in other tests.

NOTE 1

The Self Test program does not test the power supply or Display Module. Power supply problems are relatively easy to isolate. For more information on the power supply, consult the theory of operation section.

The Display Module is not automatically checked during Power Up or Extended Self Test. However, you may check the basic parts of the Display Module by running Adjustment Self Test. The adjustment patterns listed in the display menu may be used to determine what part of the Display Module is malfunctioning. Also, a green LED on the top of the Display Control board is on if the Display Module circuitry is generating a +5 volt supply.

This appendix covers the levels of Self Test, how errors are reported, how to start and run the different levels of Self Test, descriptions of the tests that are performed, and how to select and run menu items.

SELF TEST OVERVIEW

LEVELS OF SELF TEST

There are three levels of the Self Test diagnostic program. These are: Power Up Self Test, Extended Self Test, and Adjustment Self Test. Figure C-1 shows how these levels relate to one another.

Power Up Self Test

Power Up Self Test runs automatically every time the terminal is turned on, or the RESET button is pushed. It performs a quick check of the various hardware modules. This check takes less than 15 seconds to run, and occurs during the time between turning on (or resetting) the terminal and when the cursor appears.

To do more extensive testing of the terminal, use Extended Self Test or Adjustment Self Test.

Extended Self Test

Extended Self Test includes all the tests run during Power Up Self Test as well as much more extensive testing of circuitry. Extended Self Test may take up to four minutes to complete. It is initiated by pressing the SELF TEST and RESET buttons (located on the rear of the terminal) in the proper sequence. The procedure for starting Extended Self Test is covered later in this appendix.

The Continuous Self Test, also called Cycle Mode, is part of Extended Self Test. In that mode, the extended tests run repeatedly. If an error occurs during such cycle testing, Self Test will stop and the error message will remain on the screen.

During Extended Self Test, a menu appears that allows you to enter Adjustment Self Test.

Adjustment Self Test

Adjustment Self Test is used primarily for making adjustments and performance checks. However, this version of Self Test may also be used as a troubleshooting tool for certain parts of the terminal, such as the host port and copier port. Detailed information about Adjustment Self Test is located near the end of this appendix.

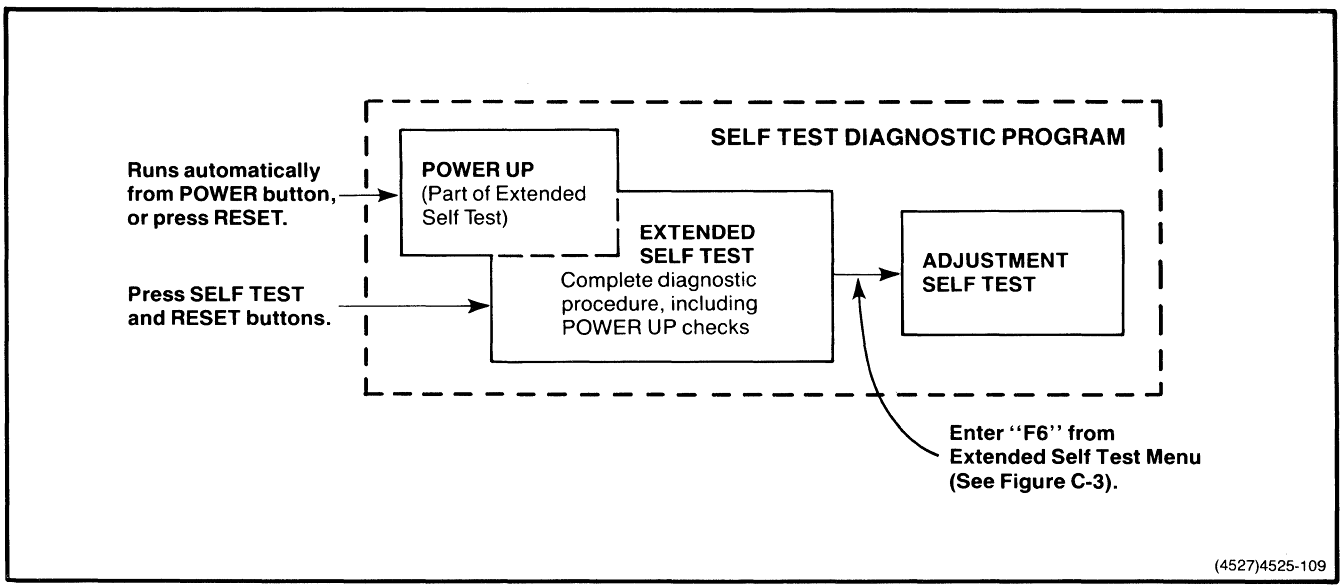


Figure C-1. Self Test Functional Diagram.

ERROR REPORTING

If the terminal finds a problem with itself while running Self Test, it reports this fact in the form of a message. Error messages may occur in one or more forms. These are: a printed message, the terminal bell, the light on the CAPS LOCK key, and internal indicator LEDs.

Printed Message

Anytime Self Test finds a problem, it tries to write a message on the screen. The message relates to what failed when Self Test tried to test it. A printed error message begins with the words "Self Test Error —".

The possible printed error messages are:

Processor System Failure [xx.zzzz] (see NOTE 2)

Uxxx ROM Checksum Failure (Uxxx is the component number of the defective ROM)

Uxxx ROM is Wrong Part (Uxxx is the component number of the defective ROM)

RAM System Failure [xx.zzzz]

Nonvolatile Parameters Failure — Defaults Reset [xx.zzzz]

Keyboard Failure or Not Attached [xx.zzzz] (see NOTE 3)

Keyboard Interface Failure [xx.zzzz]

Host Port Failure [xx.zzzz]

Port 0 Failure [yy.zzzz]

Port 1 Failure [yy.zzzz]

Printer Port Failure [xx.zzzz]

Dialog Display System Failure [xx.zzzz]

Graphics Display System Failure [xx.zzzz]

The bracketted part of the message is a code that provides more detailed information; xx is the test number, and zzzz is the actual error code. A list of definitions for these many codes, is located at the end of this appendix under the heading, Error Codes.

NOTE 2

The Processor System Failure test has no unique test number. It may locate system errors during any of the other tests. This message displays the number of the test where the system error occurred. The error code is also borrowed from that test.

NOTE 3

The bell will not ring if this error occurs.

Terminal Bell

If the terminal's bell rings once, Self Test is waiting for input from the keyboard.

The terminal bell rings twice when Self Test encounters a problem. The only exception to this is if the keyboard is not connected.

CAPS LOCK Key Light

When Self Test checks the keyboard, the light on the CAPS LOCK key flashes quickly. If Self Test finds a problem with the keyboard, this light stays on.

Additional Indicators

On the rear panel of the terminal, there is a pop-off cover that protects the Terminal Control board ROMs. With this cover removed, three red LEDs are visible (see Figure C-2).

- The left LED represents the Terminal Control board
- The middle LED represents the RAM3 board
- the right LED represents the Display Control board

When a test is running for circuitry on one of the boards, the corresponding LED flashes. If a problem is found with that circuit board, its LED remains lit. This way, for certain messages printed on the screen, you can further isolate the problem to one of the two main boards. Take the cover off, and observe which LED is lit, to determine which of the three circuit boards failed.

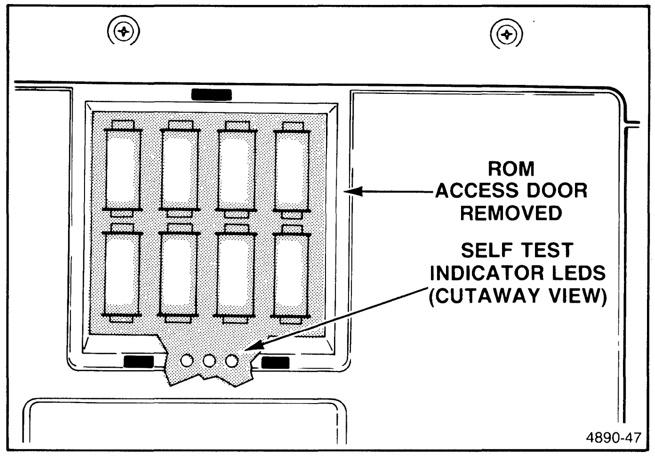


Figure C-2. Indicator LEDs.

RUNNING SELF TEST

STARTING EXTENDED SELF TEST

Perform the following steps when starting Extended Self Test or Adjustment Self Test:

1. Locate the SELF TEST and RESET buttons on the rear of the terminal.
2. Press SELF TEST and hold it in. While holding in SELF TEST, press and release RESET.
3. Hold in the SELF TEST button for another two seconds, then release it.

A graphics crosshair cursor appears on the screen to indicate that Extended Self Test is running. The crosshairs blink alternately between black and white.

After about 30 seconds, the crosshairs disappear, a menu appears on the screen (see Figure C-3), and the bell rings once (one bell is a prompt for user input). The last line in the menu says *Selection:*. This is the Self Test prompt, which means that whenever this word is displayed on the screen, Self Test is waiting for your input before it will continue. The prompt always refers to selections listed in the last menu displayed.

When this menu appears, you have four choices:

- You can press F5 (which cycles Extended Self Test continuously until you stop it)
- You can press the F6 key (which displays the Adjustment Self Test menu and puts the terminal in Adjustment mode)
- You can press F7 to continue Extended Self Test
- Or you may exit Extended Self Test by pressing F8.

If you do nothing at all, the terminal waits for 20 seconds. After this amount of time, if it has received no keyboard input, it goes ahead and continues with Extended Self Test.

```
F5      Continuous Self Test
F6      Adjustment Procedures Menu
F7      Continue Self Test
F8      Exit Self Test

Selection:
```

Figure C-3. Extended Self Test Menu.

CONTINUING EXTENDED SELF TEST

When Extended Self Test continues, the crosshair cursor is placed back on the screen. It continues to blink between white and black as long as everything is proceeding normally. When Extended Self Test has finished testing (after about four minutes), the bell rings once, the menu shown later in Figure C-6 is placed on the screen, and Extended Self Test halts.

You must select an item from this menu. The test does not "time out" and continue if nothing is done. Pressing F7 takes you out of the current adjustment test and returns you to Extended Self Test. Pressing F8 takes you out of Self Test. Pressing any of the other keys in the menu enters Adjustment Self Test and performs the tests or displays the menus indicated.

NOTE

The F7 key actually moves you up to the next higher level of Self Test, which depends on where you are in the Self Test program.

ABOUT CYCLE MODE

Self Test's "cycle mode" is like Continuous Self Test, except that it can run without the keyboard attached and it will continue after a power interruption. Cycle mode is used only during manufacturing testing.

As the adjustment menu indicates, pressing S1 (shifted F1) sets the nonvolatile parameters to cycle mode. This means that S1 only sets a bit so that any reset or power-up will cause the terminal to go into Factory Cycle Mode. Upon pressing the Reset button, Self Test enters that mode and the screen then displays a message about using cycle mode. The message tells you how to exit that mode, because turning the power off and on will not do it. See Figure C-4.

CAUTION

Remember that Cycle Mode resets the terminal's non-volatile parameters to their factory settings.

```
Factory Cycle Mode Enabled
This test will run with or without a keyboard attached
to the terminal and will not display any related
failures pertaining to that condition!

***  To exit Factory Cycle Mode  ***
1. Press Reset and Self Test Buttons
2. Release Reset Button
3. Release Self test Button
4. Wait for Main Self Test Menu
5. Press Function Key F8
Selection:
```

Figure C-4. Cycle Mode Message.

CONTROL FLOW OF SELF TEST

Table C-1 shows the order in which the various hardware modules are tested. During Power Up Self Test, only the tests marked PUP are performed. During Extended Self Test, all of the tests are performed. Figure C-5 is a set of flow charts for Self Test; these are located on foldouts at the end of this section.

Table C-1

POWER UP/EXTENDED SELF TEST SEQUENCE

Test Name	When Executed[a]	Board Tested
ROM checksum and position	PUP/EST	TCB
TCB Short RAM memory	PUP/EST	TCB
TCB Long RAM memory	EST	TCB
Keyboard	PUP/EST	KBD & TCB
Host port (internal loopback)	PUP/EST	TCB
Host port interrupt check	PUP/EST	TCB
RS-232 peripheral port check	PUP/EST	TCB
RS-232 peripheral ports interrupt check	PUP/EST	TCB
Printer/copier port check	PUP/EST	TCB
Printer/copier port interrupt check	PUP/EST	TCB
RAM3 Short memory test	PUP/EST	RAM3
RAM3 Long memory test	EST	RAM3
Display I/O handshake	PUP/EST	DCB/TCB
Display Read/Write ports	PUP/EST	DCB/TCB
CRT Controller timing	PUP/EST	DCB
Color map	PUP/EST	DCB
Graphics Control	PUP/EST	DCB
Graphics memory (short test)	PUP/EST	DCB
Graphics memory (long test)	EST	DCB/RAM3
Dialog memory (short test)	PUP/EST	DCB
Dialog memory (long test)	EST	DCB/RAM3
Character ROM	PUP/EST	DCB
Video paths	PUP/EST	DCB
Dialog attributes	PUP/EST	DCB
RAM4 pages memory test (short)	PUP/EST	RAM4
RAM4 pages memory test (long)	EST	RAM4
Display interrupt check	PUP/EST	DCB
CX Interface test	PUP/EST	CX I/F

[a] **EST means the test is performed during Extended Self Test. PUP means the test is performed during Power Up Self Test.**

Once a test has passed, the components tested can be ruled out as being good. So, as an example, if Extended Self Test failed during the Color Map test, all components associated with the tests before the color map are good. The problem is likely in the Color Map circuitry itself, but it could also be caused by one of the areas not yet tested.

TEST DESCRIPTIONS

Following are descriptions of all the tests listed in Table C-1 (the interrupt checks are described under one title). The test descriptions tell what area of the terminal each test checks and what each test does.

ROM Checksum and Position

This test performs a checksum on all ROMs in the terminal. A position test is also performed to make sure that the ROMs are plugged in the correct sockets and are residing at the right address space.

RAM Memory Test

This test is done on all system RAM. The various tests that are done are:

- A walking ones check. All system RAM is set to zero. A one bit is then "walked through" the field of zeros for all memory space. If a bit is not able to be raised to a logical one, an error results.
- A walking zeros check. Similar to the walking ones check. All system RAM space is set to one. A zero bit is then walked through memory space. If a bit is not able to be set to zero, an error results.
- A March II check. Data is written into a memory location and then immediately read back. If the data is correct, the test moves to the next memory location.
- Refresh Test. A bit pattern is written in RAM. Self Test then waits 15 seconds and checks the RAM to make sure the bit pattern is still there. Because of the time required for the refresh memory test, it is only done during Extended Self Test.

Keyboard Test

This test verifies that all hardware within the keyboard is functional. During this test, the terminal holds the keyboard inactive (this allows testing to be done while preventing input to the terminal). A loopback test of the keyboard interface on the Terminal Control board is then performed (keyboard output is looped back to become keyboard input). At the same time, the keyboard microprocessor performs its own test. At the end of this test, the keyboard sends a status byte to the terminal. If the keyboard passes the test, this status byte is F0 (hex). If the keyboard does not pass; either no status byte, or a value of FF (hex) is returned.

During the keyboard test, the light on the CAPS LOCK key flashes briefly. If a problem occurs, this light stays on.

To test the keyboard keys and their mechanical connections, use the keyboard key switch test, available in Adjustment Self Test.

Host Port Test

This test checks the RS-232 host interface by placing the Dual Universal Asynchronous Receiver-Transmitter (DUART) chip in internal loopback mode. Characters are then transmitted and received internally without affecting the external lines going to the host computer or modem.

