OPERATING AND MAINTENANCE MANUAL

MODEL 1038-D14A

MAINFRAME
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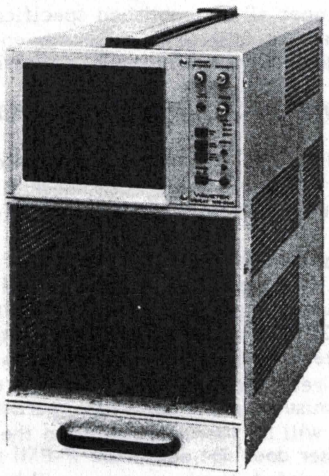
WAVETEK PACIFIC MEASUREMENTS, INC.

OPERATING AND MAINTENANCE MANUAL



MAINFRAME

MODEL 1038-D14A

SERIAL NUMBER _____

WAVETEK PACIFIC MEASUREMENTS, INC.

488 TASMAN DRIVE, SUNNYVALE, CALIFORNIA 94089
TEL: (408) 734-5780 TWX: 910-339-9273

1499-15689
Code 25 (10-85)

CERTIFICATION

WAVETEK PACIFIC MEASUREMENTS, INC. ("W-PMI") certifies that this instrument was thoroughly tested and inspected and found to meet all its published specifications when it was shipped from the factory. W-PMI further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

ONE YEAR LIMITED WARRANTY

WAVETEK PACIFIC MEASUREMENTS, INC. ("W-PMI") warrants to the original purchaser, that this instrument will be free from defects in material and workmanship, under normal recommended use and operating conditions for a period of one year after the date of delivery to the original purchaser.

W-PMI's obligation under this Warranty is limited to (1) repairing or replacing, at W-PMI's option, any part or parts (excluding RF diodes, RF connectors, batteries, and fuses) which are returned to W-PMI in the manner specified below and which, upon inspection by W-PMI's personnel, are determined to be defective as described above; and (2) calibrating the repaired instrument to current published specifications. If it is determined that the instrument is not defective, a nominal inspection charge will be charged and the instrument will be returned with transportation charges collect. If it is determined that the defect has been caused by misuse and/or abnormal operating conditions or that the instrument is not under Warranty, an estimate will be submitted prior to the commencement of necessary repair and calibration work. If the purchaser does not authorize W-PMI to commence such repairs within fifteen days after such estimate is submitted, the instrument will be returned to the purchaser transportation charges collect.

W-PMI'S OBLIGATION TO REPAIR OR REPLACE DEFECTIVE PARTS, AS DESCRIBED ABOVE, SHALL BE THE PURCHASER'S EXCLUSIVE REMEDY AND NO OTHER REMEDY SHALL BE AVAILABLE (INCLUDING, BUT NOT LIMITED TO, INCIDENTAL OR CONSEQUENTIAL DAMAGE FOR LOST PROFITS, LOST SALES, OTHER ECONOMIC LOSS, INJURY TO PERSON OR PROPERTY, OR ANY OTHER INCIDENTAL OR CONSEQUENTIAL LOSS SUSTAINED BY THE ORIGINAL PURCHASER OR ANY OTHER PERSON.)

THE WARRANTY DESCRIBED ABOVE IS THE ONLY WARRANTY APPLICABLE TO THIS W-PMI INSTRUMENT AND IS MADE EXPRESSLY IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR INFRINGEMENT.

WARRANTY PROCEDURE AND SHIPPING INSTRUCTIONS

If any fault develops, the following steps should be taken:

a. Notify W-PMI immediately, giving model number, serial or part number, code number, and a detailed description of the nature and/or conditions of failure. On receipt of this information, service, operating, or shipping instructions will be supplied to you.

b. On receipt of shipping instructions, ship the instrument transportation prepaid to W-PMI. The instrument should be shipped in the original shipping carton, or if damaged or not available, in a suitable rigid container with the instrument wrapped in paper or plastic and surrounded with at least four (4) inches of cushioning material on all sides. If under Warranty, the instrument will be repaired and returned transportation prepaid.

RECEIVING INSTRUCTIONS

The instrument must be thoroughly inspected immediately upon receipt. All material in the shipping container should be checked against the enclosed packing list. W-PMI will not be responsible for shortages against the packing list unless notified immediately. Upon receipt of shipment, if there is any visible evidence of damage, make a notation on the way bill of such damage and immediately contact the nearest office of the carrier in your city. If there is evidence of damage after the goods are unpacked, contact the nearest office of the carrier, request an inspection, and save all packing and materials therein until the inspection has been completed. A full report of the damage shall be obtained by the carrier's claim agent, and a copy of this report forwarded to W-PMI. Upon receipt of this report, you will be advised of the disposition of the equipment for repair or replacement. W-PMI shall have no responsibility for damaged instruments if the above inspection requirements are not complied with. Time is of the essence regarding the above instructions.

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1. GENERAL INFORMATION

1.1 WAVETEK PACIFIC MEASUREMENTS, INC. (W-PMI) MODEL 1038-D14A MAINFRAME

The Model 1038-D14A is a CRT display/mainframe capable of accepting all of the various W-PMI plug-in modules used in the Model 1038-series of swept measurement systems. In addition to interfacing the data processed by the plug-ins to the CRT display, the mainframe also:

- Supplies low voltage regulated power to the plug-ins;
- Amplifies vertical and horizontal signals for deflection drive;
- Stores display signals in digital memory;
- Provides auxiliary inputs and outputs separate from the plug-in modules;
- Optionally interfaces the system to a remote controller/calculator via the IEEE Bus (GPIB) per STD 488-1978, and;
- Has an X-Y recorder interface capable of operating any modern X-Y recorder.

Electronic switching between the two vertical channels (A and B) is provided, allowing them to timeshare the beam for simultaneous presentation of both channels.

The auxiliary inputs and outputs are located on the rear panel, along with a multi-pin connector used to operate auxiliary equipment. The four BNC auxiliary inputs are tied in parallel to four lines on the multi-pin connector. Five other BNCs provide output voltages proportional to the beam deflection for the horizontal and vertical channels, plus an input for external blanking and external retrace signals, if required. X-Y recorder drive circuitry is incorporated into the memory board, and terminates at the four remaining BNC connectors. These BNCs provide an interface to almost any response recorder, as described in Section 3.4.5.5 on page 3-8.

1.2 CRT DISPLAY SUB-ASSEMBLY

The display section of the D14A is comprised of a single beam CRT, power supply, and storage and deflection circuitry. The CRT has type P31 phosphor, and features a digitally refreshed memory to allow viewing slow sweep displays. Filters are available to reduce glare, if desired.

1.3 MAINFRAME CONNECTOR AND MAJOR COMPONENT SPECIFICATIONS

Following are external connector and major component specifications for the D14A Mainframe. Sections 1.3.1 and 1.3.2 will give pin assignments and power supplies furnished to the system via the input/output connector and the optional IEEE Interface board. Section 1.3.3 on page 1-4 lists the functions of the AUX 1, 2, 3, and 4 connections when the mainframe is used with the various Model 1038 plug-ins.

REAR PANEL CONNECTORS

Display Unit:	A CHAN OUT
	B CHAN OUT
	HORIZ OUT
	BLANKING IN
	+ = Blank (the level should exceed 3.4V)
	- = Unblank
Connector:	BNC Jack
Output Coefficient:	100mV/DIV
Coefficient Accuracy:	±2%
Output Voltage with Spot Centered on CRT Face:	0V, within 25mV
Impedance:	Approx. 0 Ohms

Response Recorder Output:
(For any modern X-Y recorder)

Signal Voltage (Rec X & Rec Y):	100mV/DIV ±1.0%
Impedance:	1000 Ohms ±1.0%
Horizontal Ramp:	0 to 1.0V
Vertical:	-0.4 to +0.4V
Record Time:	Approx. 30 sec
Penlift Logic (TTL & Contact):	TTL high supplied for pen up, and then drops to a low level during recording.
	Contact connector output will provide a contact closure signal during recording.
Connectors:	Four BNCs

Plug-In Chassis Unit:

INPUT/OUTPUT:	AUX 1, AUX 2, AUX 3, AUX 4
Connectors:	BNC Jacks
Signals:	Dependent on plug-ins

Input/Output:

Connector:	Amphenol type 57-40360
Signals:	See Section 1.3.1, and the manual(s) for the specific plug-in(s) being used.

IEEE Interface:

Connector:	24 pin, Amphenol 552791-2
Signals:	See Section 1.3.2
Format:	IEEE 488 GPIB

CRT Display:

Electron Gun:	Single beam
Display Area:	4" x 5" (8 x 10 divisions)
Phosphor:	P31
Memory Modes:	
Channel A:	Continuous line
Channel B:	Dashed or continuous line, switch selectable (see Section 3.4.6.1 on page 3-9)
Saved Data:	Storage mode

Temperature Range:

Operating:	0° to +50°C (+32° to +122°F)
Non-operating:	-40° to +65°C (-40° to +149°F)

Altitude:

Operating:	to 4600 m (15,000 ft)
Non-operating:	to 15000 m (50,000 ft)

Dimensions: (H x W x D)

Bench Mount:	380 x 216 x 483 mm (15 x 8.5 x 19 in)
Rack Mount:	178 x 483 x 483 mm (7 x 19 x 19 in)

Shipping Weight: 18 kg (40 lbs)

Power Requirements: 100/120/220 or 240VAC rms ±10% 50-440Hz

Power Requirements: (con't.)

Fuse Rating: 2A s.b. (120VAC)
1A s.b. (240VAC)

1.3.1 Input/Output Connector Pin Assignments

The following listing shows the connection of each of the pins of the Input/Output connector located on the rear panel of the D14A. Pin numbers with nothing listed after them in the Connection column indicate no connection.

Pin No.	Connection
1	+15V
2	-15V
3	15V Common
4	
5	
6	
7	+5V
8	5V Common
9	AUX 3 Common
10	AUX 4 Common
11	AUX 4
12	AUX 4 Common
13	A/X
14	AUX 2 Common
15	AUX 2
16	AUX 2
17	
18	AUX 1
19	+15V
20	-15V
21	15V Common
22	
23	
24	
25	+5V
26	5V Common
27	AUX 3
28	AUX 4
29	B/X
30	INTENSITY
31	RATIO Common
32	AUX 2
33	
34	LINE FREQUENCY
35	
36	AUX 1 Common

1.3.2 IEEE Interconnect Pin Assignments

The following listing shows the connection of each of the pins of the IEEE Interconnect connector located on the rear panel of the D14A. Pin numbers with nothing listed after them in the Connection column indicate no connection.

Pin No.	Connection
A1	LAC
A2	SRQ
A3	OUTPUT A
A4	ANALOG Common
A5	5V Common
A6	+5V
A7	15V Common
A8	-15V
A9	+15V
A10	DATA BUS 3
A11	DATA BUS 1
A12	INPUT RATIO A/X
B1	TAC
B2	
B3	HORIZ +
B4	OUTPUT B
B5	5V Common
B6	+5V
B7	15V Common
B8	-15V
B9	+15V
B10	DATA BUS 0
B11	DATA BUS 2
B12	INPUT RATIO B/X

1.3.3 AUX 1, 2, 3, and 4 Functions

The AUX (Auxiliary) 1, 2, 3, and 4 BNC connections on the rear panel of the D14A are used for various plug-in input/output functions in conjunction with the specific swept measurement system in use (NS20, N10, or H/V).

In the H/V system, only AUX 1 is used to provide the horizontal input signal to the horizontal (H11 or H13) plug-in. None of the AUX connections are used with the vertical (V12, V13, or V20) plug-ins.

The listing below gives the AUX connector functions when used with the N10 or NS20 systems.

N10

AUX 1 External Sweep signal input

AUX 2 V∝F signal input

AUX 3 Peak Power input (CH B only)

AUX 4 Marker Pulse input

NS20

AUX 1 Not Used

AUX 2 V∝F signal output

AUX 3 Peak Power input (CH B)

AUX 4 Peak Power input (CH A)

2. INITIAL INSTRUCTIONS

2.1 RECEIVING INSPECTION

See the Receiving Instructions in the "Warranty" statement on page i in the front of this manual, and inspect the instrument for shipping damage.

2.2 POWER REQUIREMENT

WARNING: Before applying AC mains power to the instrument, be sure that the instrument is set for the correct line voltage.

The unit is set at the factory for operation at the normal supply voltage for the country in which it is sold. The input must be 50-440Hz. The combination of the module and transformer design allows instrument operation of 100, 120, 220, or 240 volts. Conversion from one voltage to another can be made by changing the voltage selection PC board. (See Figure 2-1, below.)

2.3 CHASSIS GROUNDING

DANGER: FAILURE TO PROPERLY GROUND THE INSTRUMENT CAN ALLOW HIGH VOLTAGES TO BUILD UP ON THE CHASSIS. THE VOLTAGE LEVELS COULD BE DANGEROUS TO OPERATING PERSONNEL.

The instrument is supplied with a three-conductor NEMA type power cord. The current carrying conductor is white and its return is black.

The green wire is for connection to earth ground. The instrument will only be safely grounded if the plug is connected into a properly installed three-prong receptacle. If a three-prong to two-prong adapter is used, be sure that the pigtail lead of the adapter is earth-grounded.

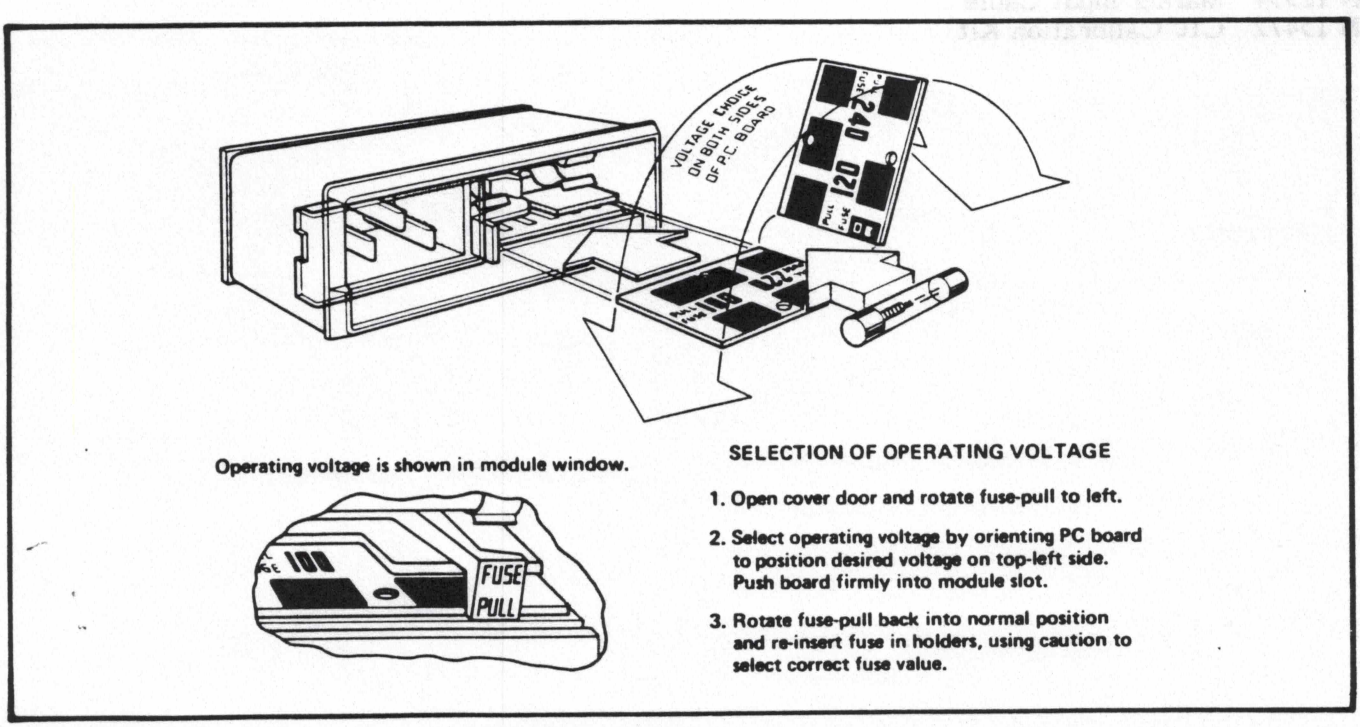

Figure 2-1. Operating Voltage Selection

2.4 RETURNING THE INSTRUMENT

If it is felt that the instrument should be returned to W-PMI for any reason, it is recommended that the Wavetek Pacific Measurements Customer Service Department be contacted prior to returning the unit. It is often the case that problems can be resolved over the telephone without the necessity of sending the instrument back to the factory. The telephone number is (408) 734-5780, ext. 260, or Telex 3716460. See the shipping instructions on the Warranty statement on page i at the front of this manual.

2.5 ACCESSORIES

The following accessories are supplied with each instrument:

1ea P/N 12356 Power Cord
1ea P/N 15689 Operating & Maint. Manual

2.5.1 Optional Accessories

P/N 12777 Viewing Hood
P/N 12954 Marker Input Cable
P/N 15472 C10 Calibration Kit

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3. OPERATION

3.1 INTRODUCTION

The Model 1038-D14A Mainframe will accept a variety of signal conditioning plug-in modules to function as a swept measurement system. The purpose of this section is to provide detailed operating instructions only for the mainframe and its CRT display. Separate instruction manuals containing operating and maintenance information come with each of the various plug-in modules.