A more thorough test of the RS-232 port may be performed using Adjustment Self Test. This requires use of the RS-232 loopback connector and checks the connections to the host connector itself.

2-Port Peripheral Interface Test

This test checks the other half of the DUART. The test is the same as the Host Port Test, but checks the 2PPI input and output paths and the related part of the DUART.

Copier Port Test

The Programmable Peripherial Interface (PPI) chip is checked by reading and writing to registers in the chip. However, no data is output to the copier port to be read back.

A more thorough test of the copier port may be performed using Adjustment Self Test. This requires use of the copier port loopback connector and checks connectors to the copier port connector itself.

Interrupt Tests

The interrupt inputs and masks are tested by generating interrupts and then checking that the interrupts are recognized and serviced correctly. This is accomplished in the following manner:

1. Interrupts are generated and serviced from the sources HOSTDAV, MISCCOMINT, PRINTERINT, and DISPINT (see the schematics, Section 11, for the location of these signals).
2. The interrupts are again generated from the same sources, this time with the masks on. Self Test checks to make sure that the processor is not interrupted.
3. HOSTDAV and MISCCOMINT are again generated to make sure that the interrupts are nested properly.

Display I/O Handshake Test

This test makes sure that the processor can communicate with the Display Control board (DCB) and that the board responds with the appropriate acknowledge. Both, the dialog and graphics, handshake circuitries are verified.

Display Read/Write Ports Test

This test exercises the read/write ports to make sure that no lines are stuck to a logic high or low.

Graphics Control

This test verifies operation of the programmable array logic chips that control the graphics display section of the DCB.

Dialog Controller Timing Test

This test verifies the horizontal and vertical sync timing of the DCB's 9007 CRT Controller, within the limits of the microprocessor.

Dialog Memory Test

This test checks the RAM memory for the dialog area. The same four tests are performed on this RAM as is performed on the system RAM. For more information, see the description of the RAM memory tests.

Graphics Memory Test

This test checks the the RAM memory for the graphics area. The same four tests are performed on this RAM as is performed on the system RAM. There is one difference, however, in that unused data bits are masked off. For more information, see the description of the RAM memory tests.

Character ROM test

The character ROM is checked by forcing the ROM to output each character. The character dot information is then captured from the processor and compared to character data in system firmware. If these do not match, an error is generated.

Color Map Test

The Color Map RAM is checked using a "walking 0" and a "walking 1" test. For information on these tests, see the descriptions under RAM memory tests.

Dialog Attributes test

The dialog attributes are tested by setting and clearing attribute bits in the dialog RAM. Whether the appropriate attributes were tested, is determined by reading attribute status from the processor.

Video Paths Test

Using special Self Test modes, the video data is selected from an alpha foreground, alpha background, alpha cursor, graphics, graphics cursor, and blanking. By programming the appropriate data on a scan line from the selected source, the video data path can be verified by reading the color map address. Each data bit, from each video source, is set high and low. The color map address is then checked to make certain the data path is functioning correctly.

RAM4 (Paged Memory) Tests

The RAM4 memory board is tested by a set of Paged Memory tests. There are two versions of the RAM4 tests (a long and short version); the long version runs only during Extended Self Test.

The RAM4 board, if installed, is tested by a set of patterns which are described later in this appendix (under the Error Codes list). Also, the Paging Register is tested to verify that each 64K page of memory is individually addressable, and that one page can be read while another is being written.

At power up or reset, an address in the Color Map is read to see if a RAM4 board is installed. If bit 13 is cleared, neither a RAM3 or RAM4 board is present. If that bit is set, the processor then writes 0080 to the RAM4 page register. Then, it reads the register again. If that bit is cleared, a RAM4 board is installed; if the bit is still set, this means that a RAM3 board is present.

The first Paged Memory subtest checks to see if any bits are stuck at 0 or 1. (This test is used instead of the familiar "walking ones", "walking zeros", "ones", and "zeros" tests.) The test writes five patterns (0FF00, 0F0F0, OCCCC, 0AAAA, and 0007 hex) used with complement addressing. The entire megabyte of memory is written with each pattern and then checked. This test is not included in the Power Up test.

The next subtest is the Paged RAM March Test. This test uses a March II test pattern to check for addressing problems or cell disturbance problems on the RAM4.

The third subtest verifies that each page of RAM4 memory can be written individually. (To keep the test from running too slowly, only every 509th location is checked.)

The final subtest is the split read/write check. It checks to see that data can be written to one page of RAM while data is read from another. (Again, only every 509th location is checked.)

CX Interface Test

This test checks to see if the CX Interface board is installed (is the terminal a CX?). The processor then checks the main status bit (bit 4) coming from the CX board. If bit 4 is high, the CX Interface board's internal self test is reporting an error.

ADJUSTMENT SELF TEST

Adjustment Self Test is used to perform adjustment procedures on the Display Module or to perform validation checks on the terminal's interfacing ports.

Adjustment Self Test is entered after starting Extended Self Test. The Adjustment Self Test menu may be displayed by pressing the F6 key, when the first menu appears (see Figure C-3), or by waiting until Extended Self Test is finished. The Adjustment Procedures Menu is shown in Figure C-6.

A test or pattern may be selected by pressing the key associated with that test or pattern. The remainder of this appendix describes these menu items.

F1: RESET NONVOLATILE PARAMETERS

CAUTION

Pressing the F1 key, changes any communication parameters that are not set to the default value. Unless this is desired, do NOT press this key.

Pressing the F1 key causes all nonvolatile parameters to be set to the default value. This may take up to a minute, depending on how many parameters must be reset. When the parameters have been reset, the following message appears on the screen:

Nonvolatile Parameters Reset
Selection:

Once this message has appeared, you may select any of the other items from the Adjustment Procedures Menu.

F2: KEYBOARD SWITCH TEST

After pressing the F2 key, a message appears telling you what type of keyboard is installed (North American, French, etc.), and prompts you to press a key:

North American Keyboard
Press keyboard keys. Press F7 twice to exit.

As each key is pressed, its unshifted nomenclature is displayed. For instance, if the A, S, D, F, F1, TAB, and ESC keys are pressed, this appears on the screen:

A S D F F1 TAB ESC

While the key is pressed, the key identifier (nomenclature) displayed on the screen blinks. When the key is released, the nomenclature stops blinking. This test is useful for verifying that all keys make contact and display the proper code.

F7 must be pressed twice to exit this test. The first time F7 is pressed, **F7** is displayed.

```
Adjustment Procedures Menu

Dialog Coax Interface Menu
F1     Reset Nonvolatile Parameters
F2     Keyboard Switch Test
F3     RS-232 Interface Menu
F4     Hard Copy Menu
F5     Display Pattern Menu
F6     Graphics Tablet Test

S1     Set Nonvolatile Parameters to Factory Cycle Mode
F7     Continue Self Test
F8     Exit Self Test

Selection:
```

Figure C-6. Adjustment Procedures Menu.

F3: RS-232 INTERFACE MENU

Pressing the F3 key causes the RS-232 ports menu to be displayed. This menu is shown in Figure C-7.

NOTE

These tests require that the RS-232 loopback connector be used. This connector is an optional accessory to the terminal and may be ordered if one is not available. There is no way to perform this test without this loopback connector.

You may select any item from this menu. Each test is similar, but checks a different data path (from connector to DUART and back).

F1 — Host Port Test

Pressing the F1 key causes the following message to be displayed:

Install RS-232 Loopback. Press Space Bar.

If a cable is connected to the host port, disconnect this cable and connect the RS-232 loopback connector to the host port. Once the connector is in place, press the Space Bar. This causes the terminal to do three checks:

- Hex characters 00, 55, AA, and FF are transmitted at the highest baud rate and then looped back to be received. This test checks to make sure that transmitted characters match the received characters. Status bit timing is also checked.
- The timing of user-selectable baud rates is checked.
- RS-232 status and control lines (RTS and CTS for example) are checked for proper flagging.

After these checks are completed (about 2 seconds) the following message is printed on the screen:

RS-232 Interface Test Completed.
Selection:

If an error occurs during the test, the bell rings twice, and this message appears:

Self Test Error - Host Port Failure
RS-232 Interface Test Completed
Selection:

F2 and F3 — Peripheral Port Tests

Pressing the F2 or F3 key causes the following message to be displayed:

Connect Host Port cable to Port x. Press Space Bar.

(x is port 0 or 1)

If a cable is connected to the peripheral port (to be checked), unplug it. Connect one end of the host RS-232 cable to the host port. Then connect the other end of that cable to the peripheral port to be checked (port 0 for F2, port 1 for F3). The terminal sends/receives data from the host connector to the respective peripheral port. This verifies the operation of the internal send and receive paths.

After these checks are successfully completed (about 2 seconds), the following message appears:

Peripheral Port Test Completed
Selection:

If a fault occurs during the test, the bell rings twice, and the following message appears:

Self Test Error - Port × Failure
Peripheral Port Test Completed.
Selection:

```
RS-232 Interface Menu
F1    Host Port Test
F2    Port 0 Test
F3    Port 1 Test

F7    Exit Current Menu
F8    Exit Self Test

Selection:
```

Figure C-7. RS-232 Interfaces Menu.

F4: HARD COPY MENU

Pressing the F4 key causes the hard copy menu to be displayed. For pre A-series terminals, the menu will appear as in Figure C-8. For A-series terminals, the menu looks like Figure C-9. You may now select one of the items from this menu.

Pressing the F7 key returns to the Adjustment Procedures Menu. Pressing the F8 key exits Self Test.

```
Hard Copy Menu
F1   Loopback Test
F2   Color Copier Pattern

F7   Exit Current Menu
F8   Exit Self Test

Selection:
```

Figure C-8. Hard Copy Menu (Pre A-series Only).

```
Hard Copy Menu
F1   Loopback Test
F2   4695 Copier Pattern
F3   4691/4692 Copier Pattern

F7   Exit Current Menu
F8   Exit Self Test
```

Figure C-9. Hard Copy Menu (A-series Only).

F1 — Copier Port Loopback Test

NOTE

Selecting the Loopback test from the Hard Copy menu requires that the hard copy loopback connector be used. This connector is an optional accessory to the terminal and may be ordered if one is not available. The loopback test can not be performed without the loopback connector.

The hard copy loopback test is similar to the RS-232 loopback test just described. After selecting the hard copy loopback test, the following message appears:

Install Copier Port Loopback. Press Space Bar.

After space is typed, the test will run and then return to the hard copy menu when finished. The following message is displayed when the test has finished with no errors detected:

Copier Loopback Test Completed
Selection:

If an error is detected by this test, the bell rings twice, and the following message is displayed on the screen[1]:

Self Test Error - Printer Port Failure
Copier Loopback Test Completed.
Selection:

[1] **If you have not attached the loopback connector to the COPIER port, error message [A1.0001]** will also be displayed.

F2 — Color Copier Pattern (Pre A-series only)

This test outputs a color pattern to a color copier connected to the copier port; this checks the interface connection between the terminal and the copier/printer. This pattern may be used to verify that the pattern displayed on the screen is accurately reproduced by the copier.

From the Hard Copy Menu, press F2. This displays the following message:

Connect Copier. Check that the copier READY light is on.
Press Space Bar.

If the copier is not connected or not functioning, when the Space Bar is pressed, the following message is displayed on the screen (and it exits back to the hard copy menu):

*** **Copier not ready** ***

If the copier is functioning, the pattern shows up, and this message appears on the screen:

This pattern should be on the Copier and display:

The pattern consists of eight adjacent vertical bars (each is 10 character-cells wide). The bars are painted these colors: black, blue, red, magenta, green, cyan, yellow, and white. The test then prints the following message, and exits back to the Hard Copy Menu.

Test Completed.
Selection:

F2 — 4695 Color Copier Pattern (A-series only)

This test outputs a color pattern to a 4695 color copier connected to the COPIER port; this checks the interface connection between the terminal and the copier/printer. You can use this test to verify that the copier is accurately reproducing the screen display.

From the Hard Copy Menu, press F2. This displays the following message:

Connect Copier. Check that the copier READY light is on.
Press Space Bar.

If the copier is not connected or not functioning when you press the Space Bar, the following message is displayed on the screen (and it exits back to the Hard Copy Menu):

*** **Copier not ready** ***
Selection:

If the copier is functioning, the pattern shows up, and this message appears on the screen:

This pattern should be on the Copier and display:

The pattern consists of eight adjacent vertical bars (each is 10 character-cells wide). The bars are painted these colors: black, blue, red, magenta, green, cyan, yellow, and white. The test then prints the following message, and exits back to the Hard Copy Menu.

Test Completed.
Selection:

F3 — 4691/4692 Color Copier Pattern (A-series only)

This test outputs a color pattern to a 4691 or 4692 color copier connected to the COPIER port; this checks the interface connection between the terminal and the copier/printer. This pattern may be used to verify that the pattern is reproduced by the copier.

From the Hard Copy Menu, press F2. This displays the following message:

Connect Copier. Check that the copier is ready.
Press Space Bar.

If the copier is not connected or not functioning, when the Spece Bar is pressed, the following message is displayed on the screen (and it exits back to the Hard Copy Menu):

*** **Copier not ready** ***
Selection:

If the copier is functioning, the pattern shows up, and this message appears on the screen:

This pattern should be on the Copier and display:

The pattern consists of eight adjacent vertical bars (each is 10 character-cells wide). The bars are painted these colors: black, blue, red, magenta, cyan, yellow, and white. The test then prints the following message, and exits back to the Hard Copy Menu.

Test Completed.
Selection:

F5: DISPLAY PATTERN MENU

Pressing the F5 key causes the Display Pattern Menu to be displayed. This menu is shown in Figure C-10.

These display patterns are used primarily for adjustment of the terminal, before being shipped from the factory. Some of these patterns, however, may be useful for on-site adjustment of the terminal. To find out which patterns are used, consult the adjustment section (5) in this manual.

The crosshairs test displays the cross hair cursor. The cursor begins in the upper left corner of the screen and moves to the lower right corner. The cursor may be stopped by pressing a keyboard key. If no key is pressed, the process is repeated.

On any of the patterns, the red, green, and blue components of the display may be controlled. Each color may be turned on or off, or may be increased in intensity by pressing the designated key. There are four levels of intensity for each color component; after selecting the highest level, the color goes back to the lowest level on the next select. When a new display pattern is selected, or the Display Menu Pattern is exited, the color map is reset to the default values.

The Set Color key toggles between a visible and invisible menu.

```
Display Pattern Menu
F1     Grid Pattern
F2     Gray Scale Pattern
F3     White Screen Pattern
F4     Color Pattern
F5     H Pattern
F6     Crosshairs Test

F7     Exit Current Menu
F8     Exit Self Test
Sh F1  Video Amp Zero Level
Sh F2  Video Amp Maximum Level
SH F3  Dot Pattern

Dialog      Toggle red video on and off
Setup       Toggle green video on and off
S Copy      Toggle blue video on and off
Sh Dialog   Increment red intensity
Sh Setup    Increment green intensity
Sh S Copy   Increment blue intensity
Menu        Turn the menu on and off

Selection:
```

Figure C-10. Display Pattern Menu.

F6: GRAPHICS TABLET TEST

After selecting the graphics tablet test, this message appears on the screen:

Connect Table to Port 1. Press Space Bar.

Upon pressing the space bar, the test begins, and the screen displays one or the other of these messages (depending on whether the tablet pen is in presence or not):

Tablet Self Test Passed - Cursor on Tablet [4F].
Selection:

Or

Tablet Self Test Passed - Cursor off Tablet [47].
Selection:

If the tablet test fails, the following message is displayed:

Tablet Self Test Failed.
Selection:

Furthermore, if the tablet does not respond to the query from Self Test, the following message is displayed:

No Response from Tablet.
Selection:

As indicated, all of these messages are followed by the prompt message (which lets you return to the Adjustment Menu):

Selection:

DIALOG: CX INTERFACE TEST

After pressing the Dialog key, the CX Power-Up test runs. If no error is detected, the following message is printed on the screen.