3.2 FRONT PANEL CONTROLS
(See Figure 3-1)

The more frequently adjusted controls are located on the upper right side of the front panel of the D14A, adjacent to the CRT. This section will give a description of those controls. Section 4 will describe the GPIB indicators.

MARKER INTENSITY

Controls only the brightness of the marker pips on the CRT display.

INTENSITY

Controls only the brightness of the display trace. (Not the markers.)

FOCUS

Adjusts the sharpness of focus of the displayed trace.

RECORD (A and B)

These switches will cause the selected channel (A or B) to start recording whatever is currently being displayed on the CRT. The D14A must be properly interfaced with an external X-Y recorder (see Section 3.4.5.5 on page 3-8).

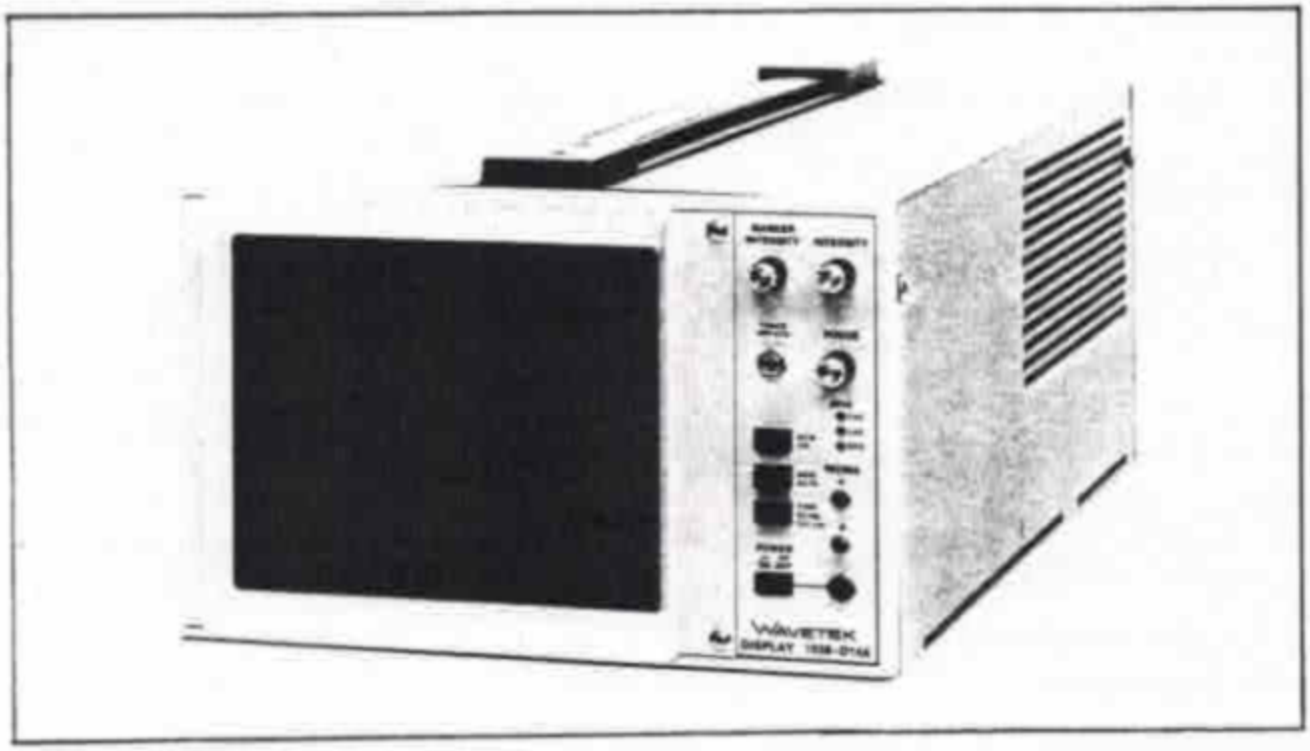


Figure 3-1. Front Panel Controls

MEMORY ON

Provides a flicker-free display of whatever data is stored in the D14A's memory when ON. When OFF, causes incoming data to be displayed in real time at whatever sweep speed is currently being used.

MEMORY SAVE

Freezes the CRT display to allow photographs to be made.

FIND BEAM (Rec Cal)

Brings the trace onto the CRT screen when it is not visible. Also provides for the output of a precision calibration signal to an X-Y recorder.

POWER

Primary ac mains ON or OFF switch.

TRACE ROTATE

This screwdriver-adjustable control is used to align the displayed trace with the horizontal line on the CRT graticule.

3.3 REAR PANEL CONNECTORS
(See Figure 3-2)

A CHAN OUT/B CHAN OUT

These 50 Ohm BNC connectors provide external access to a voltage proportional to the vertical CRT deflection for channel A and channel B, regardless of what display mode is currently in use. The scale factor is 100mV per CRT graticule division.

HORIZ OUT

This 50 Ohm BNC provides external access to a signal proportional to the horizontal CRT deflection. The scale factor is 100mV per CRT graticule division.

BLANKING IN

This BNC is provided to operate the Z-axis or intensity control via an external TTL level. A low TTL logic level will unblank the display. The level must exceed 3.4V.

EXT RETRACE

This connection can be used with sweepers that do not always give a precise retrace signal indication in the normal signal input mode (such as the HP-8350). This direct connection between the D14A and the sweeper will provide the retrace information at the correct time.

X-Y RECORDER Outputs

These four BNC connectors provide an interface to most X-Y recorders. Both TTL and Contact Closure pen lift logic signals are supplied, as well as the X and Y axis drive signals.

AUX 1 through AUX 4

These BNC connectors provide access to and from the plug-ins via the Interconnect circuit. (See Section 1.3.3 on page 1-4 and the manual(s) for the plug-in(s) being used for descriptions.)

INPUT-OUTPUT

This multi-pin connector contains the signal and power supply connections for accessory equipment. The signals present at this connector will depend on the particular plug-in(s) being used with the mainframe.