Coax <nationality> Keyboard
Coax Interface Test Completed
Selection:

If a non-coax style keyboard is installed, the following message is displayed:

<nationality> Keyboard
Non-Coax Keyboard installed
Coax Interface Test Completed
Selection:

If an error occurs during the test, the bell rings twice, and this message appears:

Self Test — Coax Interface Failure
[xx.zzzz]
Coax Interface Test Completed
Selection:

where xx.zzzz is an error code.

ERROR CODES

Each error message displayed by the main part of Self Test (not Adjustment Self Test) contains a text message followed by a numeric error code, such as:

Display System Failure [20.000F]

This part of the Self Test appendix lists these error codes and explains how to read them.

The English part of the message is self-explanatory, such as "Display System Failure." This means that a failure occurred on the Display Control board (not the Display Module). The error code is more involved and requires some study in the following error code tables to determine the meaning. The first part of the code (the two digit in front of the decimal) stand for the test name where the fault occurred. In the case above, "20" stands for the test named "Graphics Memory Bank Select test;" see Error Codes List.

The second part of the code is a four-bit Hex code. Each test has its own unique error codes, so you need to first look up the test description and then read the error code description under that test name. There are two basic types of error codes:

- One is a simple Hex number that stands for an area of memory that failed, etc.
- The other type of code is also a Hex number; but you must convert it to a binary number and look up the active binary bits, to see what the error code stands for.

The following explanation tells you how to convert these Hex numbers into code definitions.

INTERPRETING HEX ERROR CODES

Many of the error codes listed in this appendix are listed as Bit 0 thru Bit 9 set. However, the displayed error code is a Hex number. Use the following steps to convert these Hex codes to meaningful information.

1. First, read the last four digits of the code as a four-digit Hex number.
2. Then, look up the Hex number in Table C-2. Convert each Hex digit into a corresponding binary number.
3. Write down each binary group in order.
4. Write the numbers 0 through 9 (bit numbers) over these binary digits.
5. See which of the ten bits are active, and look for the corresponding bit-descriptions under the test name.

EXAMPLE 1 —

The following error message is reported:

"Dialog Display System Failure [2A.00FF]"

The 2A represents the "Dialog foreground index test." The error code is "00FF". We look up each Hex number in Table C-2, and record the binary groups as follows:

0	0	F	F
0000	0000	1111	1111

Now number these bits right to left:

10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	1	1	1	1	1	1

This means that bits 0 through 7 are all active. Looking under the description of the 2A test, we find bits 0 through 7 indicate which background indices (0 to 7) have failed. In this case all eight background indices failed, which seems to indicate a problem common to the entire dialog background display. You would look for a part of the circuitry that affects all of the dialog background.

Table C-2

HEX-TO-BINARY CONVERSION

Hex	Binary	Hex	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

EXAMPLE 2 —

Let's try another error code, just to be sure we have the picture. Suppose this error message appears:

"Display Timing Fault [1D.001A]"

Apparently there is some type of timing problem on the Display Control board. The "1D" test is called "CRT Controller Timing test". Now we know that the problem is related to the 9007 CRT controller chip.

Looking up the 001A Hex code in Table C-2, we find the following bit pattern:

0	0	1	A
0000	0000	0001	1010

Setting these binary groups against the bit numbers yields:

10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	1	0	1	0

This means that bits 1, 3, and 4 are active (high).

Under the error code explanation for test 1A, we find these errors correspond to the bits listed in the error message.

Bit 0 — (ignore)

Bit 1 — VS bit was never set low.

Bit 2 — (ignore)

Bit 3 — On the first visible line, one or more of the following status bits was set incorrectly: VS should be high, HS should be high, VLT should be low, and DRB should be high.

Bit 4 — On the second visible line, DRB was not low.

Bit 5 — (ignore)

etc.

This points to problems with VLT and DRB signals in the CRT Controller chip.

SELF TEST ERROR CODES LIST

The following error codes may appear while the main part of Self Test is running. (The second group of codes in this section only appear during the Adjustments part of Self Test.) Each test is listed here (by name and test number), and the error code(s) for that test are explained in brief terms.

Test 1 — RAM Memory Walking Ones

Error code indicates a bad memory block. Error code (nnnn) indicates the location (between 0 and 7FFF) of a 32K block of faulty memory.

Test 2 — RAM Memory Walking Zeroes

This code (nnnn) indicates the location of a bad 32K memory block, between 0 and 7FFF.

Test 3 — RAM Memory March

This code (nnnn) indicates the location of a memory problem, between 0 and 7FFF.

Test 4 — RAM Memory Ones

Error code points to location of memory fault (as in Tests 1 thru 5).

Test 5 — RAM Memory Zeros

Error code points to location of memory fault (as in Tests 1 thru 4).

Test 8 — Nonvolatile parameters test and load

Bit 0 = EEROM Ready line did not go true.

Bit 1 = EEROM checksum bad.

Bit 2 = EEROM system version number incorrect.

Bit 3 = EEROM byte cannot be written correctly.

Test 9 — DUART Timer Test

Bit 0 = Timer finished counting too quickly.

Bit 1 = Timer did not finish counting in the time allowed.

Test A — Keyboard interface loopback test

Bit 0 = TxRDYA not set after transmitting the first character.

Bit 1 = TxRDYA was set after the second character was sent.

Bit 2 = TxEMTA, RxRDYA, and/or FFULLA were set after the first character finished transmission.

Bit 3 = RxRDYA not set, or FFULLA set, after first character finished transmission.

Bit 4 = TxRDYA, RxRDYA, and/or FFULLA not set after waiting for the third character.

Bit 5 = TxEMTA not set after fourth character finishes transmission.

Bit 6 = First character received is not 00 (H).

Bit 7 = Second character received is not 0FF (H).

Bit 8 = Third character received is not 5 (H).

Bit 9 = Fourth character received was not 0AA (H).

Test B — Keyboard Self Test results

Bit 0 = Data was received from the keyboard before the data clamp was released.

Bit 1 = No status code was received from the keyboard.

Bit 2 = Keyboard Self Test failed.

Test D — Host Port Transmit/Receive Test (internal loopback)

Bit 0 = TxRDYB not set after transmitting first character.

Bit 1 = TxRDYB was set after the second character was sent.

Bit 2 = TxEMTB, RxRDYB, and/or FFULLB was set after the first character finished transmission.

Bit 3 = RxRDYB not set or FFULLB set after first character finished transmission.

Bit 4 = TxRDYB, RxRDYB, and/or FFULLB not set after waiting for the third character.

Bit 5 = TxEMTB was not set after the fourth character finished transmission.

Bit 6 = The first character received was not 00 (H).

Bit 7 = The second character received was not 0FF (H).

Bit 8 = The third character received was not 55 (H).

Bit 9 = The fourth character received was not 0AA (H).

Test E — Test of Host Port baud rates (internal loopback).

If bit is set, its baud rate failed the test.

Bit 0 = 19.2 Kbaud

Bit 1 = 9600 Baud

Bit 2 = 4800 Baud

Bit 3 = 2400 Baud

Bit 4 = 1800 Baud

Bit 5 = 1200 Baud

Bit 6 = 600 Baud

Bit 7 = 300 Baud

Bit 8 = 150 Baud

Bit 9 = 110 Baud

Test F — Host port HOSTDAV interrupt test

Bit 0 = HOSTDAV did not generate an NMI interrupt.

Bit 1 = NMI interrupt was detected while it was disabled.

Test 10 — Host port MISCCOMINT interrupt test

Bit 0 = MISCCOMINT did not generate an interrupt.

Bit 1 = MISCCOMINT was detected while masked off at the processor.

Test 11 — PPI DUART timer test

Bit 0 = Timer finished counting too quickly.

Bit 1 = Timer did not finish counting in the time allowed.

Test 12 — Port 0 transmit/receive test (internal loopback)

Error Bit definitions are same as for Test D, except that this test references TxRDYA/RxRDYA instead of TxRDYB/RxRDYB.

Test 13 — Port 1 transmit/receive test (internal loopback)

Error Bit definitions are same as for Tests D and 12. This test references TxRDYB and RxRDYB.

Test 14 — PPI Interrupt test

Bit 0 = PPI interrupt did not generate an interrupt.

Bit 1 = PPI interrupt was detected while masked of by the processor.

Test 15 — Hard Copy port internal data test

Bit 0 = The data written to hard copy output port was not same as the corresponding data when read back over this port.

Test 16 — Hard Copy port PRINTERINT interrupt test

Bit 0 = PRINTERINT did not generate an interrupt.

Bit 1 = PRINTERINT was detected while masked off by the processor.

Test 17 — RAM Memory walking ones check

Error codes indicate bad memory location as follows:

2000 = 32K memory block from 20,000 (H) to 27,FFF (H).

2800 = 32K memory block from 28,000 (H) to 2F,FFF (H).

3000 = 32K memory block from 30,000 (H) to 37,FFF (H).

3800 = 32K memory block from 38,000 (H) to 3F,FFF (H).

C000 = 32K memory block from C0,000 (H) to C7,FFF (H).

C800 = 32K memory block from C8,000 (H) to CF,FFF (H).

D000 = 32K memory block from D0,000 (H) to D7,FFF (H).

D800 = 32K memory block from D8,000 (H) to DF,FFF (H).

Test 18 — RAM Memory Walking Zeroes check

Same error codes as for Test 17

Test 19 — RAM Memory March

Same error codes as for Test 17.

Test 1A — RAM Memory Ones check

Same error codes as for Test 17.

Test 1B — RAM Memory Zeroes test

Same error codes as for Test 17.

Test 1C — Display I/O Handshake test

Bit 0 = DISPRDY line stayed in not-ready condition after writing the Graphics Control Register.

Bit 1 = DISPRDY line stayed in not-ready condition after reading the Graphics Control Register.

Test 1D — CRT Controller Timing test

Bit 0 = VS bit (Vertical Sync) was never set high.

Bit 1 = VS bit was never set low.

Bit 2 = Vertical sync ended too soon.

Bit 3 = On the first visible line, one or more of the following status bits was set incorrectly: VS should be high, HS should be high, VLT should be low, and DRB should be high.

Bit 4 = On the second visible line, DRB was not low.

Test 1E — Display Read/Write Registers test

Bit 0 = Graphics Control Register failed.

Bit 1 = Alpha Control Register failed.

Bit 2 = 9007 Vertical Cursor Register failed.

Bit 3 = 9007 Horizontal Cursor Register failed.

Test 1F — Color Map RAM test

The error code indicates the color map bad address offset. The bad address is reported as the four digit code <nnnn> in this message:

1F00:<nnnn>

Test 20 — Graphics Memory Bank Select test

Bit 0 = Writing data to graphics memory Bank 1 caused the data in memory Bank 0 to be modified instead.

Bit 1 = Incorrect data was written to graphics memory Bank 1.

Bit 2 = Writing both pages did not write the correct data to Bank 0.

Bit 3 = Writing both pages did not write the correct data to Bank 1.

Test 21 - Graphics Memory test

The error code represents the 64K segment of graphics memory that failed, as follows:

4000 = failure in memory between locations 40,000 and 4F,FFF.

5000 = memory problem between 50,000 and 5F,FFF.

6000 = memory problem between 60,000 and 6F,FFF.

7000 = memory problem between 70,000 and 7F,FFF.

Test 22 — Graphics 16-byte Write test

Bit 0 = Writing even words to 16 locations failed to write 16 bytes at a time.

Test 23 — Graphics Plane Write Enable test

Bit 0 = Plane 0 write-disabling failed.

Bit 1 = Plane 1 write-disabling failed.

Bit 2 = Plane 2 write-disabling failed.

Bit 3 = Plane 3 write-disabling failed.

Test 24 — Graphics ALU Modes test

Bit 0 = ALU Replace-mode failed.

Bit 1 = ALU XOR-mode failed.

Bit 2 = ALU OR-mode failed.

Bit 3 = ALU AND-mode failed.

Test 25 — Graphics Data Shift test

Bit 0 = Failed to shift ALU data 0 space left (no shift).

Bit 1 = Failed to shift ALU data 1 space to left.

Bit 2 = Failed to shift ALU data 2 spaces to left.

Bit 3 = Failed to shift ALU data 3 spaces to left.

Bit 4 = Failed to shift ALU data 0 space to right (no shift).

Bit 5 = Failed to shift ALU data 1 space to right.

Bit 6 = Failed to shift ALU data 2 spaces to right.

Bit 7 = Failed to shift ALU data 3 spaces to right.

Test 26 — Dialog Handshake test

Bit 0 = DISPRDY line stayed in not-ready condition after writing the Dialog Memory base address.

Bit 1 = DISPRDY line stayed in not-ready condition after reading the Dialog Memory base address.

Test 27 — Dialog Memory test

Error code represents the 8K segment of dialog memory that failed, as follows:

1800 = Memory failure located between 18000 and 19FFF.

Test 28 — Dialog Character ROM test

The error code represents the address of the first byte in the ROM that had an error.

Test 29 — Graphics Index (0 thru 15) test

Bit 0 = Graphics Index 0 failed.

Bit 1 = Graphics Index 1 failed.

Bit 2 = Graphics Index 2 failed.

etc., through

Bit 15 = Graphics Index 15 failed.

Test 2A — Dialog Foreground Index test

Bit 0 = Dialog foreground index 0 failed.

Bit 1 = Dialog foreground index 1 failed.

Bit 2 = Dialog foreground index 2 failed.

etc., through

Bit 7 = Dialog foreground index 7 failed.

Test 2B — Dialog Background Index test

Bit 0 = Dialog background index 0 failed.

Bit 1 = Dialog background index 1 failed.

etc., through

Bit 7 = Dialog background index 7 failed.

Test 2C — Dialog Cursor Index test

Bit 0 = Dialog cursor foreground index failed.

Bit 1 = Dialog cursor background index failed.

Test 2D — Graphics Cursor Index test

Bit 0 = Graphics cursor foreground index failed.

Bit 1 = Graphics cursor background index failed.

Test 2E — Retrace Blanking Index test

Bit 0 = Blanking index failed.

Test 2F — Dialog Windowshade test

Bit 0 = Top windowshade control failed.

Bit 1 = Bottom windowshade control failed.

Test 30 — Dialog Transparent Control test

Bit 0 = Dialog index 0 was not transparent with transparency enabled.

Bit 1 = Dialog index 1 was transparent.

Bit 2 = Dialog index 2 was transparent.

Bit 3 = Dialog index 4 was transparent.

Bit 4 = Dialog index 0 was transparent with transparency DISabled.

Test 31 — Dialog Blink Attribute test

Bit 0 = With solid-block character, and character blink clock low, the dialog foreground index was not enabled.

Bit 1 = With solid-block character, and character blink clock high, the dialog background index was not enabled.

Test 32 — Dialog Underline Attribute test

Bit 0 = The underline row (14th row in character cell) was enabled in a line of space-characters, with the underline attribute disabled.

Bit 1 = The underline row was not enabled in a line of space-characters, with the underline attribute enabled.

Test 33 — Display DISPINT test

Bit 0 = Enabling a vertical sync interrupt did not create a processor interrupt.

Bit 1 = A processor interrupt occurred after disabling the vertical sync interrupt.

Test 34 — Read CX Status

Bit 4 = Error detected

Bit 0 to Bit 3 = Address of detected error.

Test 35 — Paged RAM Memory, Stuck at 0 or 1

Error codes indicate bad RAM4 memory as follows:

E000 = 32K memory block from E0000(H) to E7FFF(H) on Page 0.

E800 = 32K memory block from E8000(H) to EFFFF(H) on Page 0.

E001 = 32K memory block from E0000(H) to E7FFF(H) on Page 1.

E801 = 32K memory block from E8000(H) to EFFFF(H) on Page 1.

E002 = 32K memory block from E0000(H) to E7FFF(H) on Page 2.

E802 = 32K memory block from E8000(H) to EFFFF(H) on Page 2.

E003 = 32K memory block from E0000(H) to E7FFF(H) on Page 3.

E803 = 32K memory block from E8000(H) to EFFFF(H) on Page 3.

E004 = 32K memory block from E0000(H) to E7FFF(H) on Page 4.

E804 = 32K memory block from E8000(H) to EFFFF(H) on Page 4.

E005 = 32K memory block from E0000(H) to E7FFF(H) on Page 5.

E805 = 32K memory block from E8000(H) to EFFFF(H) on Page 5.

E006 = 32K memory block from E0000(H) to E7FFF(H) on Page 6.

E806 = 32K memory block from E8000(H) to EFFFF(H) on Page 6.

E007 = 32K memory block from E0000(H) to E7FFF(H) on Page 7.

E807 = 32K memory block from E8000(H) to EFFFF(H) on Page 7.

E008 = 32K memory block from E0000(H) to E7FFF(H) on Page 8.

E808 = 32K memory block from E8000(H) to EFFFF(H) on Page 8.

E009 = 32K memory block from E0000(H) to E7FFF(H) on Page 9.

E809 = 32K memory block from E8000(H) to EFFFF(H) on Page 9.

E00A = 32K memory block from E0000(H) to E7FFF(H) on Page A (10)

E80A = 32K memory block from E8000(H) to EFFFF(H) on Page A (10)

E00B = 32K memory block from E0000(H) to E7FFF(H) on Page B (11)

E80B = 32K memory block from E8000(H) to EFFFF(H) on Page B (11)

E00C = 32K memory block from E0000(H) to E7FFF(H) on Page C (12)

E80C = 32K memory block from E8000(H) to EFFFF(H) on Page C (12)

E00D = 32K memory block from E0000(H) to E7FFF(H) on Page D (13)

E80D = 32K memory block from E8000(H) to EFFFF(H) on Page D (13)

E00E = 32K memory block from E0000(H) to E7FFF(H) on Page E (14)

E80E = 32K memory block from E8000(H) to EFFFF(H) on Page E (14)

E00F = 32K memory block from E0000(H) to E7FFF(H) on Page F (15)

E80F = 32K memory block from E8000(H) to EFFFF(H) on Page F (14)

Test 36 — Paged RAM Memory, March Test

Error codes indicate bad RAM4 memory blocks in the same manner as for Test 35.

See error codes for Test 35. These Test 36 error codes and addresses only go up to RAM4 memory Page B (code E80B).

Test 37 — Paged RAM Memory, Page Unique Test

These error codes show that a page of the RAM4 memory failed the retain its unique data during this test.

Bit 0 = Page 0 data is not unique.

Bit 1 = Page 1 data is not unique.

Bit 2 = Page 2 data is not unique.

Bit 3 = Page 3 data is not unique.

Bit 4 = Page 4 data is not unique.

Bit 5 = Page 5 data is not unique.

Bit 6 = Page 6 data is not unique.

Bit 7 = Page 7 data is not unique.

Bit 8 = Page 8 data is not unique.

Bit 9 = Page 9 data is not unique.

Bit 10 = Page A (10) data is not unique.

Bit 11 = Page B (11) data is not unique.

Bit 12 = Page C (12) data is not unique.

Bit 13 = Page D (13) data is not unique.

Bit 14 = Page E (14) data is not unique.

Bit 15 = Page F (15) data is not unique.

Test 38 — Paged RAM Memory, Split Read/Write Test

This test verifies the integrity of RAM4 memory during a read to one page and a write to another page.

Bit 0 = Page 0 data changed.

Bit 1 = Page 1 data changed.

Bit 2 = Page 2 data changed.

Bit 3 = Page 3 data changed.

Bit 4 = Page 4 data changed.

Bit 5 = Page 5 data changed.

Bit 6 = Page 6 data changed.

Bit 7 = Page 7 data changed.

Bit 8 = Page 8 data changed.

Bit 9 = Page 9 data changed.

Bit 10 = Page A (10) data changed.

Bit 11 = Page B (11) data changed.

Bit 12 = Page C (12) data changed.

Bit 13 = Page D (13) data changed.

Bit 14 = Page E (14) data changed.

Bit 15 = Page F (15) data changed.

ADJUSTMENT PROCEDURE ERROR CODES

The following error codes are only displayed while running the Adjustment part of Self Test. The explanation of these codes follows the same format as used to describe the main codes (preceding discussion). The test name, as printed on the display screen, appears first. Then, the error codes are listed and described for each test.

Host Port Test Error Codes

Test A1 — Host port transmit/receive test (external loopback)

Bit 0 = TxRDYB not set after transmitting first character.

Bit 1 = TxRDYB set after transmitting second character.

Bit 2 = TxEMPTB, RxRDYB, and/or FFULLB was set before the first character was finished transmitting.

Bit 3 = RxRDYB not set, or FFULLB set, after first character finished transmission.

Bit 4 = TxRDYB, RxRDYB, and/or FFULLB not set after waiting for third character.

Bit 5 = TxEMTB not set after fourth character finishes transmission.

Bit 6 = First character received is not 00 (H).

Bit 7 = Second character received is not 0FF (H).

Bit 8 = Third character received is not 55 (H).

Bit 9 = Fourth character received is not 0AA (H).

Test A2 — Host Port Baud Rates test (with external loopback)

The bits tell which tests failed.

Bit 0 = 19.2 Kbaud

Bit 1 = 9600 Baud

Bit 2 = 4800 Baud

Bit 3 = 2400 Baud

Bit 4 = 1800 Baud

Bit 5 = 1200 Baud

Bit 6 = 600 Baud

Bit 7 = 300 Baud

Bit 8 = 150 Baud

Bit 9 = 110 Baud

Test A3 — RTS and CTS test

Bit 0 = CTS not high, or Delta CTS bit not set, after setting RTS high.

Bit 1 = Delta CTS bit not cleared by reading the Input Port.

Bit 2 = CTS not low, or Delta CTS not set, after setting RTS low.

Test A4 — DTR and DSR test

Bit 0 = DSR not high, or Delta DSR bit not set, after setting DTR high with OP2 = low, OP5 = low, and OP6 = low.

Bit 1 = Delta DSR bit not cleared by reading the Input Port.

Bit 2 = DSR not low, or Delta DSR bit not set, after setting DTR low with OP2 = low, OP5 = low, and OP6 = high.

Bit 3 = DSR not high after setting DTR high with OP2 = high, OP5 = high, and OP6 = high.

Bit 4 = DSR not low, after setting DTR low with OP2 = low, OP5 = high, and OP6 = high.

Bit 5 = DSR not low, after setting DTR low with OP2 = high, OP5 = low, and OP6 = high.

Test A5 — SRTS, DCD, and SDCD test

Bit 0 = DCD not high, or Delta DCD not set, after setting SRTS high.

Bit 1 = SDCD not high, or Delta SDCD not set, after setting SRTS high.

Bit 2 = Delta DCD, or Delta SDCD, not cleared by reading the input port.

Bit 3 = DCD not low, or Delta DCD not set, after setting SRTS low.

Bit 4 = SDCD not low, or Delta SDCD not set, after setting SRTS low.

Peripheral Port 0 Tests

Test A1 — Port 0 Baud Rates test (external loopback)

Same error codes as for Test A2, Host Port Baud Rates test.

(Bit 0 = 19.2 Kbaud, thru Bit 9 = 110 Baud.)

Test A2 — Port 0 Status Lines test

Bit 0 = RTS not high, or Delta RTS not set, when driven high by Host RTS.

Bit 1 = Delta RTS not cleared by reading input port.

Bit 2 = RTS not low, or Delta RTS not set, when driven low by Host RTS.

Bit 3 = DTR not high, or Delta DTR not set, when driven high by Host DRT.

Bit 4 = Delta DTR not cleared by reading Input Port.

Bit 5 = DTR not low, or Delta DTR not set, when driven low by Host DTR.

Bit 6 = SRTS not set high when driven high by SRTS from host.

Bit 7 = SRTS not set low when driven low by SRTS from host.

Test A3 — Port 0 Control Lines test

Bit 0 = Host CTS not driven high by a high on Port CTS.

Bit 1 = Host CTS not driven low by a low on Port CTS.

Bit 3 = Host DSR not driven high by a high on port DSR.

Bit 4 = Host DSR not driven low by a low on port DSR.

Bit 5 = Host DCD not driven high by a high on port DCD.

Bit 6 = Host DCD not driven low by a low on port DCD.

Peripheral Port 1 Tests

These tests and error codes (for Peripheral Port 1) are identical to those for Port 0. The only exception is that the screen message says "Port 1 Test" (instead of "Port 0 Test").

Hard Copy Loopback Test

This error message deals with the 4107's Printer port.

Test A1 — Hard Copy Loopback test

Bit 0 = Data or status bit failure on Hard Copy port.

CX Interface Test

This test and error message deals only with the CX Interface board (and its connectors) on the CX terminal.

Test A2 — CX Interface test

Hex Code	Error Report
00	Incorrect keyboard for Coax Interface
12	Transmitter not done
18	Data not received in loopback[1]
19	Bad data, bits 2 thru 9, received in loopback[1]
20	Bad data, bits 10 or 11, received in loopback[1]
1D	Memory error — unable to clear memory to 0
1E	Memory error — fails memory content = Address location test[2]
1F	Memory error — '55' write & read test[3]
20	Memory error — 'AA' write & read test[3]
31	Timeout on attempt to write to Coax Interface
32	Timeout on attempt to read from Coax Interface
33	Data read from the Interface did not match what was written
34	Timeout on attempt to reset the Coax Interface

1 The loopback is internal. The relay closes, so the CX transmitter talks directly to the receiver (bypassing the coax connector, line, and Control Unit).
2 If memory contents are bad, it probably read the wrong address.
3 Writes 55 or AA as data and then reads it back.

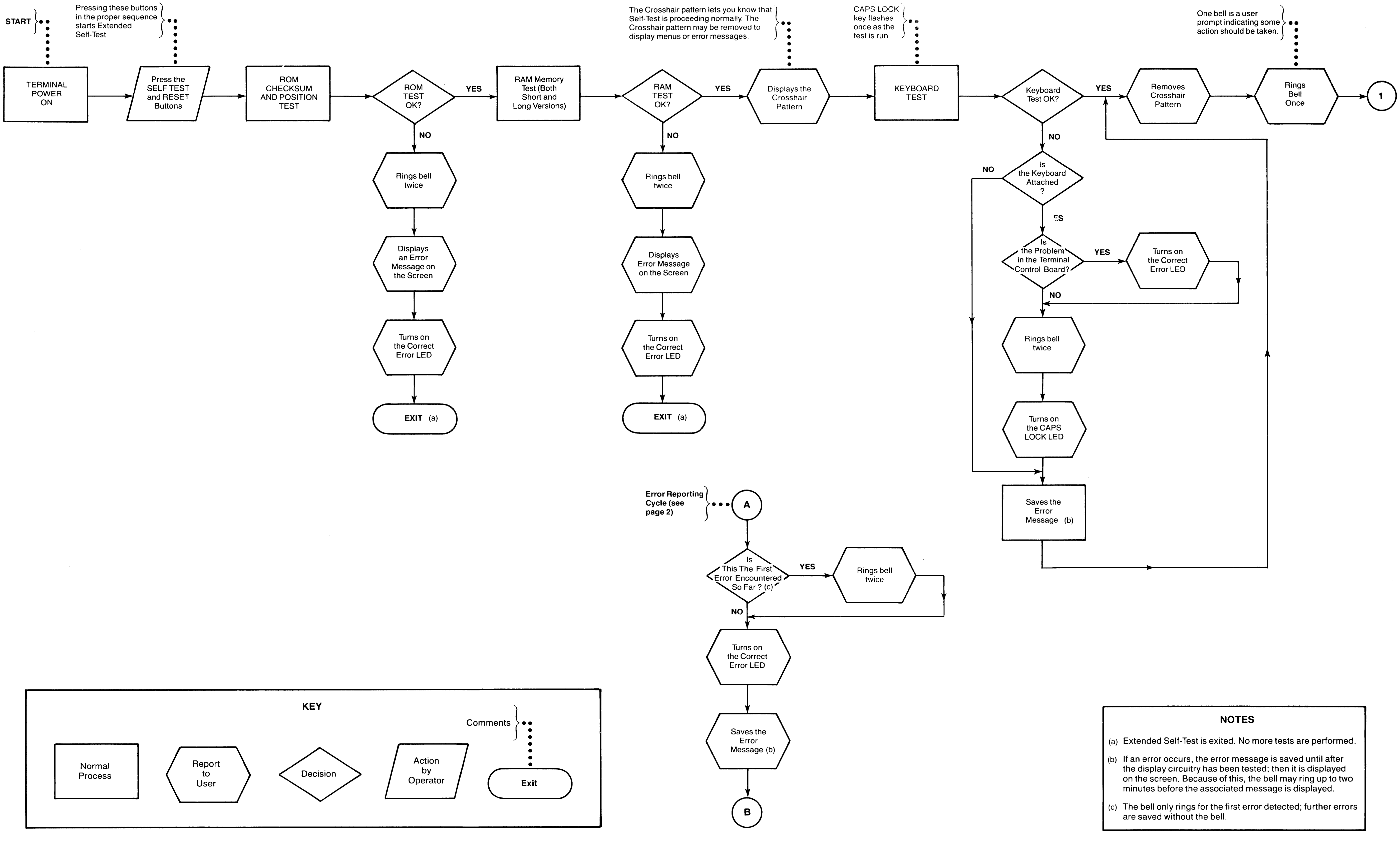
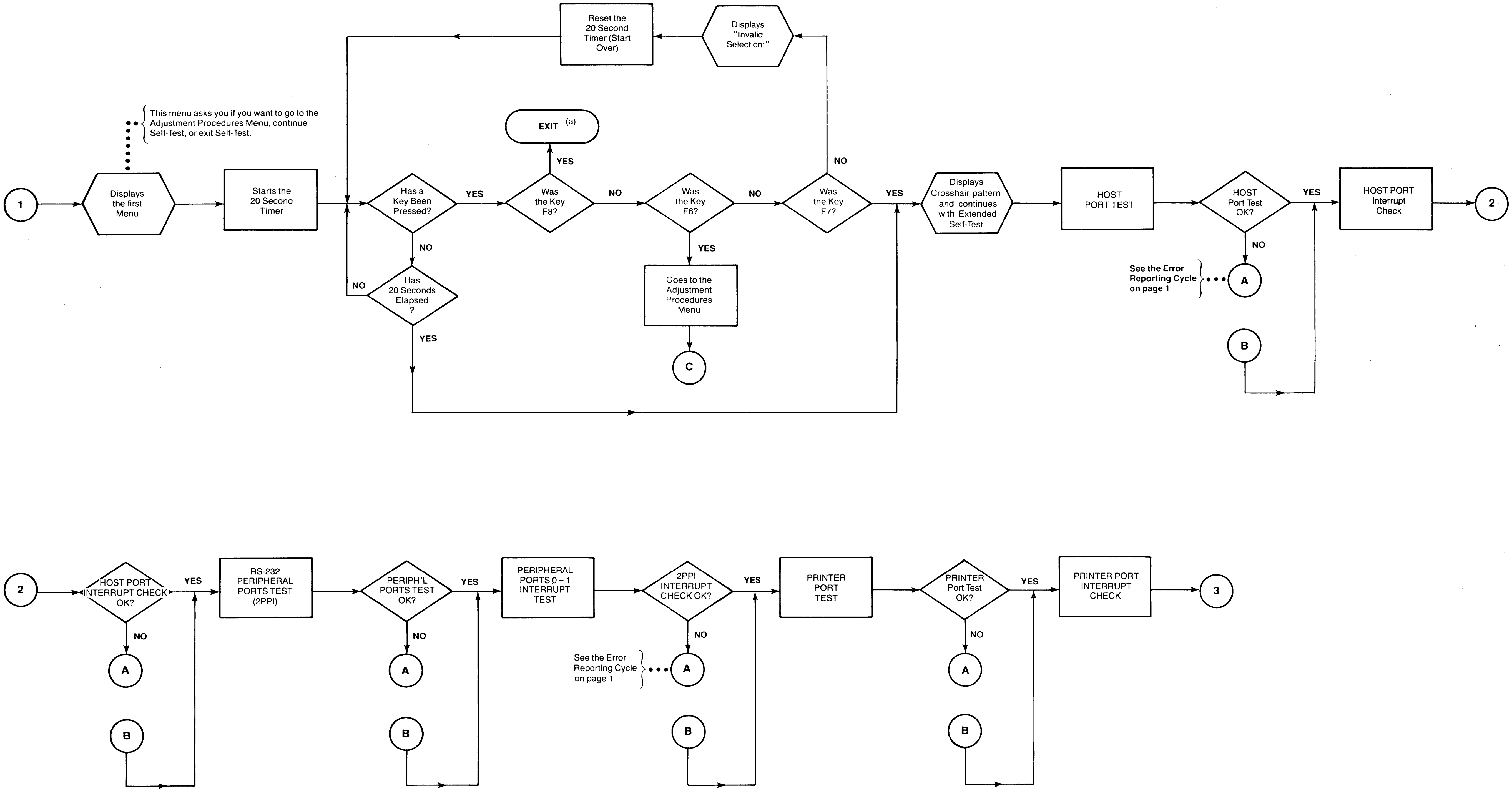


Figure C-5A. Self Test Control Flow.