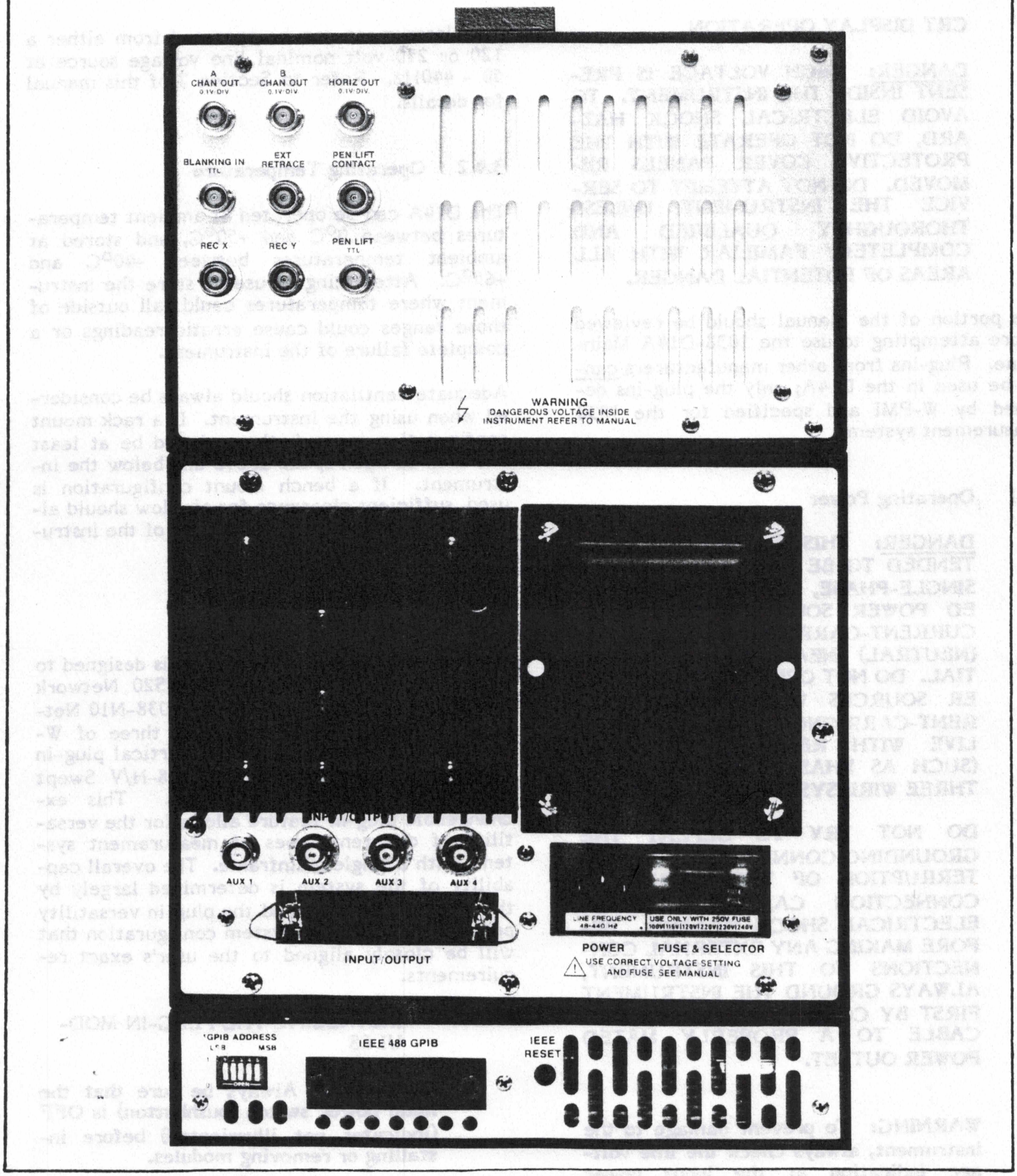


Figure 3-2. Rear Panel Connectors

3.4 CRT DISPLAY OPERATION

DANGER: HIGH VOLTAGE IS PRESENT INSIDE THE INSTRUMENT. TO AVOID ELECTRICAL SHOCK HAZARD, DO NOT OPERATE WITH THE PROTECTIVE COVER PANELS REMOVED. DO NOT ATTEMPT TO SERVICE THE INSTRUMENT UNLESS THOROUGHLY QUALIFIED AND COMPLETELY FAMILIAR WITH ALL AREAS OF POTENTIAL DANGER.

This portion of the manual should be reviewed before attempting to use the 1038-D14A Mainframe. Plug-ins from other manufacturers cannot be used in the D14A; only the plug-ins designed by W-PMI and specified for the 1038 measurement systems.

3.4.1 Operating Power

DANGER: THIS INSTRUMENT IS INTENDED TO BE OPERATED FROM A SINGLE-PHASE, EARTH-REFERENCED POWER SOURCE HAVING ONE CURRENT-CARRYING CONDUCTOR (NEUTRAL) NEAR EARTH POTENTIAL. DO NOT OPERATE FROM POWER SOURCES WHERE BOTH CURRENT-CARRYING CONDUCTORS ARE LIVE WITH RESPECT TO EARTH (SUCH AS PHASE TO PHASE ON A THREE WIRE SYSTEM).

DO NOT TRY TO DEFEAT THE GROUNDING CONNECTION. ANY INTERRUPTION OF THE GROUNDING CONNECTION CAN CREATE AN ELECTRICAL SHOCK HAZARD. BEFORE MAKING ANY EXTERNAL CONNECTIONS TO THIS INSTRUMENT, ALWAYS GROUND THE INSTRUMENT FIRST BY CONNECTING THE POWER CABLE TO A PROPERLY MATED POWER OUTLET.

WARNING: To prevent damage to the instrument, always check the line voltage indication at the input power connector before applying primary power.

This instrument can be operated from either a 120 or 240 volt nominal line voltage source at 50 - 440Hz. Refer to Section 2 of this manual for details.

3.4.2 Operating Temperature

The D14A can be operated at ambient temperatures between 0°C and +50°C, and stored at ambient temperatures between -40°C and +65°C. Attempting to use or store the instrument where temperatures could fall outside of those ranges could cause erratic readings or a complete failure of the instrument.

Adequate ventilation should always be considered when using the instrument. If a rack mount configuration is used, there should be at least one inch of open space above and below the instrument. If a bench mount configuration is used, sufficient clearance for air flow should always be left at the sides and back of the instrument.

3.4.3 Plug-In Units

The Model 1038-D14A Mainframe is designed to accept the W-PMI Model 1038-NS20 Network Measurement System, the Model 1038-N10 Network Analyzer Plug-In, or up to three of W-PMI's individual horizontal and vertical plug-in modules to form the Model 1038-H/V Swept Frequency Measurement System. This exchangeable plug-in feature allows for the versatility of different types of measurement systems with a single mainframe. The overall capability of the system is determined largely by the plug-in selection, and the plug-in versatility permits the choice of system configuration that will be closely aligned to the user's exact requirements.

3.4.3.1 INSTALLING THE PLUG-IN MODULES

WARNING: Always be sure that the main power switch (pushbutton) is OFF (indicator not illuminated) before installing or removing modules.

Align the guides in the top and bottom of the plug-in with the corresponding slots in the

mainframe housing. Pull the latch at the bottom of the plug-in straight out and push the plug-in firmly into its compartment until it locks into place. Secure the module by pressing the latch in, flush with the front panel.

To remove the plug-in, pull the latch at the bottom out until the module is released, and slide the unit out of the D14A housing.

3.4.4 Pre-Operation Checkout

Before using the D14A Mainframe for the first time, it is recommended that the unfamiliar operator execute the following step-by-step procedure if an H/V System (individual horizontal and vertical plug-ins) is to be used. Otherwise, perform the test of Section 6 (Performance Verification) prior to the installation of an NS20 or N10 Plug-In. Correct instrument operation can be verified and basic calibration made without internal adjustments.

NOTE: If recalibration of the mainframe appears necessary, qualified service personnel should refer to Section 7, Maintenance for calibration procedures.

Step 1: Set the POWER switch to OFF and connect the instrument to a power source that meets the specified requirements.

Step 2: Install the horizontal plug-in module into the left compartment, and a vertical plug-in module into the A CHANNEL DISPLAY compartment (immediately to the right of the horizontal plug-in).

Step 3: Connect a detector to the vertical plug-in and turn the INTENSITY control fully counterclockwise. Turn the POWER switch ON.

Step 4: Connect the detector input to the CALIBRATOR OUTPUT jack on the horizontal plug-in, and set the CALIBRATOR switch to ON. Select INT position on the HORIZONTAL slide switch, and A CHAN on the DISPLAY pushbutton. Allow the instrument to warm up for at least 10 minutes.

Step 5: On the vertical plug-in, set the OFFSET thumbwheels to 10.0 and the POLARITY pushbutton to + (press in). Select the INPUT/dBm and 10.0dB/DIV pushbuttons. Set the REF LINE control to center.

Step 6: Set the INTENSITY control until the trace is at the desired viewing level. Set the MARKER INTENSITY control so that the markers stand out (can bloom slightly). Whenever photos are to be taken, the intensity of the trace can be reduced to make the markers stand out, if desired. After the intensities have been set, the FOCUS control can be adjusted to produce a sharp, well defined trace.

Step 7: Position the trace exactly on the center line graticule using the HIGH LEVEL (screwdriver) adjustment on the vertical plug-in.

Step 8: If the trace is not parallel along the center horizontal CRT graticule line, adjust the TRACE ROTATE adjustment to align it with the center line.

Step 9: Select 00.0 at the vertical plug-in OFFSET switch, and note that the trace is displaced one major vertical division upwards on the CRT display.

Step 10: Turn the REF LINE control clockwise to the +4 position to move the trace off the screen upwards. Push the FIND BEAM button and observe that the display compresses into the CRT screen area. Release the FIND BEAM control, and reposition the trace.

3.4.5 General Operating Information

3.4.5.1 INTENSITY CONTROL

WARNING: Damage to the CRT phosphor can occur if an extremely bright, sharply focused spot is left in one position for too long a time.

Adjustment of this control is interactive with display focus. Therefore, slight adjustment of the FOCUS control may be necessary when the intensity level is changed. To protect the CRT phosphor coating, do not turn the INTENSITY control any higher than necessary to produce a satisfactory display

Apparent trace intensity can be improved by reducing the ambient light level or using the viewing hood, P/N 12777.

3.4.5.2 DISPLAY FOCUS

If a well-defined display cannot be obtained with the FOCUS control, even at low INTENSITY control settings, adjust the internal ASTIGMATISM control (refer to Section 7.2.3.J on page 7-2).

To check the setting of the astigmatism adjustment, slowly turn the FOCUS control through the optimum setting with a signal displayed on the CRT screen. If the astigmatism is correctly set, the vertical and horizontal sections of the trace will come into sharpest focus at the same setting of the FOCUS control.

3.4.5.3 TRACE ALIGNMENT

If the free-running trace is not parallel with the horizontal graticule lines, the front panel TRACE ROTATE can be adjusted per Step 8 of Section 3.4.4 on page 3-7.

3.4.5.4 BEAM FINDER (Recorder Calibration)

The first function of the FIND BEAM (Rec Cal) switch provides a means of locating a display that is outside the viewing area of the CRT, horizontally or vertically. When FIND BEAM is pressed, the display is compressed within the graticule area of the screen and the intensity of the trace is increased. To locate and reposition an overscanned display:

Step 1: Press the FIND BEAM (Rec Cal) switch, hold it in, and adjust the vertical and horizontal position controls to approximately center the display around the X and Y axes center lines.

Step 2: Release the FIND BEAM (Rec Cal) switch; the display should remain within the viewing area.

The second function of the FIND BEAM (Rec Cal) switch is to provide a precision signal to calibrate an X-Y recorder. When proper interconnection has been made between the D14A and the X-Y recorder, the FIND BEAM (Rec Cal) switch is pressed. This causes the recorder pen (if the recorder has pen lift logic) to move to the upper right corner of the graph paper. The recorder can then be precisely adjusted.

3.4.5.5 RECORDING CHANNEL A OR B

The D14A Mainframe contains internal circuits which provide signals to drive an X-Y plotter so that a copy of the CRT display can be made on ordinary graph paper. The signal voltage from the D14A to the plotter is 100mV/DIV with a horizontal ramp of 0 to 1V and vertical of -0.4 to +0.4V.

Interconnection must first be made between the D14A and the recorder. Attach the BNC connectors of the recorder cables to the proper BNC outputs on the rear of the D14A. If the recorder has TTL pen lift logic, connect to the PEN LIFT - TTL output. If the recorder has switch closure pen lift logic, connect to the PEN LIFT CONTACT output.

The D14A provides for recorder pen-lift contacts that are "Normally Open (NO)" or "Normally Closed (NC)". The setting of switch A6S2 on the Memory PC Board (#A6) can be checked to see if it is in the proper position (NO or NC --- etched on the board) for the recorder being used. If not, the switch can be reset for the NO or NC characteristic of the recorder. Refer to page 8-14 for the physical location of this switch (S2) on the PC board. To gain access to the A6 PC board, the top, right side of the D14A housing's cover must be removed.

If the recorder has no pen lift feature, there is sufficient dwell time before the start of the recorder's sweep to allow the operator to manually lower the pen after pressing the "Record" button on the front panel of the D14A. The recorder pen will also pause long enough at the end of the sweep for the pen to be lifted before retrace.

3.4.5.5.1 How To Record

Step 1: Set the recorder for plotting in the X-Y mode per the recorder's instruction manual and then calibrate the recorder, referring to the last paragraph of Section 3.4.5.4.

Step 2: When the desired A or B channel display is present on the CRT screen of the mainframe, press the selected channel (A or B) button on the front panel of the D14A. This will cause the recorder pen to move from its vertical center rest position on the left side to the vertical start position, drop the pen (automatically, if the pen lift feature is built in, otherwise, manually), and start recording. When the X-Y plot reaches the end of the graph in about 30 seconds, the pen will lift and return to the rest position, if the pen lift feature is active.

If, for some reason, it is decided not to record after the "A" or "B" Record button has been pressed, press the button again and recording will stop. If the pen lift feature is active, the pen will lift and return to the rest position.

3.4.5.6 CRT GRATICULE

The graticule or CRT viewing screen division lines are marked on the inside of the CRT faceplate to provide accurate, parallax-free measurement information. The graticule is divided into eight vertical and ten horizontal divisions. Each major division forms a 0.5 inch (12.7 mm) square. In addition, the major divisions are divided into five minor scale divisions. The vertical gain and horizontal timing of the plug-in units are calibrated to the graticule markings, allowing measurement data to be accurately displayed.

When extracting time or frequency measurement data from the trace information presented on the graticule, the center eight divisions provide the most accurate portion of the scale. Position the start of the timing area to be measured from the second vertical division, and the end to any point before the ninth vertical division.

3.4.5.7 INTENSITY MODULATION

Intensity (Z-axis) modulation can be used to relate a third element of electrical phenomena to the vertical (Y-axis) and horizontal (X-axis) coordinates, without effecting the waveshape of the displayed signal. The Z-axis modulating signal, applied to the amplifier's summing junction, is derived either from memory or from external sources via the rear panel I/O connector.

When the D14A is operating in the real-time mode, positive-going signals will generally increase the brightness of the display and negative-going signals will decrease the brightness. The actual value of the brightness level is determined by the initial setting of the intensity control.

When the instrument is in the memory mode, the intensity is set by specific internal signals. Marker intensity is controlled only by the front panel MARKER INTENSITY control knob.

The BLANKING IN connector on the rear panel also accesses the Z-axis amplifier via a logical OR gate chain which is controlled by a TTL high level signal (the level should exceed 3.4V). Access from the plug-in retrace blanking signal is also available at this connector, and is derived from the horizontal plug-in or plug-in section when sweeping.

3.4.6 Refresh Memory

The Model 1038-D14A incorporates a display memory circuit to enable the digital storage of X and Y axis deflection signals. When the front panel MEMORY ON button is pressed, the display is driven by deflection signals from the RAM circuit (after D/A conversion and processing). When the MEMORY ON button is released, the CRT displays real-time deflection signals from the plug-in(s).

When the MEM SAVE button is pressed, the digital signals from the RAM memory are continuously converted to CRT deflection drive signals, without any update from the plug-in(s). The display can then be photographed using conven-

tional CRT scope mounting camera equipment.

3.4.6.1 SETTING OF SWITCH A6S1

Switch A6S1 is a dip switch located on the upper section, toward the rear, of the A6 Memory Board. It controls whether or not the channel B signal will be displayed as a dashed or solid line. (The top cover of the mainframe must be removed to allow access to this switch.) The switch is labeled "1" and "2" on the top segment, and "Closed" on the bottom segment. The switch can be set as follows to allow the display of channel B as indicated:

a. A6S1-1 and 2 both open. Channel B trace always displayed as a dashed line.

b. A6S1-1 closed and 2 open. With both channels A and B displayed, channel B is a dashed line. If channel B only is displayed (without channel A), the channel B trace will be a solid line.

c. A6S1-1 and 2 both closed. Channel B trace is always displayed as a solid line.

d. A6S1-1 open and 2 closed. Same as c. above. Channel B always a solid line.

3.5 MEASUREMENT SYSTEM OPERATION

Consult the appropriate plug-in operating and maintenance manual for detailed information on making measurements with a specific D14A/-plug-in system.

4. IEEE BUS (GPIB) INTERFACE

4.1 GENERAL INFORMATION

This section describes the IEEE Interface Board of the D14A, including circuit theory, functions, and calibration procedures. Sample programs and other specific information detailing programming methods for the various 1038 systems are contained in Application Notes, separate from this manual.

4.2 GENERAL DESCRIPTION

Option 04 of the Model 1038-D14A provides for connection to a remote calculator/controller via an interface board furnished by W-PMI (see Figure 4-1). The connection conforms to IEEE STD 488-1978, and is known as the General Purpose Interface Bus (GPIB). This bi-directional interface permits the D14A/plug-in system to send data (talk) to the controller, and to receive both data and commands from the controller (listen).

Bus functions that can be implemented include:

SH1, AH1, T6, TE0, L4, LE0, SR1 or SR0, RL1, PP0, DC1, ST0, and C0.

4.3 INSTALLATION AND PRE-OPERATING DATA

The D14A is pre-wired to accept the circuitry and hardware required for option 04 with no further modifications. If the D14A was not originally ordered to be equipped with option 04 and the user should decide to install the option at a later date, W-PMI recommends that the instrument be returned to the factory for complete installation and calibration. If this is not possible, option 04 can be ordered and installed by the user. The following items will be included in the user-installed kit:

a. D14A option 04 Installation Kit, P/N 15937

b. D14A option 04 Installation Procedure Instructions, P/N 15347

c. Schematic Diagram (SD) #15776

The Installation Procedure Instructions will detail the steps required to install option 04, using the hardware supplied in the Installation Kit.

The IEEE Board uses two addresses. The first or "major" address is programmed by the 5-bit binary switch (S4 on Figure 4-1, page 4-2) located at the bottom of the rear panel of the mainframe when the Interface Board is installed. The setting of this switch applies to mainframe functions and plug-in functions when the command sequence is preceded by a "P". The second or "minor" address is one plus the binary switch setting (e.g. if the binary switch were set at "4", the minor address would be "5"). The minor address applies to plug-in functions when the command sequence is <u>not</u> preceded by a "P". The minor address can be used when using the N10, NS20, or any future plug-in units developed by W-PMI.

After installation, the IEEE Interface Board must be calibrated as described in Section 4.6.1. on page 4-7.