4525-115

Figure C-5B. Self Test Control Flow.

FIGURE C-5B
SELF TEST CONTROL FLOW

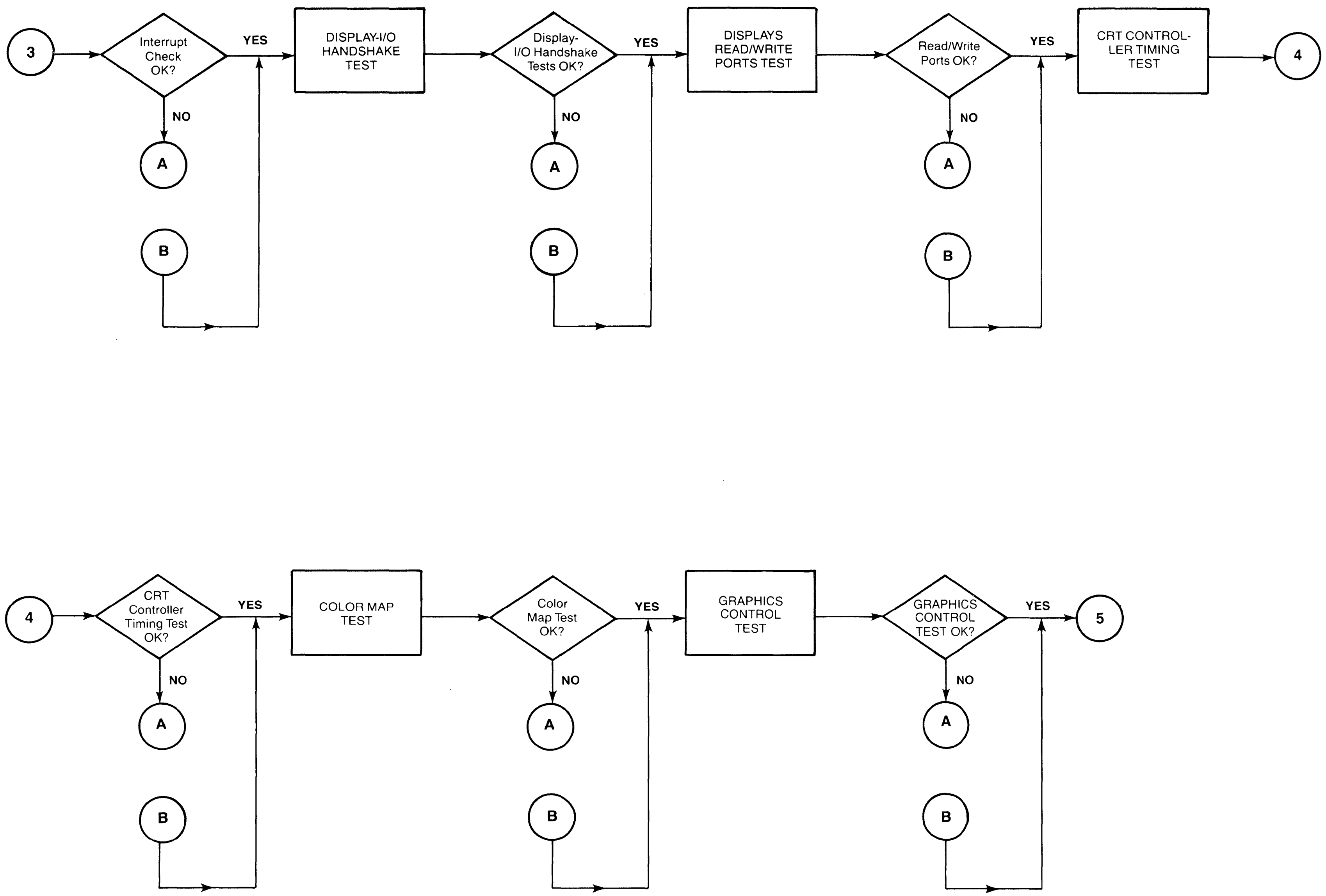


Figure C-5C. Self Test Control Flow.

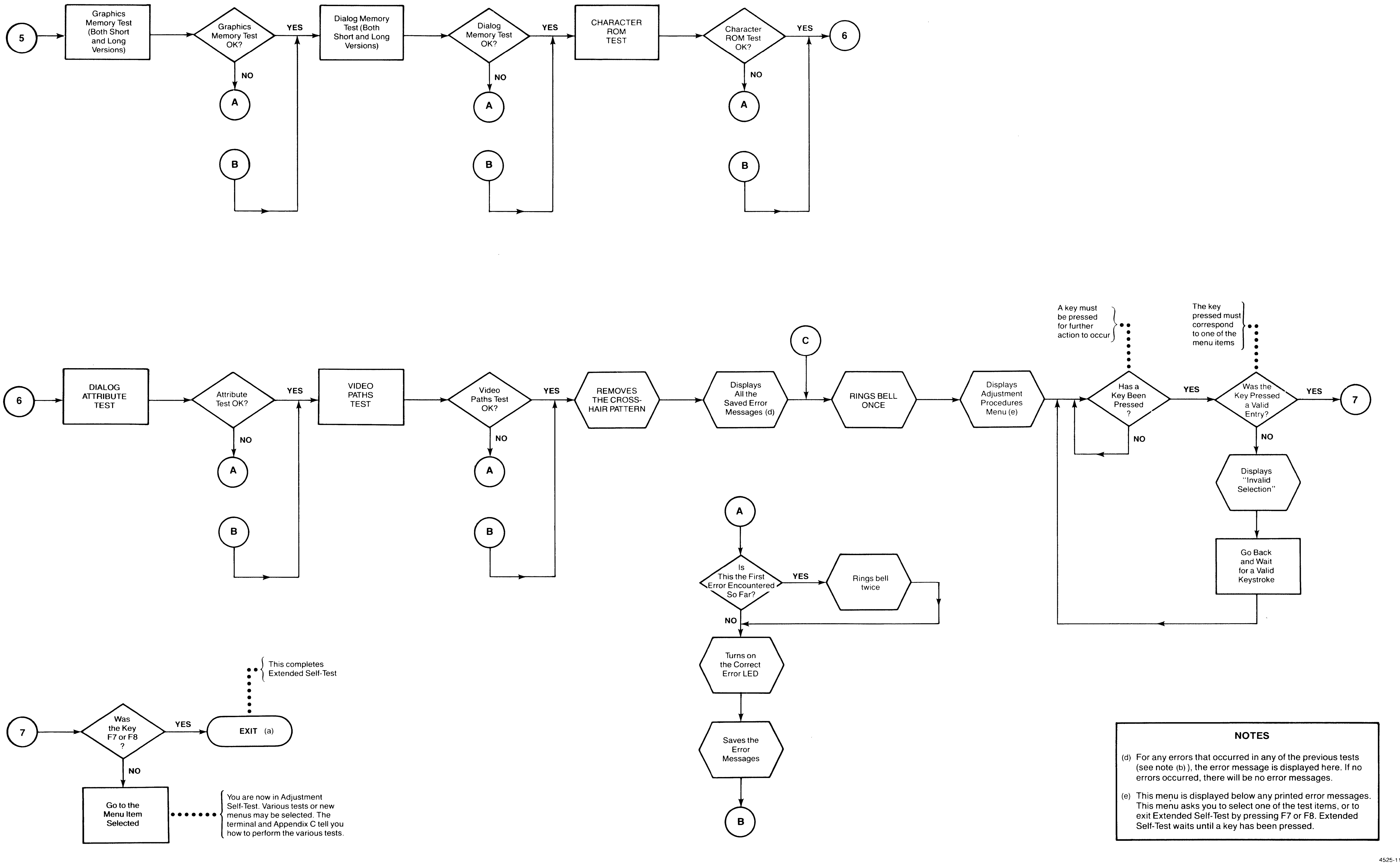


Figure C-5D. Self Test Control Flow.

FIGURE C-5D
SELF TEST CONTROL FLOW

Appendix D

SIGNAL LIST

The following table contains a list of all signals that appear on the edges of the schematic sheets in Section 11. The number in parenthesis (immediately following a signal name) is the number of the times that signal appears on the schematics. The right column contains a short definition/ description of each signal. This list does not show the Display Module signals. See the *Display Module Service Manual* for these signals.

Table D-1

SIGNAL NAMES

NAME	DEFINITION
+21 VOLTS	Required to read or write the 2817 EEPROMs.
+21 VOLT CONTROL	Same as 21 VOLTSON-0.
+5V LIMITED	+5 volts supplied for device at Copier port.
21 VOLTSON-0	Turns on the +21 V supply for 2817 read or write.
2817CS-0	2817 chip select line.
2817RDY-1	Indicates to the processor that the 2817 is ready for a read or a write.
4109-0	Tells DCB that it is installed in a 4109.
5V ON-1	Confirms that the +5V supply is working; and sends +5V to Display Module.
9007CS-0	9007 dialog controller chip select – enabled so the 80186 may set this controller's internal registers.
A0-1 to A13-1, A9-1	Latched processor address lines.
ABUSY-0	Alpha controller busy, status line.
ACK-0	Acknowledge – input from copier port.
ACNTLRD-0	Alpha controller read enable.
ACNTLWR-0	Alpha controller write enable.
AD0-1 to AD15-1	Address/Data bus – multiplexed processor address and data bus.
ADREN-0	Enable line for 9007 I/O address buffer.
AHIWR-0	Dialog List RAM high bank write strobe.
ALE-1	Address Latch Enable – processor externally latches an address via this enable line.
ALOWR-0	Dialog List RAM low bank write strobe.
ALPHACS-0	Alpha Chip Select – enables a data transfer between the processor data bus and the DCB dialog data bus.
ALPREQ-1	Alpha System Request – caused by VIDIO or ALPHACS.
ALU0-1 to ALU2-1	ALU Mode select lines.
ALUD0-1 to ALUD3-1	ALU Data – to RAM data write buffers on DCB.
APAGE0-1 to APAGE2-1	Alpha Font Selector – Selects one of three fonts in the Font ROM (default is 0).
ARAMWR-0	Alpha Memory (RAM) write strobe.
ARDY-1	Asynchronous Ready – a processor input from an addressed device; indicates its need for wait state(s).
ATTRTEST-1	Attribute PAL test line.
B0-1 to B3-1	Four-bit blue video from DCB to Piggyback board.

(continued)

Table D-1 (cont)

SIGNAL NAMES

NAME	DEFINITION
BG0-1 to BG2-1	Background – indicates the background color index.
BG0D-1 to BG2D-1	Background Delayed – delays the background color index by 1 dot-clock cycle.
BHE-0	Byte High Enable – this processor input selects either a word transfer or a byte transfer (on the upper half of the data bus).
BLA0-1 to BLA17-1[a]	Latched address lines 0 through 17.
BLANK-0	Blanking signal to the Display Module.
BLBHE-0	Latched Byte High Enable (see BHE-0).
BLD0-1 to BLD12-1	Latched data lines 1 through 12.
BLERCY-0	Latched Early Write Cycle.
BLINKENB-1	Blink Enable – enables blink attributes for dialog characters.
BLOCKCUR-1	Dialog area rectangular block cursor enable line.
BLPAGE1-0	Latched "page 1" memory bank enable signal.
BLUE	Blue external output.[b]
BLUE VIDEO	Analog blue video to the Display Module.[a]
BLUE VIDEO RETURN	Return path for BLUE VIDEO from the Display Module.
BLWRCY-1 (-0)	Latched Write Cycle – indicates the processor is doing an I/O write to DCB.
BRD-0	Buffered Read – processor read command buffered.
BRW-1	Buffered Read/Write – indicates a read or write by the processor.
BUSY-1	Busy – input from Copier port.
BWR-0	Buffered Write – processor write command (buffered).
C0-1 to C7-1	Character Code – represents the current character in the lower byte of the dialog list character word.
CAS0-0 to CAS3-0	Column Address Strobe 0 thru 3 – multiplexed CAS signals to graphics RAMs.
CBLANK-1	Composite Blanking request (from 9007) – provides blanking for retrace.
CCLK-0	Character Clock – clocks the dialog RAM output pipeline.
CHARBG-0	Character Background – background image enable.
CHARBLNKCLK-1	Character Blink Clock.
CHARFG-0	Character Foreground – foreground image enable.
CLKOUT-1	Clock Out – clock output from processor, is half the frequency of the system clock.
CLKTST-1	Clock Test – test input to DCB timing generator.
CLRPIX-0	Clears the pixel output latches.
COMPOSITE BLANK-1	Composite Blanking signal (V and H) to the Display Module.
COMPOSITE SYNC-0	Composite Sync (V and H) signal to the Display Module.
CSYNC-0	Composite Sync Request – from 9007 to Display Module.
CTS	Clear-to-Send – RS-232 signal from host (see RS-232 specifications).
CTSA	Clear-to-Send Channel A – Port 0 CTS signal.
CTSB	Clear-to-Send Chaneel B – Port 1 CTS signal.
CURBLKCLK-1	Alpha Cursor Blink Clock.
CURS-1	Alpha Cursor – cursor request signal from 9007.
D0-1 to D15-1	Data Bus lines on TCB.

[a] "BL" refers to Big Latch (I/O between DCB and TCB busses).

[b] RS-170 video signal level.