(Continued on page 4-4)

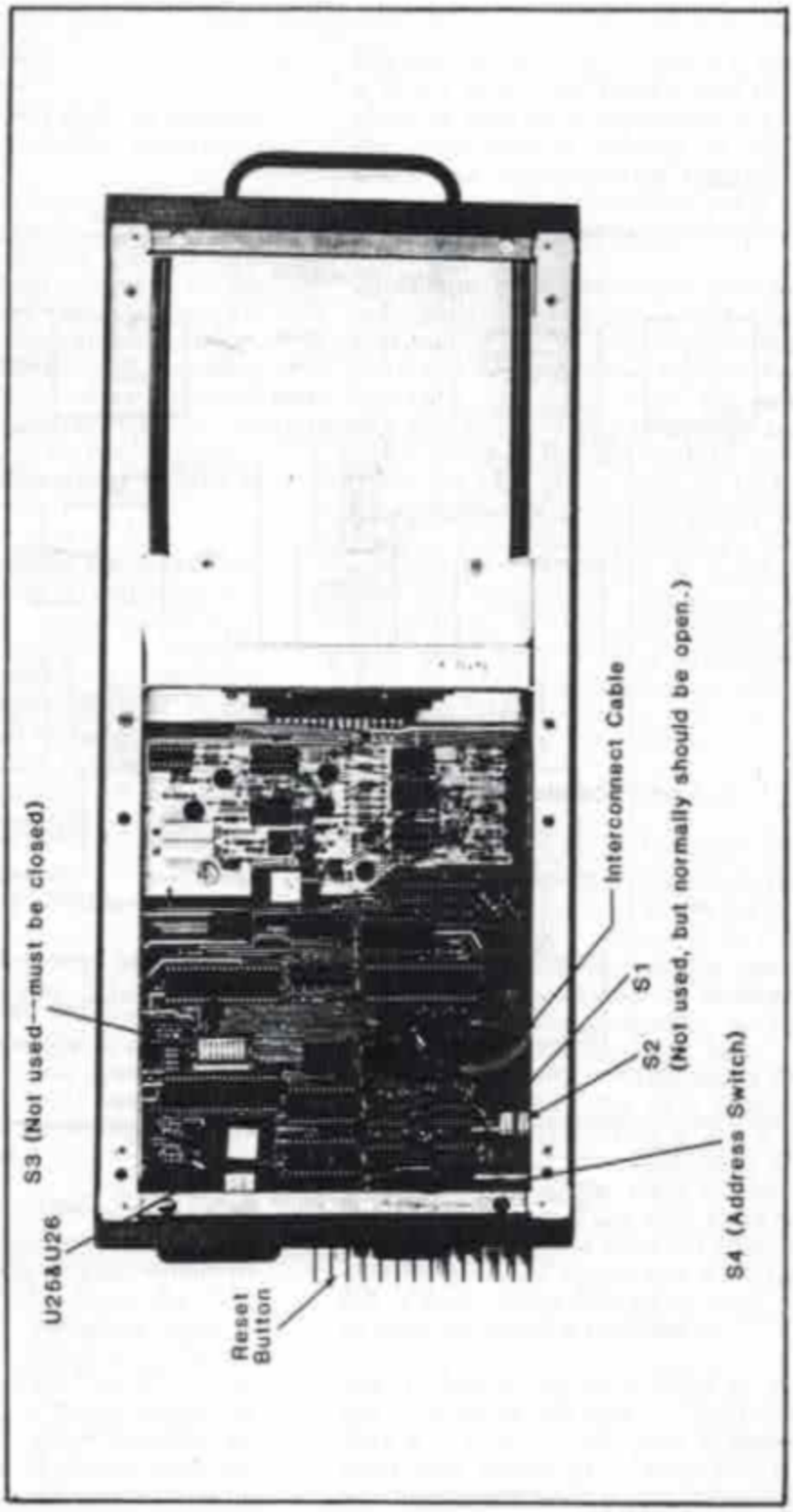


Figure 4-1. IEEE Interface Board

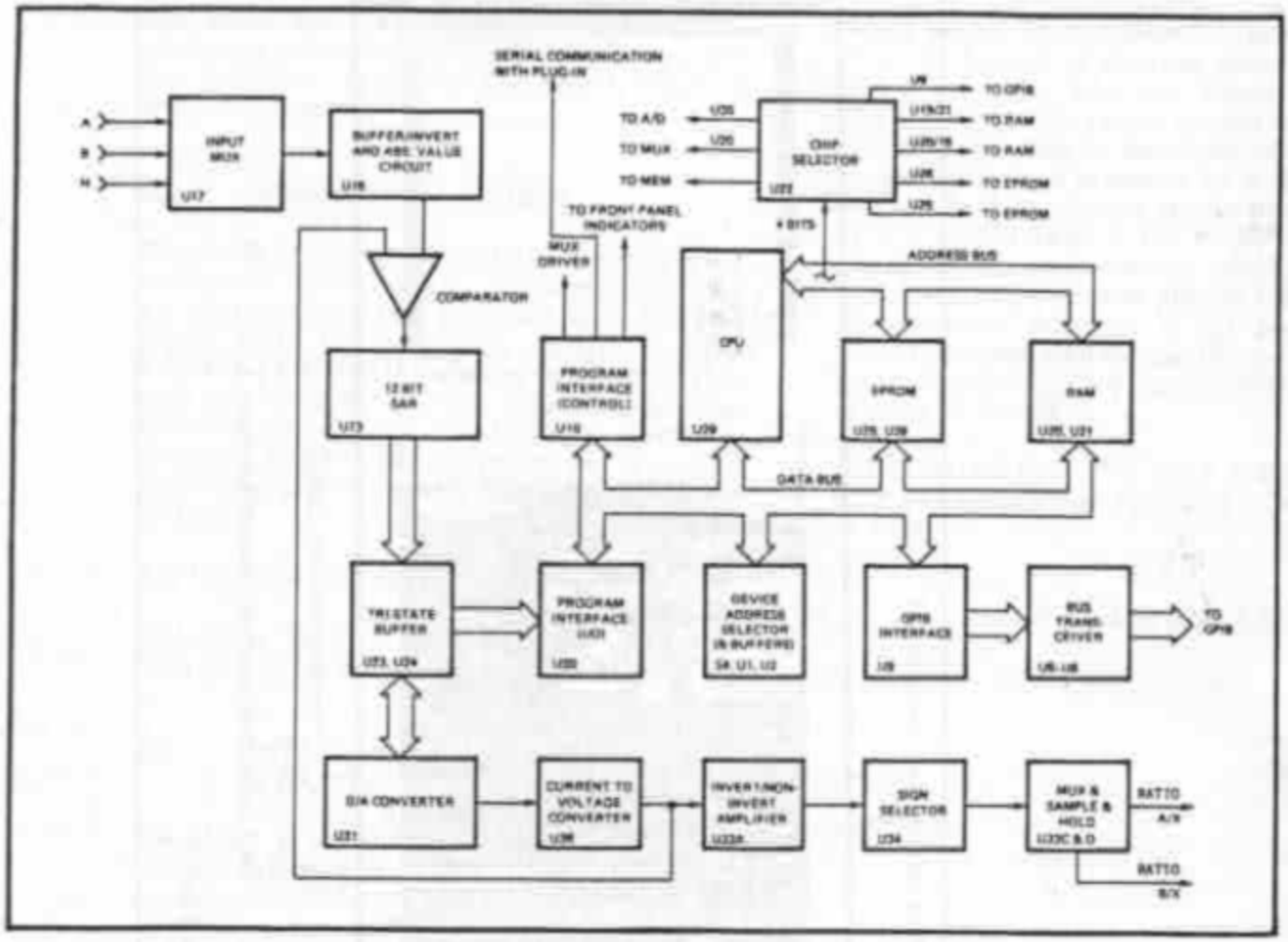


Figure 4-2. IEEE Interface Board Block Diagram

4.4 THEORY OF OPERATION

(Use Figure 4-2 on the foldout sheet to the left, and SD 13766 on page 8-19 to better understand the following discussion)

Three analog inputs (Channel A, Channel B, and Horizontal) are multiplexed into a single A/D converter (U13) whose output connects to the Z80 CPU (Central Processing Unit) data bus via an 8255 I/O device. This programmable interface exchanges data bi-directionally, inputting digital words to the CPU and outputting CPU words to the D/A converter (U31). (A second 8255 device provides control to the multiplexers, etc., and senses the presence of an N10 or NS20 plug-in unit.)

The exchange of data between the D14A and the Controller is effected bi-directionally via U9 which manages the data transfer protocol.

The Z80 CPU is a microprocessor utilized in the coordination of all operations involved in the processing, formatting, and exchanging of display or plug-in data. EPROM devices U25 and U26 contain program firmware. 4K x 8 RAM storage is supplied by U20 and U21.

4.4.1 Analog Input/Output Circuits

Multiplexer U17, under the control of the CPU (via Programmable Interface, U10), applies channel A, channel B, or the Horizontal signal to buffer stage U16B. The output is inverted in U16B, and the signal is fed to the absolute value circuit of U16C&D. This circuit converts signals of either polarity from the multiplexer into a positive-going plus sign bit.

U15 is the sign comparator. Its output, with logic equal to A "plus", is buffered and inverted by U24 and drives U30. The analog output of the absolute value at TP1007 feeds the A/D comparator U15A at pin 5. The other input at U15A is derived from U36, which is driven by the D/A converter output at pin 9 of U31. The selected input is compared with the output of U36, which represents the value supplied by U13. This value is revised 12 times, each attempt being a closer successive approximation to the input level. The value is read by U30 and available for transmission to the D14A CPU.

The net effect of this process is the creation of a 12-bit data word (plus a sign bit from U15B) which is read by Programmable Interface U30. The conversion is clocked at 500kHz at U13 where the approximation register outputs are buffered onto the interface ports (and into the U31 D/A) by U23 and U24.

Conversion of digital words into analog at U31 can be the result of either U13 successively approximating the multiplex input signal, or the CPU transmitting data via the Programmable Interface. In either case, the analog current into U36 is converted to voltage and feeds amplifier U33B. The appropriate sign is decoded (from the 13th bit or MSB) by U35, which is an analog switch that selects either the inverting input or the output of amplifier U33B. Output multiplexer U34, which is controlled by the CPU (via U10), drives the sample and hold devices, U33C or U33D, to furnish ratio A or B data when data is being transmitted. These outputs are held at zero when data is being received at U17.

4.4.2 Programmable Interface

The 8255A devices at U30 and U10 are Programmable Peripheral Interface (PPI) circuits operating under control of the CPU. They each provide 24 I/O pins organized in 3 ports: A, B, and C. Port C can be used for control function implementation. A tri-state bi-directional 8-bit buffer is provided internally to interface the device to the system data bus. The system software programs the functional configuration of each port when the CPU outputs a control word to the 8255A. Pins 8 and 9 (A0 and A1) control the input or output mode of port A, B, or C according to the state of the not-RD and not-WR lines (pins 5 and 36). Data (or status information) is sent to the CPU from the selected port (determined by A0 and A1 bits) when not-RD is true. When not-WR is true, the direction of data exchange is reversed.

The 13 bits of digitized input or output signal are coupled to the CPU by Port A (8 bits) and Port B (5 bits) of U30. Port C controls logic to drive SAR device U13. When U30 is in the output mode, the SAR output from U13 becomes the data source. U10 controls the input multiplexer, U34, via its B Port. The control of buf-

fers U23 and U24 is also from the B Port. Port C controls status indicators for Talker Active, Listener Active, Service Request, etc. It also provides 4 bits to data bus 0 through 3 for communication with the plug-ins. Both U30 and U10 communicate with the CPU on the 8-bit system data bus.

4.4.3 Central Processor Unit

The Model Z80 CPU is a monolithic 8-bit microprocessor serving as the heart of the interface control system. Software resides in U25 and U26 which, together, form an 8K x 8-bit array of UV Erasable PROM memory. Random Access Memory (RAM) is provided by U20 and U21 which form two 8K x 8-bit storage arrays. A clock circuit comprised of U27 and associated components provides the basic timing for the CPU.

U9 is a general purpose interface adapter (8291, GPIB Talker/Listener) that communicates with the microprocessor data bus. The connection is via the processor system data bus which is distributed to the memory board, the programmable interface, firmware, and RAM circuitry. A 10-bit address bus is also connected to all memory elements on the IEEE Interface Board.

U9 also communicates with the Controller via bi-directional bus transceivers U5, U6, U7, and U8. Signal lines IB0 and IB7 provide for the flow of seven bit ASCII (typically) interface messages (and dependent messages) in bit-parallel, byte-serial fashion. An additional 8 lines provide for general bus interface management and data byte transfer control.

The Controller sets the attention line (ATN at pin 11 of J21 on the SD) true when bus commands are to be transmitted to the Talker/Listener. This disables current talkers and listeners, and frees the signal lines IB0 through IB7. When information is to be exchanged on the bus data lines, a three-sequence protocol or "handshake" is established on byte transfer lines NDAC, NRFD, and not-DAV.

4.4.4 Other Circuits

Crystal clock oscillator U38 furnishes a 16MHz reference to binary counter U27 to derive the 2MHz clock input for the Z80 CPU and the U9 device. A 1MHz output is furnished to U4A, which is divided by 2 to generate the conversion cycle clock frequency of 500kHz.

The purpose of the U22 octal decoder is to read the most significant nibble (bits A12 - A15) of the 16-bit address line. The decoder selects a CPU peripheral, either the EPROMs, RAMS, the Programmable Interfaces, or the U9 Talker/Listener.

4.5 MODEL 1038-D14A SOFTWARE

The remotely programmable functions of the D14A can be divided into five major groups. These include those functions related to plug-ins, to displays, test, calibration, and some miscellaneous functions.

4.5.1 Processing of Data for Display

Channel A and B data is displayed on the CRT with respect to the horizontal sweep. At slow sweep rates, for instance, the signals may be refreshed at a flicker-free rate from the display memory board, A6 (not part of the IEEE Interface). The Controller can remotely execute all functions that an operator can perform manually with respect to the memory. These include:

- Read memory contents
- Write data into memory
- Select or de-select MEMORY ON
- Select or de-select SAVE

As an example of a typical Controller-executed function, the D14A can be programmed to replot measurement data after it has been processed by the Controller.

The remote programming codes and data formats for processed or refresh display memory functions are listed in Table 4-A on the next page.

Table 4-A. Refresh Display Functions

Code	Display Function	Description
DA	Read Display Channel A	Read display memory, Channel A, 512 points, and store in interface memory. 500 points are within the graticule.
DB	Read Display Channel B	Read display memory, Channel B, 512 points, and store in interface memory. 500 points are within the graticule.
DC[1]	Write Display Channel B	Write to interface memory at ±XX.XX horizontal divisions, a vertical value of ±Y.YY divisions.
DD[1]	Write Display Channel B	Write to interface memory at ±XX.XX horizontal divisions, a vertical value of ±Y.YY divisions.
DE	Read Display Channel A	Read to GPIB the A channel display memory data, stored in interface memory by DA or DB command, as an ordered array of 512 values separated by ",".
DF	Read Display Channel B	Read to GPIB the B channel display memory data, stored in interface memory by DA or DB command, as an ordered array of 512 values separated by ",".
DG	Write Display Channel A	Send as DG ±Y.YY, ±Y.YY . . . 512 values. Write display data from GPIB to interface memory.
DH	Write Display Channel B	Send as DH ±Y.YY, ±Y.YY . . . 512 values. Write display data from GPIB to interface memory.
DL	Display Load	Loads display memory from interface memory data as stored by "DC", "DD", "DG", and "DH" commands.
DS	Display Save	Save display memory (disable update).
DU	Display Update	Enable display memory update.
DM	Display Memory	Memory-on, enable display memory.
DR	Display Real Time	Memory-off, disable display memory.
DV[2]	Display Value	Returns display memory value at ±XX.XX horizontal divisions as stored in interface memory by "DA", "DB", "DC", or "DD" command. Format is ±Y.YY vertical divisions followed by "CRLF". ±XX.XX ranges are from -0.12 to +10.00 divisions. 50 points/division resolution. ±Y.YY ranges from -4.38 to +4.38 divisions. Approximately 30 points/division resolution.

Notes: 1) Enter ±XX.XX and ±Y.YY with code. 2) Enter ±XX.XX with code.

4.5.2 Measured Plug-In Data

Channel A and B vertical and horizontal data are available directly as outputs of the 1038-D14A system plug-ins. The Controller can read this data with 0.02dB resolution, and can program vertical data to the same resolution. Thus, the Controller can send theoretical reference data to the plug-ins to be ratioed with raw measured data via the interface memory. Another typical Controller-executed function is the stepped CW mode, in which a programmable sweeper is indexed to the desired frequency, the measurement is delayed (to allow the system to settle), and the data is read from the D14A. Since the D14A can measure horizontal sweep position, the mode described is only desireable when very precise frequency versus data correspondence is required.

The remote programming codes and data formats for measured plug-in data or direct channel functions are listed in Table 4-B on the next page.

4.5.3 Calibration Functions

Calibration functions include the following:

CA - Reads Channel A data

CB - Reads Channel B data

CH - Reads Horizontal data

CZ - Cal zero; for setting R43, R60, R68

CF - Cal full scale; for setting R34, R61

CG - Cal gain; for setting output R56

See Section 4.6.1 for the use of these codes.

4.5.3.1 TEST FUNCTIONS

Used only as troubleshooting aids.