(continued)

Table D-1 (cont)

SIGNAL NAMES

NAME	DEFINITION
DATA0 RETURN to DATA7 RETURN	Data Return – ground lines for Copier port data.
DCD (J22)	Data Carrier Detect – Host port RS-232 signal.
DCDA	DCD channel A – Port 0, DCD RS-232 signal.
DCDB	DCD channel B – Port 1, DCD RS-232 signal.
DCLK	Dot Clock – pixel rate clock signal.
DEN-0	Data Enable – processor output to indicate valid data on the bus.
DIALOGENB-0	Dialog display enable signal.
DISPINT-1	Display Interrupt – interrupt from 9007 controller to the processor.
DISPRDY-1	Display Ready – indicates to the processor whether or not the DCB is ready to receive a data tranfer.
DOTCLK0-0 to DOTCLK5-0	Dot Clocks – six clocks that run at pixel rate, with varying phases.
DRQ1-1	DMA Request – to processor from test connector.
DRB-0	Data Row Boundery – indicates the top raster line of a character row/cell on the screen.
DSRA	Data Set Ready (channel A) – RS-232 signal from peripheral Port 0.
DSRB	Data Set Ready (channel B) – RS-232 signal from peripheral Port 1.
DT-1	Data Transmit – indicates the data flow direction on the processor data bus.
DTR	Data Terminal Ready – RS-232 host signal.
DTRA	DTR (channel A) – RS-232 peripheral Port 0 siganl.
DTRB	DTR (channel B) – RS-232 peripheral Port 1 signal.
ENBPIPE-0	Enable Pipeline – clocks the Dialog List row buffer (and pipeline) output.
EOLLOCK-1	End-of-Line Lock – controls the character output pipeline.
FAULT-0	Fault – error from fault indicator on copier/printer (on Copier port input).
FG0-1 to FG2-1	Foreground 0 to 2 – color index for the foreground of the display dialog area.
FONT0-1 to FONT7-1	Outputs from the character font ROM.
FONTRD-1	Read enable for the Self Test Font Read Latch.
G0-0 to G1-0	Graphics memory Output Enables – G0 enables high bank; G1 enables low bank.
G0-1 to G3-1	Four-bit green video from DCB to Piggyback board.
GA0-1 to GA7-1	Graphics Memory Address lines.
GBUSY-0	Graphics front control PAL is busy (status line).
GCNTLRD-0	Graphics Control Read Enable.
GCNTLWR-0	Graphics Control Write Enable.
GLOAD-1 (-0)	Graphics Load – for X Position latch, and Graphics Shift Registers.
GRAMWR-0	Graphics Memory Write Command.
GRAPHCS-0	Chip Select for Graphics RAM front control PAL.
GREEN/SYNC	Green external video output with sync. [b]
GREEN VIDEO	Analog green video – to the Display Module. [b]
GREEN VIDEO RETURN	Return path for GREEN VIDEO from the Display Module.
GRFREQ-0	Graphics Request – a read from 40000 – 7FFFF, or a write to 40000 – BFFFF, translates into this request for graphics controller operation.
GSRD0-1 to GSRD3-1	Graphics Shift Register data outputs.

[b] **RS-170 video signal level.**

(continued)

Table D-1 (cont)

SIGNAL NAMES

NAME	DEFINITION
GSYNC-1	Graphics Sync – timing signal from X Position counter.
GX0-1 to GX9-1	Graphics Cursor X Position address.
GY0-1 to GY8-1	Graphics Cursor Y Position address.
HCLK-0	Horizontal Clock – from timing generator.
HIWR-0	High Write Enable – write enable for High Byte; this is the upper byte (D8 – D15) of the processor word.
HLDA-1	Hold Acknowledge – acknowledge availability of the bus following a HOLD bus request.
HOLD-0	Hold – input from test connector and from Display Control board requesting use of the processor bus.
HOSTDAV-1	Host Data Available – signal from the host port, requests processor DMA cycle.
HS-0	Horizontal Sync – used to reset the NOTEXT register.
HSYNC-0	Horizontal sync – output from the DCB.
HWSTB-0	Hardware Strobe – strobes the registers (hardware) on the DCB.
INPUT PRIME RETURN	Input Prime Return – ground return for INPUT PRIME-0.
INPUT PRIME-0	Input Prime – output from Copier port.
INT0-1 to INT3-1	Interrupts 0 to 3 – four separate processor interrupt request inputs.
INTERLACE-1	Requests interlaced mode from DCB timing generator.
IV0-0 to IV7-0	Interface Vector – 8X305 Controller interface to the TCB in CX4109 only.
KBGND	Keyboard Ground – ground line for keyboard.
KBRDATA-1	Keyboard Receive Data – data to keyboard from processor.
KBRESET-0	Keyboard Reset – resets and tests the keyboard (runs that part of Self Test).
KBTDATA-1	Keyboard Transmit Data – data and/or status from the keyboard to the processor.
KBVCC	Keyboard Power Supply Voltage – + 12 VDC (regulated down to + 5 VDC in the keyboard).
KDI-1	Keyboard data in (CX terminal only)
KDO-1	Keyboard Data Out (CX terminal only)
LATERW-0	Late Read/Write – delayed read or write control.
LCS-0	Lower Chip Select – this processor line selects chips in the lower address area.
LGSR-0	Load Graphics Shift Register.
LISTENB-0	List Enable – enables dialog list data to become video data.
LOCK-0	Lock – indication by processor that other devices may not access the bus.
LOWR-0	Low Write Enable – allows only the low byte (B0 B7) to be written.
LRAMRDDAT-0	Latched RAM read data.
LS0-0 to LS2-0	Latched Status 0 to 2 – causes status bits 0 to 2 to be latched by the processor.
MAP0-1 to MAP4-1	Color Map address lines.
MAP4-0	Color Map Address line-4.
MAPIO-0	Color Map I/O – control line from "alpha system I/O control".
MAPWR-0	Map Write – write enable to the Color Map.
MCS0-0 to MCS3-0	Middle Chip Select – chip select lines from the processor.
MDEN-0	Manual Data Enable – not used; may be used to control data on bus from a test fixture.
MEM-1	Memory Access – request line from processor to Proc/Display arbitration PAL.
MISCOMINT-1	Miscellaneous Communications Interupt – an interrupt request from the DUART to the processor.

(continued)

Table D-1 (cont)

SIGNAL NAMES

NAME	DEFINITION
NAME	DEFINITION
NMI-0	Non-maskable interrupt – this processor interrupt causes it to perform an interrupt routine.
ODD-1	Odd condition – for double-wide characters.
P0-1 to P63-1	Pixel data bus – from RAMs to Graphics Shift Registers.
PCS0-0 to PCS6-0	Port Chip Select – indicates which 128 byte section of I/O space has been selected.
PE-1	Printer Enable – printer acknowledges it is enabled.
PIPECBLANK-1	Pipelined composite blanking signal.
PIPEDRB-0	Pipelined Data Row Boundery – piped DRB signal from the Alpha Controller.
PIPEHS-0	Pipelined Horizontal Sync signal.
PIPEVS-0	Pipelined Vertical Sync signal.
PLSTENB-0	Pipeline Strobe Enable – enables double-wide character PAL.
PRINTERINT-1	Printer Interrupt – interrupt output from processor to Printer Port.
PROCESSOR-0	Allows processor to write to graphics memories (via MUX).
QS0-1 and QS3-1	Queue Status – status outputs from processor.
QSMD-0	Queue Status Mode Disable (to processor).
R0-1 to R3-1	Four-bit red video from DCB to Piggyback board.
RAMCS0-0 to RAMCS3-0	RAM Chip Select – processor memory (RAM) chip select.
RAMD0-1 to RAMD3-1	RAM Data – Graphics RAM data from RAM chips to processor.
RAMRDCLK-0	RAM Read Clock – for Graphics RAM chips.
RAMRDY-1	RAM Ready – RAMs send ready signal to processor.
RAS0-0 to RAS3-0	Row Address Strobe A to D – Row address strobelines for graphics memory.
RC	Receive Clock – RS-232 standard.
RD-0/QSMD-0	Selects Read or Queue Status Mode for processor.
RDATA (J22)	Receive Data – RS-232 data to terminal.
RDYAND-1	Ready AND – test connector input ANDed with the terminal's internal ready signal.
RDYOR-0	Ready OR – test connector input ORed with the terminal's internal ready signal.
RED	Red external video output. [b]
RED VIDEO	Analog red video – to the Display Module.[b]
RED VIDEO RETURN	Return path for RED VIDEO from the Display Module.
RENB-0	Refresh Enable – refreshes the Dialog List RAMs.
RES-0	Reset to the CX keyboard.
RESET-0	Reset – signal from the Reset switch.
RESET	Reset – an input to the processor.
RESETOUT-1	Reset Out – reset signal from the processor to the rest of the system.
RTS (J22)	Request to Send – RS-232 signal, host port.
RTSA (J*)	Request to Send – peripheral port 0 RS-232 signal.
RTSB (J**)	Request to Send – peripheral port 1 RS-232 signal.
SDCD (J22)	Secondary Data Carrier Detect – RS-232 signal.
SELECT-1	Select – signal from printer port to procesor.

[b] **RS-170 video signal level.**

(continued)

Table D-1 (cont)

SIGNAL NAMES

NAME	DEFINITION
SHIFT0-1 to SHIFT3-1	Shift mode selector – Shifts processor/RAM data to ALU (via Shift PAL).
SL0-1 to SL3-1	Scan Line 0 to 3 – binary count for character generator; character line information from alpha CRT controller.
SMRESET-0	System Reset – processor reset to Display Control board.
SRDY-1	Synchronous Ready – processor input.
SRMODE0-0	Shift Register Mode 0 select line.
SRMODE1-0	Shift Register Mode 1 select line.
SRTS (J22)	Secondary Request to Send – RS-232 host signal.
SRTSA (J*)	Secondary Request to Send – RS-232 port 0 signal.
SRTSB (J**)	Secondary Request to Send – RS-232 port 1 signal.
STB RETURN	Standby Ground Return – ground for standby signal to printer (from printer port).
STB-0	Standby – standby signal from processor to printer.
STCLK-0	Self Test Clock signal.
STEST-0	Self Test – from Self test switch (unbuffered and unlatched).
STOPPIX-1	Stop Pixels – disables the Pixel Output-to-Display latches.
SYSRES-0	System Reset – same as SYSRESET, but originating on the Display Control board.
SYSRESET-0 and SYSRESET-1	System Reset – these complementart outputs are controlled by the processor.
TBWIN-0	Top/Bottom Window Shade – dialog window shade enable.
TC (J22)	Transmit Clock – RS-232 signal.
TDATA (J22)	Transmit Data – RS-232 signal.
TERMCLK-1	Terminal Clock – main clock, from keyboard port oscillator.
TESTCS-0	Test Chip Select – outputs the test results from system memory decoder (custom gate array).
TESTNMI-0	Test Non-Maskable Interrupt – an input from the test connector that allows manual or external NMI.
TESTRD-0	Test Read – allows data read via test connector.
TMRIN0-1 and TMRIN1-1	Timer In – these inputs control the processor's timer outputs.
TMROUT0-1 and TMROUT1-1	Timer Out – output signals from the processor's timers.
TSC-0	Tri-State Control – from processor to alpha CRT controller.
UCS-0	Upper Chip Select – processor line selects chip in upper address area.
UNDERLINE-1	Underline – indicates that a character is to be underlined.
US-0	Us (being the CX test fixture) forces a write of the data onto the CX I/F's IV bus, so the test fixture can read it.
VA0-1	Video Address 0 – represents the address of the first pixel in the dialog area.
VCLK-1	Vertical Clock – from DCB timing generator.
VD0-1 to VD7-1	Video Data 0 to 7 – latched list data for display.
VIDIO-0	Video Input/Output – this processor output is the master control line for all I/O between the terminal Control board and the Display Control board.
VIDOFF-1	Video Off – turns off the video Display Module.
VLT-0	Visible Line Time – indicates the visible portion of the scan line.
VRESET-0	Video system Reset – from processor to Display Control board.
VS-0	Vertical Sync – vertical sync signal from the alpha CRT controller.

Table D-1 (cont)

SIGNAL NAMES

NAME	DEFINITION
VSYNC-0	Vertical Sync – output from DCB.
WEHI-0	Write Enable for High RAM on RAM3 board.
WELO-0	Write Enable for Low RAMs on RAM3 board.
WINCLK-1	Dialog Window-Shade Clock.
WR-0/QS1-1	Write (or Queue Status) signal from the processor to the system.
WR0-0	Write High RAM Bank – p/o bit map on DCB.
WR1-0	Write Low RAM Bank – p/o bit map on DCB.
WRBOTH-1	Enable write to both banks of DCB bit map RAM.
WRCY-0	Write Cycle – indicates that the processor is performing an I/O write.
WRDIS0-1 to WRDIS3-1	Write Disable lines – prevents ALU from operating on all but selected graphics data lines.
XCUR-0	X Cursor signal – part of crosshair cursor.
XHAIR-1	Crosshair – cursor enable signal.
XPOS-0	X-Position counter clock pulse.
XPRNTENB-1	Transparent Mode Enable – request to pixel decoder PAL.
YCUR-0	Y Cursor signal – part of crosshair cursor.
YDCGY0-1	Y Down-Counter for Graphics Y Position.
YEP3-0	"Yes, the RAM3 board is installed."
YPOS-0	Y-Position counter clock pulse.

Appendix E

CODE CHARTS

This appendix includes the ASCII code chart and additional code charts which define the specific characters used as parameters for the optional character sets.

NOTE

ASCII stands for "American Standard Code for Information Interchange."

This appendix also shows the EBCDIC charts, which apply only to the CX terminals.

Figure E-1, at the end of this appendix, shows the press and release code for each key on the standard keyboard. Figure E-2 shows the press and release codes for the CX keyboard.

The code charts are:

Table	Description
E-1	ASCII Code Chart
E-2	United Kingdom Character Set
E-3	French Character Set
E-4	Swedish Character Set
E-5	Danish/Norwegian Character Set
E-6	German Character Set
E-7	Supplementary Character Set
E-8	Rulings Character Set
E-9	North American CX Code Chart
E-10	United Kingdom CX Code Chart
E-11	French CX Code Chart
E-12	Swedish CX Code Chart
E-13	Danish/Norwegian CX Code Chart
E-14	German CX Code Chart

Table E-1

ASCII CODE CHART

B7 B6 B5 BITS				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	@ 64	P 80	` 96	p 112
Ø	Ø	Ø	1	SH 1	D1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	EX 3	D3 19	# 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	ET 4	D4 20	$ 36	4 52	D 68	T 84	d 100	t 116
Ø	1	Ø	1	EQ 5	NK 21	% 37	5 53	E 69	U 85	e 101	u 117
Ø	1	1	Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	f 102	v 118
Ø	1	1	1	BL 7	EB 23	' 39	7 55	G 71	W 87	g 103	w 119
1	Ø	Ø	Ø	BS 8	CN 24	(40	8 56	H 72	X 88	h 104	x 120
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	Ø	1	Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	Ø	1	1	VT 11	EC 27	+ 43	; 59	K 75	[91	k 107	{ 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124
1	1	Ø	1	CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125
1	1	1	Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DT 127

(4526)4893-18

Table E-2

UNITED KINGDOM CHARACTER SET

B7 B6 B5 BITS				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	@ 64	P 80	` 96	p 112
Ø	Ø	Ø	1	SH 1	D1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	EX 3	D3 19	£ 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	ET 4	D4 20	$ 36	4 52	D 68	T 84	d 100	t 116
Ø	1	Ø	1	EQ 5	NK 21	% 37	5 53	E 69	U 85	e 101	u 117
Ø	1	1	Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	f 102	v 118
Ø	1	1	1	BL 7	EB 23	' 39	7 55	G 71	W 87	g 103	w 119
1	Ø	Ø	Ø	BS 8	CN 24	(40	8 56	H 72	X 88	h 104	x 120
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	Ø	1	Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	Ø	1	1	VT 11	EC 27	+ 43	; 59	K 75	[91	k 107	{ 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124
1	1	Ø	1	CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125
1	1	1	Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	— 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DT 127

(4526)4893-20A

Table E-3

FRENCH CHARACTER SET

BITS B4	B3	B2	B1	B7 B6 B5: Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
				CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	à 64	P 80	µ 96	p 112
Ø	Ø	Ø	1	SH 1	D1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	EX 3	D3 19	£ 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	ET 4	D4 20	$ 36	4 52	D 68	T 84	d 100	t 116
Ø	1	Ø	1	EQ 5	NK 21	% 37	5 53	E 69	U 85	e 101	u 117
Ø	1	1	Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	f 102	v 118
Ø	1	1	1	BL 7	EB 23	' 39	7 55	G 71	W 87	g 103	w 119
1	Ø	Ø	Ø	BS 8	CN 24	(40	8 56	H 72	X 88	h 104	x 120
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	Ø	1	Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	Ø	1	1	VT 11	EC 27	+ 43	; 59	K 75	° 91	k 107	é 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	ç 92	l 108	ù 124
1	1	Ø	1	CR 13	GS 29	– 45	= 61	M 77	§ 93	m 109	è 125
1	1	1	Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	¨ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DT 127

(4526)4893-22A

Table E-4

SWEDISH CHARACTER SET

B7 B6 B5 BITS				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	@ 64	P 80	\ 96	p 112
Ø	Ø	Ø	1	SH 1	D1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	EX 3	D3 19	# 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	ET 4	D4 20	¤ 36	4 52	D 68	T 84	d 100	t 116
Ø	1	Ø	1	EQ 5	NK 21	% 37	5 53	E 69	U 85	e 101	u 117
Ø	1	1	Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	f 102	v 118
Ø	1	1	1	BL 7	EB 23	' 39	7 55	G 71	W 87	g 103	w 119
1	Ø	Ø	Ø	BS 8	CN 24	(40	8 56	H 72	X 88	h 104	x 120
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	Ø	1	Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	Ø	1	1	VT 11	EC 27	+ 43	; 59	K 75	Ä 91	k 107	ä 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	Ö 92	l 108	ö 124
1	1	Ø	1	CR 13	GS 29	- 45	= 61	M 77	Å 93	m 109	å 125
1	1	1	Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	‾ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DT 127

(4526)4893-24

Table E-5

DANISH/NORWEGIAN CHARACTER SET

B7 B6 B5 / BITS B4 B3 B2 B1				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	@ 64	P 80	\ 96	p 112
Ø	Ø	Ø	1	SH 1	D1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	EX 3	D3 19	# 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	ET 4	D4 20	$ 36	4 52	D 68	T 84	d 100	t 116
Ø	1	Ø	1	EQ 5	NK 21	% 37	5 53	E 69	U 85	e 101	u 117
Ø	1	1	Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	f 102	v 118
Ø	1	1	1	BL 7	EB 23	' 39	7 55	G 71	W 87	g 103	w 119
1	Ø	Ø	Ø	BS 8	CN 24	(40	8 56	H 72	X 88	h 104	x 120
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	Ø	1	Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	Ø	1	1	VT 11	EC 27	+ 43	; 59	K 75	Æ 91	k 107	æ 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	Ø 92	l 108	ø 124
1	1	Ø	1	CR 13	GS 29	– 45	= 61	M 77	Å 93	m 109	å 125
1	1	1	Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	— 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DT 127

(4526)4893-26

Table E-6

GERMAN CHARACTER SET

BITS B4	B3	B2	B1	B7 B6 B5: Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
				CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	§ 64	P 80	\ 96	p 112
Ø	Ø	Ø	1	SH 1	D1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	EX 3	D3 19	# 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	ET 4	D4 20	$ 36	4 52	D 68	T 84	d 100	t 116
Ø	1	Ø	1	EQ 5	NK 21	% 37	5 53	E 69	U 85	e 101	u 117
Ø	1	1	Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	f 102	v 118
Ø	1	1	1	BL 7	EB 23	' 39	7 55	G 71	W 87	g 103	w 119
1	Ø	Ø	Ø	BS 8	CN 24	(40	8 56	H 72	X 88	h 104	x 120
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	Ø	1	Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	Ø	1	1	VT 11	EC 27	+ 43	; 59	K 75	Ä 91	k 107	ä 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	Ö 92	l 108	ö 124
1	1	Ø	1	CR 13	GS 29	– 45	= 61	M 77	Ü 93	m 109	ü 125
1	1	1	Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	ß 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DT 127

(4526)4893-28A

Table E-7

SUPPLEMENTARY CHARACTER SET

B7 B6 B5 BITS				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø	Ø	Ø	Ø	NU 0	DL 16	SP 32	0 48	— 64	Ñ 80	◆ 96	112
Ø	Ø	Ø	1	SH 1	D1 17	Ä 33	1 49	¢ 65	ñ 81	█ 97	113
Ø	Ø	1	Ø	SX 2	D2 18	ä 34	2 50	¦ 66	¿ 82	HT 98	114
Ø	Ø	1	1	EX 3	D3 19	Å 35	3 51	† 67	¡ 83	FF 99	115
Ø	1	Ø	Ø	ET 4	D4 20	å 36	4 52	□ 68	α 84	CR 100	116
Ø	1	Ø	1	EQ 5	NK 21	Æ 37	5 53	■ 69	σ 85	LF 101	117
Ø	1	1	Ø	AK 6	SY 22	æ 38	6 54	● 70	τ 86	° 102	118
Ø	1	1	1	BL 7	EB 23	à 39	7 55	Δ 71	φ 87	± 103	119
1	Ø	Ø	Ø	BS 8	CN 24	ç 40	8 56	∂ 72	μ 88	NL 104	120
1	Ø	Ø	1	HT 9	EM 25	é 41	9 57	λ 73	Σ 89	VT 105	≤ 121
1	Ø	1	Ø	LF 10	SB 26	è 42	ù 58	┐ 74	Ω 90	106	≥ 122
1	Ø	1	1	VT 11	EC 27	Ö 43	β 59	└ 75	⌠ 91	107	π 123
1	1	Ø	Ø	FF 12	FS 28	ö 44	Θ 60	┌ 76	⌡ 92	108	≠ 124
1	1	Ø	1	CR 13	GS 29	ø 45	¤ 61	┘ 77	÷ 93	109	£ 125
1	1	1	Ø	SO 14	RS 30	Ü 46	§ 62	¬ 78	≈ 94	110	• 126
1	1	1	1	SI 15	US 31	ü 47	•• 63	∞ 79	√ 95	111	DT 127

(4526)4893-29C

Table E-8

RULINGS CHARACTER SET

B7 B6 B5 / BITS B4 B3 B2 B1	Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
	CONTROL		FIGURES		UPPERCASE		LOWERCASE	
Ø Ø Ø Ø	NU 0	DL 16	SP 32	0 48	@ 64	P 80	◆ 96	112
Ø Ø Ø 1	SH 1	D1 17	! 33	1 49	A 65	Q 81	█ 97	113
Ø Ø 1 Ø	SX 2	D2 18	" 34	2 50	B 66	R 82	HT 98	114
Ø Ø 1 1	EX 3	D3 19	# 35	3 51	C 67	S 83	FF 99	115
Ø 1 Ø Ø	ET 4	D4 20	$ 36	4 52	D 68	T 84	CR 100	116
Ø 1 Ø 1	EQ 5	NK 21	% 37	5 53	E 69	U 85	LF 101	117
Ø 1 1 Ø	AK 6	SY 22	& 38	6 54	F 70	V 86	° 102	118
Ø 1 1 1	BL 7	EB 23	' 39	7 55	G 71	W 87	± 103	119
1 Ø Ø Ø	BS 8	CN 24	(40	8 56	H 72	X 88	NL 104	120
1 Ø Ø 1	HT 9	EM 25	) 41	9 57	I 73	Y 89	VT 105	≤ 121
1 Ø 1 Ø	LF 10	SB 26	* 42	: 58	J 74	Z 90	106	≥ 122
1 Ø 1 1	VT 11	EC 27	+ 43	; 59	K 75	[91	107	π 123
1 1 Ø Ø	FF 12	FS 28	, 44	< 60	L 76	\ 92	108	≠ 124
1 1 Ø 1	CR 13	GS 29	– 45	= 61	M 77	] 93	109	£ 125
1 1 1 Ø	SO 14	RS 30	. 46	> 62	N 78	^ 94	110	• 126
1 1 1 1	SI 15	US 31	/ 47	? 63	O 79	95	111	DT 127

(4526)4893-30

Table E-9

NORTH AMERICAN CX CODE CHART

BINARY BITS	0,1	00				01				10				11			
	2,3	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
4,5,6,7	HEX 1 0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL				SP	&	—						{	}	\	0
0001	1		SBA					/		a	j	~		A	J		1
0010	2		EUA							b	k	s		B	K	S	2
0011	3		IC							c	l	t		C	L	T	3
0100	4									d	m	u		D	M	U	4
0101	5	PT	NL							e	n	v		E	N	V	5
0110	6									f	o	w		F	O	W	6
0111	7									g	p	x		G	P	X	7
1000	8	GE		SA						h	q	y		H	Q	Y	8
1001	9		EM	SFE					`	i	r	z		I	R	Z	9
1010	A					¢	!	¦	:								
1011	B					.	$	,	#								
1100	C	FF	DUP	MF	RA	<	*	%	@								
1101	D	CR	SF			(	)	_	'								
1110	E		FM			+	;	>	=								
1111	F				SUB	|	¬	?	"								

4890-68

Table E-10

UNITED KINGDOM CX CODE CHART

BINARY BITS 0,1		00				01				10				11			
2,3		00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
4,5,6,7	HEX 1 0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL				SP	&	—						{	}	\	0
0001	1		SBA					/		a	j	‾		A	J		1
0010	2		EUA							b	k	s		B	K	S	2
0011	3		IC							c	l	t		C	L	T	3
0100	4									d	m	u		D	M	U	4
0101	5	PT	NL							e	n	v		E	N	V	5
0110	6									f	o	w		F	O	W	6
0111	7									g	p	x		G	P	X	7
1000	8	GE		SA						h	q	y		H	Q	Y	8
1001	9		EM	SFE					`	i	r	z		I	R	Z	9
1010	A					$	!	¦	:								
1011	B					.	£	,	#								
1100	C	FF	DUP	MF	RA	<	*	%	@								
1101	D	CR	SF			(	)	_	’								
1110	E		FM			+	;	>	=								
1111	F				SUB	|	¬	?	”								

4890-69

Table E-11

FRENCH CX CODE CHART

BINARY BITS	0,1	00				01				10				11			
	2,3	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
4,5,6,7	HEX 1 0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL				SP	&	—						é	è	c	0
0001	1		SBA					/		a	j	¨		A	J		1
0010	2		EUA			â	ê			b	k	s		B	K	S	2
0011	3		IC			ä	ë			c	l	t		C	L	T	3
0100	4									d	m	u		D	M	U	4
0101	5	PT	NL							e	n	v		E	N	V	5
0110	6						i			f	o	w		F	O	W	6
0111	7						ï			g	p	x		G	P	X	7
1000	8	GE		SA						h	q	y		H	Q	Y	8
1001	9		EM	SFE						i	r	z		I	R	Z	9
1010	A					°	§	ù	:								
1011	B					.	$	,	£					ô	û		
1100	C	FF	DUP	MF	RA	<	*	%	à					ö	ü		
1101	D	CR	SF			(	)	_	'								
1110	E		FM			+	;	>	=								
1111	F				SUB	!	^	?	"						ÿ		

[a] AZERTY Keyboard.

4890-70

Table E-12
SWEDISH CX CODE CHART

BINARY BITS 0,1		00				01				10				11			
2,3		00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
4,5,6,7	HEX 1 0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL				SP	&	—						ä	å	É	0
0001	1		SBA					/		a	j	ü		A	J		1
0010	2		EUA							b	k	s		B	K	S	2
0011	3		IC							c	l	t		C	L	T	3
0100	4									d	m	u		D	M	U	4
0101	5	PT	NL							e	n	v		E	N	V	5
0110	6									f	o	w		F	O	W	6
0111	7									g	p	x		G	P	X	7
1000	8	GE		SA						h	q	y		H	Q	Y	8
1001	9		EM	SFE					é	i	r	z		I	R	Z	9
1010	A					§	¤	o	:								
1011	B					.	Å	,	Ä								
1100	C	FF	DUP	MF	RA	<	*	%	Ö								
1101	D	CR	SF			(	)	_	'								
1110	E		FM			+	;	>	=								
1111	F				SUB	!	^	?	"								

4890-71

Table E-13

DANISH/NORWEGIAN CX CODE CHART

BINARY BITS	0,1	00				01				10				11			
	2,3	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
4,5,6,7	HEX -1 0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL				SP	&	—						æ	å	\	0
0001	1		SBA					/		a	j	ü		A	J		1
0010	2		EUA							b	k	s		B	K	S	2
0011	3		IC							c	l	t		C	L	T	3
0100	4									d	m	u		D	M	U	4
0101	5	PT	NL							e	n	v		E	N	V	5
0110	6									f	o	w		F	O	W	6
0111	7									g	p	x		G	P	X	7
1000	8	GE		SA						h	q	y		H	Q	Y	8
1001	9		EM	SFE					`	i	r	z		I	R	Z	9
1010	A					§	¤	ø	:								
1011	B					.	Å	,	Æ								
1100	C	FF	DUP	MF	RA	<	*	%	Ø								
1101	D	CR	SF			(	)	_	'								
1110	E					+	;	>	=								
1111	F				SUB	!	^	?	"								

4890-72

Table E-14

GERMAN CX CODE CHART

BINARY BITS	0,1	00				01				10				11			
	2,3	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
4,5,6,7	HEX 1 0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL				SP	&	–						ä	ü	Ö	0
0001	1		SBA					/		a	j	ß		A	J		1
0010	2		EUA							b	k	s		B	K	S	2
0011	3		IIC							c	l	t		C	L	T	3
0100	4									d	m	u		D	M	U	4
0101	5	PT	NL							e	n	v		E	N	V	5
0110	6									f	o	w		F	O	W	6
0111	7									g	p	x		G	P	X	7
1000	8	GE		SA						h	q	y		H	Q	Y	8
1001	9			EM	SFE				`	i	r	z		I	R	Z	9
1010	A					Ä	Ü	ö	:								
1011	B					.	$	,	#								
1100	C	FF	DUP	MF	RA	<	*	%	§								
1101	D	CR	SF			(	)	_	'								
1110	E		FM			+	;	>	=								
1111	F				SUB	!	^	?	"								

4890-73

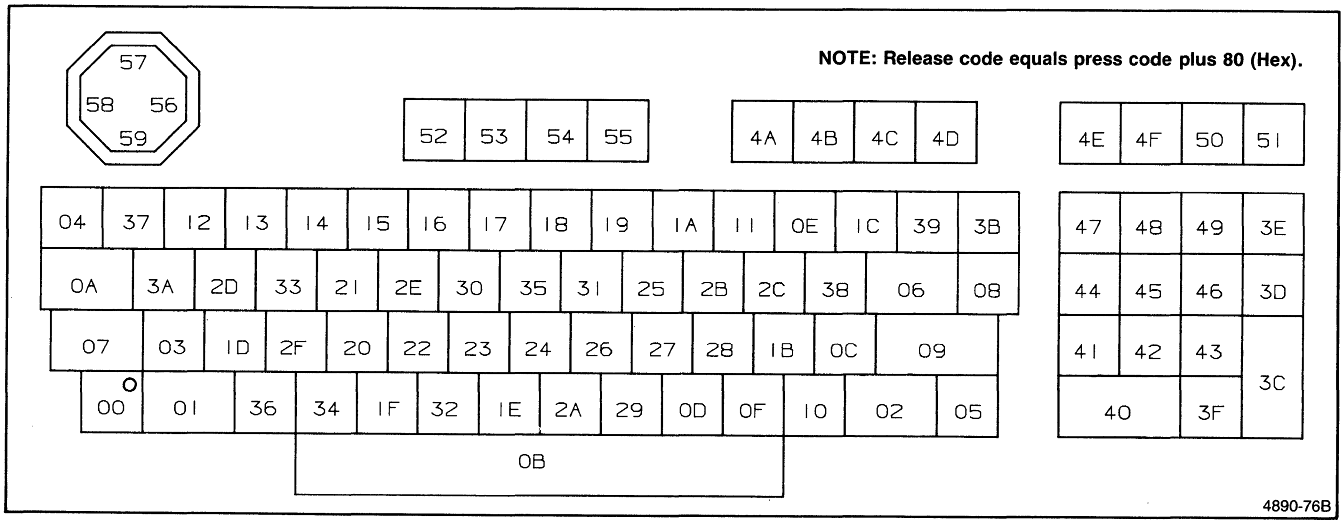


Figure E-1. Standard Keyboard Key Press Codes.

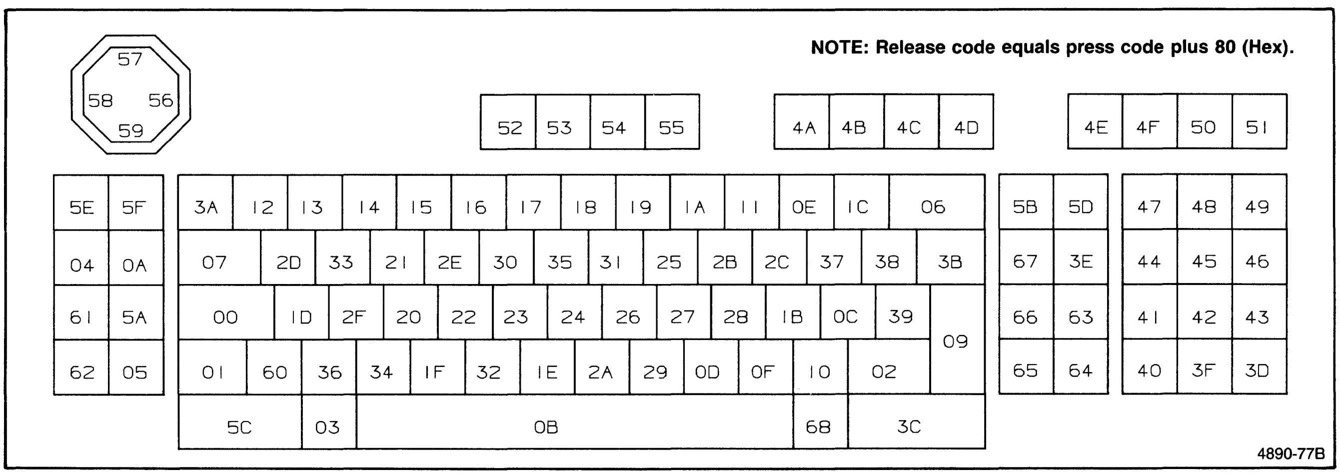


Figure E-2. CX Keyboard Key Press Codes.

Appendix F

CX TERMINAL INTERFACING INFORMATION

This appendix describes the terminal-to-Control Unit-to-IBM host interface for the CX terminals. The end of Section 4 describes the theory of operation for the CX Interface board.

CX TERMINAL OVERVIEW

The CX terminals have the following device features. The CX terminal does the following:

- Connects to an IBM system through a coaxial cable as if it were an IBM 3279 terminal.
- Emulates an IBM terminal when displaying alphanumeric text, 34 lines total. It displays the IBM "operator information line," or status line, at the bottom of the screen (the bottom two lines of the 34).
- Uses an IBM-style 87-key typewriter keyboard layout, but adds a TEKTRONIX joy disk and function keys.
- Connects to other host computers through the existing RS-232 host port connector, and is fully compatible with regular 4109 terminals despite the different keyboard layout.
- TEKTRONIX graphics commands and software are also supported when transmitted over the coax cable from an IBM host.
- Does not support the following IBM 3279 options: Programmable Symbol Cell Graphics (GDDM), APL keyboard and character set, magnetic card reader, light pen, security keyswitch.

Figure F-1 shows how the CX terminal connects to the IBM mainframe. The coaxial cable leads from the terminal's host port BNC connector (labeled "COMM") to an IBM 3274/3276 Control Unit. The Control Unit then connects to the host.

CONNECTION FROM CONTROL UNIT TO HOST

The details of the connection between the Control Unit and the host are transparent to the terminal and its user. The connection may be over telephone lines and modems, or by an IBM "channel" direct to the host. It may use either the BSC or SNA/SDLC communications protocol for carrying data streams between the host and Control Unit. The important characteristics of this connection are as follows:

- The host communicates with the Control Unit by command opcodes and text embedded in an "Extended 3270 Series Data Stream." Any text included in the data stream is encoded in IBM's EBCDIC[1] character code.
- The communications protocol (BSC or SNA/SDLC), between the Control Unit and host, is directed by the host and is responsible for transporting the 3270 series data stream to and from the Control Unit.
- The host graphics applications programmer must format his commands as required by the 3270 series data stream. The details of the host I/O routines and how to send TEK graphics to the CX terminal are described in the *CX4100 Series CDT Host Support Manual* (by TEKTRONIX).

[1] Extended Binary Coded Decimal Interchange Code.

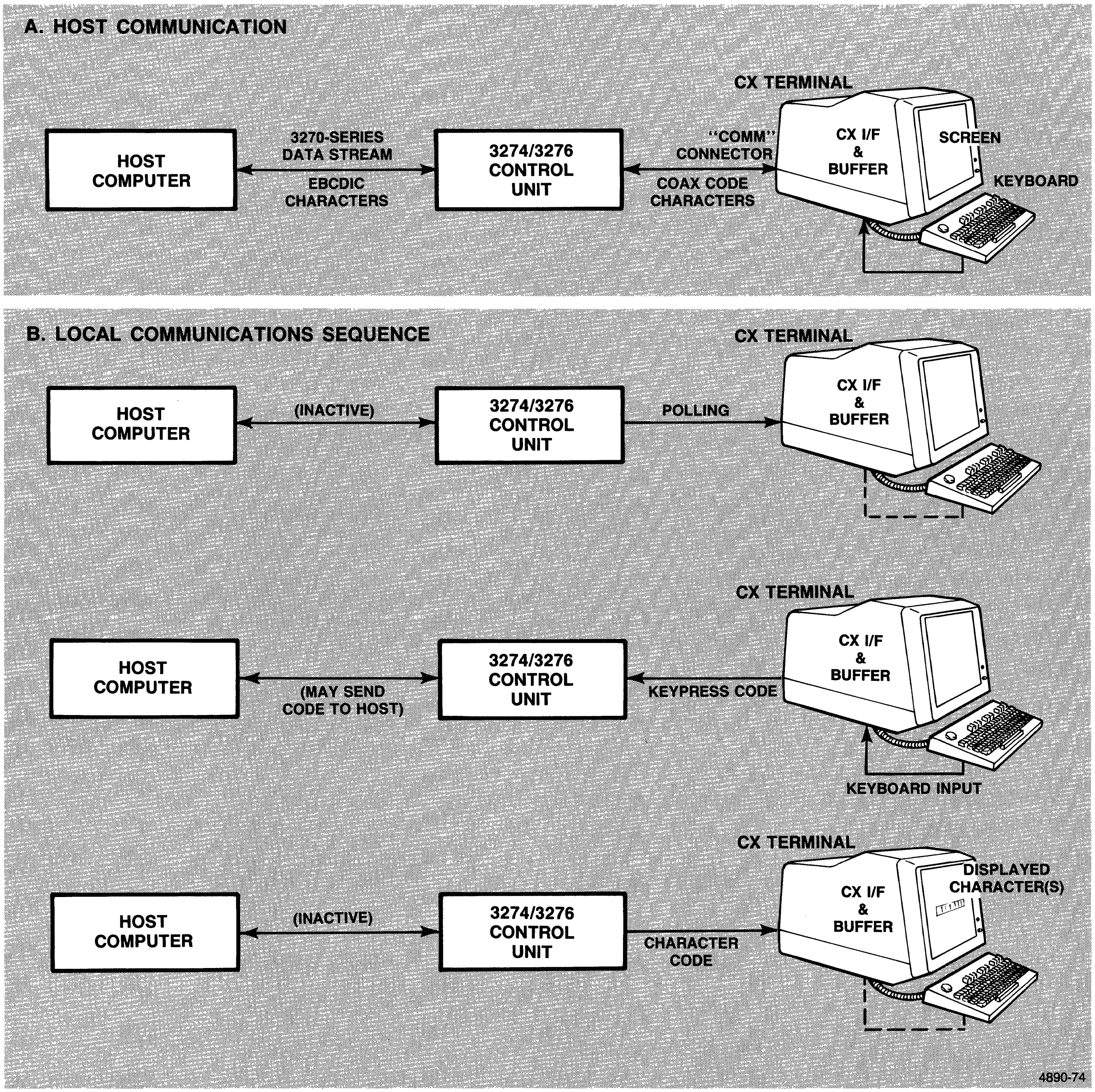


Figure F-1. Connecting the CX Terminal to an IBM Host.

CONNECTION FROM TERMINAL TO CONTROL UNIT

In an IBM system, the terminal shares many of its intelligent functions with the Control Unit. The IBM terminology for the terminal is "display unit." The communications between the display unit and the Control Unit are on a fairly primitive level.

The Control Unit is continually polling the terminal. Actually, up to 32 "terminals" (displays or printers) may be connected to a single Control Unit. The Control Unit continually polls its terminals to see if any need service.[2]

When the operator presses a key, the terminal sends a keyscan code in response to the next poll from the Control Unit. The Control Unit then converts this code to a character code, using the special "coax code" character set. It sends the character code back to the terminal, writing it into the terminal's "character buffer." It is the responsibility of the terminal to display all text that is stored in its character buffer.

To send text onward to the host computer, the operator presses the ENTER key. The Control Unit then reads text from the terminal's character buffer and sends that text onward to the computer. In doing so, the Control Unit converts the characters from special "coax code", used in the terminal's character buffer, to the EBCDIC code used by the host computer.

Also, when the operator of the CX terminal presses the LOCAL COPY key (lower left corner of the keyboard), the Control Unit interprets the LOCAL COPY keyscan code as a command to spool the text from the terminal to the printer that is attached to another of the Control Unit's coax ports. It reads text from the terminal's character buffer, sends that text to a similar character buffer in the printer, and then commands the printer to print its buffer contents.

[2] This does not refer to repair.

PHYSICAL INTERFACE AND MODULATION SCHEME

The terminal-to-Control Unit interface is a type RS62A/U coaxial cable. The cable coming from the Control Unit has a male BNC connector, which mates with the female BNC connector on the terminal.

Data is transmitted serially in either direction, but in only one direction at a time. The bit rate of the data transfer is 2.3587 MHz. The Control Unit acts as a master, the terminal is a slave.

A biphase modulation scheme is used.[3] Bits on the coax appear as positive- and negative-going voltage changes in the middle of their respective 424 ns bit intervals. A positive voltage change (in the middle of a bit interval) represents a binary 1, while a negative voltage change represents a binary 0. That is, a 1 is represented by a 212 ns low level, followed by a 212 ns high level; while a 0 is represented by a 212 ns high level, followed by a 212 ns low level.

The transmitting device (Control Unit or terminal) generates a predistorted pulse for each transition from high to low or visa versa. Figure F-2 shows these waveforms. Figures F-2A and 2B show waveforms measured across the coaxial cable at the transmitting end. Figures F-2C and 2D show the same waveforms as they appear after being attenuated and distorted by the maximum cable length of 5000 feet (1524 m).

[3] The wave-train consists of two types of pulse patterns: bi-phase 0, and bi-phase 1. These are shown in Figure F-2A and B.

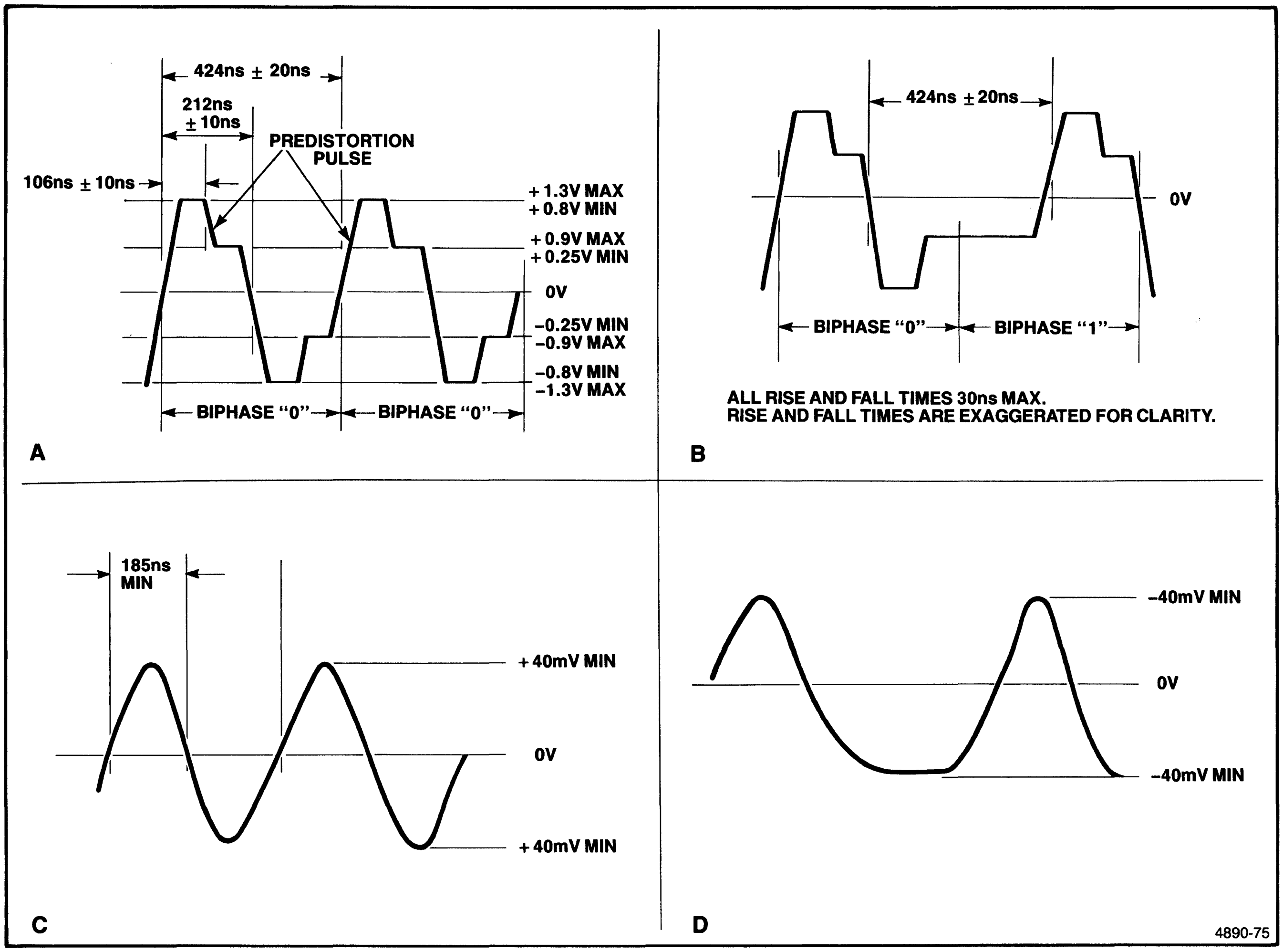


Figure F-2. Waveforms on the Coaxial Cable.