TA - Writes and reads only location 0, then writes a "crossed X" test pattern to the display confirming the proper operation of the IEEE Bus with respect to display capabilities.

TB - Turns on the TAC light on the front panel.

TC - Turns on the LAC light on the front panel.

TD - Turns on the SRQ light on the front panel.

TE - Writes a "crossed X" test pattern to the display memory.

TI - Exercises the IEEE Bus address read function for troubleshooting tri-state buffers, data lines, and chip selects.

TL - Exercises the U22 chip select decoder for troubleshooting chip selects.

TM - Exercises the U35 output sign selector for troubleshooting the sign selector circuitry.

TN - Exercises the U34 output multiplexer for troubleshooting.

TO - Samples and holds data on C16 and C17 to test S/H droop.

TP - Exercises the U17 input multiplexer for troubleshooting.

TQ - Free run the A/D converter for troubleshooting.

TR - Exercise the D/A converter for troubleshooting.

These functions are available on all of WPM's IEEE Interface Boards.

4.5.3.2 MISCELLANEOUS FUNCTIONS

SE - Enables IEEE Bus function SR1, enables serial poll capability. The instrument will generate SRQ when specified operations are completed. RA or RB complete generates 60H (Hex).

An SRQ can be generated from an N10 keypad by sequence Chan A (or B), SF1, 9, 0 through 9, and will generate SRQ responses 40H through

Table 4-B. Direct Channel Functions

Code	Plug-In Function	Description
RA	Read Channel A Output	Read A output, 512 points, and store in interface memory.
RB	Read Channel B Output	Read B output, 512 points, and store in interface memory.
RC[1]	Write Ratio A	Write ratio input ±YY.YYdB at ±XX.XX horizontal divisions. Store data in interface memory.
RD	Ratio (disable)	Disable ratio activity of "RH" or "RJ".
RE	Read Horizontal, Channel A, and Channel B	Read Horizontal, A output, and B output, 1 data point each, separated by "," and followed by "CRLF". Format is ±YY.YYdB.
RF	Read A or B Channel Output	Read to GPIB the plug-in data for A and B channel as stored by "RA", "RB", "RC", or "RG" commands. The data is an ordered array of 512 values separated by ",".
RG	Write to Interface Memory	Write plug-in ratio data from the GPIB to the interface memory. The command code is followed by 512 values separated by ",". Data can then be used by "RH" or "RJ" command.
RH	Ratio Channel A	Ratio A channel measurements to the data stored by "RC" command.
RJ	Ratio Channel B	Ratio B channel measurements to the data stored by "RC" command.
RV[2]	Ratio Value	Return plug-in ratio value at ±XX.XX horizontal divisions as stored in interface memory by "RA", "RB", or "RC" command. Format is ±YY.YYdB followed by "CRLF". ±XX.XX ranges from -0.12 to +10.10. ±YY.YY ranges from -81.90 to +81.90.

Notes: 1) Enter ±XX.XX and ±YY.YY with code. 2) Enter ±XX.XX with code.

49H. For example, this feature can be used to call up special programs stored in a controller.

SD - Sets the instrument to IEEE Bus function SRQ and disables the serial poll capability.

XA - Plot channel A. Same function as pressing RECORD A button on the front panel.

XB - Plot channel B. Same function as pressing RECORD B button on the front panel.

4.6 MAINTENANCE AND CALIBRATION

No special preventative maintenance routines are required for the IEEE Interface Board, but a number of variable resistors are available for adjustment in order to calibrate the circuitry to operate in concert with the measurement system. The test equipment required includes a DVM (Digital Volt Meter) and a precision power supply.

4.6.1 Calibration Procedure

Several software routines have been designed to exercise the D14A with option 04 to assure the proper adjustment of the IEEE Interface Board.

Note 1: The nature of the control elements requires that the alignment procedure precisely follow the sequence as given below.

Note 2: The Test Point (TP) number may be printed on the PC board as "J" as well as "TP". In this case, disregard the J number and use the TP number (e.g. a J16 test point shown on the board would be the same as TP1016 as given in the instructions.

4.6.1.1 ZERO SET ADJUSTMENTS

Step 1: Issue the command CZ from the controller. This sets up the D/A converter for zero alignment.

Step 2: Adjust A10R43 (D/A ZERO) for 0V ±1mV as read across A10TP1013 and A10TP1016.

Step 3: Adjust A10R60 (- OUT) for 0V ±1mV across A10TP1013 and A10-TP1016.

Step 4: Adjust A10R68 (+ OUT) for 0V ±1mV across A10TP1011 and A10-TP1025.

4.6.1.2 FULL SCALE ADJUSTMENTS

Step 1: Issue the command CF from the controller.

Step 2: Adjust A10R34 (D/A FS) for 10.2375V ±1mV across A10TP1013 and A10TP1016.

Step 3: Adjust A10R61 (+ G OUT) for -8.190V ±1mV across A10TP1011 and A10TP1025.

4.6.1.3 OUTPUT GAIN ADJUSTMENTS

Step 1: Issue the command CG from the controller.

Step 2: Adjust A10R56 (- G OUT) for 8.190V ±1mV across A10TP1011 and A10TP1025.

4.6.1.4 A/D CONVERTER ADJUSTMENTS

Note: All calibration steps must be performed in the order given.

In order to calibrate the A/D Converter for gains and offsets, a voltage must be injected between TP1003 and TP1025 for channel A, and between TP1005 and TP1025 for the horizontal faction. The injected voltage is then converted by sending a "CA" or "CH" command over the bus from the controller, and reading the result to the controller. ±W.XYZ injected at TP1003 will convert (by the "CA" command) to ±WX.YZ dB ±0.02dB read into the controller.

Step 1: Mask off (insulate) pins A3 and B3 of A8J1. These are the A channel and Horizontal inputs into the A/D converter. Inject -0.02V ±10mV (corresponding to +0.2dB) at TP1003.

Step 2: Issue the CA command from the controller. Read the dB level measured on the controller display. Example:

```
Print @ 4:  "CA"
Input @ 4:  A$
Print A$
```

(Tektronix Basic address "4")

Step 3: If the value is not within ±0.02dB of the injected value, adjust A10R12 (- IN) and issue the CA command again. Repeat as required.

Step 4: Re-adjust the plug-in for +0.02V ±10mV (-0.02dB) across A10TP1003 and A10TP1025.

Step 5: Issue the CA command and read the dB level. If not within ±0.2dB of the injected value, perform Step 6.

Step 6: Adjust A10R13 (+ IN) and issue the CA command again. Repeat as required.

Step 7: Re-adjust the plug-in for -8.000V across A10TP1003 and A10TP1025 (or -80.00dB on the display).

Step 8: Issue the CA command and read the dB level. If not 80.00dB ±0.02dB, perform Step 9.

Step 9: Adjust A10R18 (- G IN) and issue the CA command again. Repeat as required.

Step 10: Re-adjust the plug-in for +8.000V across A10TP1003 and A10TP1025 (or -80.00dB on the display).

Step 11: Issue the CA command and read the dB level. If not -80.00dB ±0.02dB, perform Step 12.

Step 12: Adjust A10R20 (+ G IN) and issue the CA command. Repeat as required.

4.6.1.5 HORIZONTAL ADJUSTMENTS

Step 1: Remove the horizontal plug-ins.

Step 2: Connect the precision power supply, set for 0V across A10TP1005 and A10TP1025.

Step 3: Issue the CH command. Read the dB level measured on the controller display. (See the example given in Step 2 of Section 4.6.1.4. Substitute "CH" for "CA".)

Step 4: Adjust A10R92 (HORIZ OFFSET ADJ) for 5.000V ±10mV on the controller display. Repeat Steps 3 and 4 as required.

5. CIRCUIT DESCRIPTION

5.1 INTRODUCTION

This section of the manual contains a functional description of the electrical circuits contained in the plug-in chassis and CRT display chassis sections of the D14A Mainframe housing. Table 5-A lists the circuit assemblies by reference designation, and includes the pertinent schematic drawing and assembly numbers for convenience. Assembly A10 is optional, and is covered separately in Section 4 of this manual.

5.2 BLOCK DIAGRAM DESCRIPTION

(See Figure 5-1 on page 5-2)

The Interface Board (A1) accepts horizontal and vertical signals from the plug-in unit(s). Vertical signals are processed for display on the CRT and/or storage in the memory. Horizontal signals are processed to supply the deflection signals for the display.

The Interconnect Board (A2) couples the low voltage power supply outputs to the system via the Interface Board. It also furnishes certain signals to the Input/Output and other connectors located on the rear panel of the instrument.

The Power Supply Assembly (A3) provides three different voltages to the system. These include +15V, +5V, and -15V dc.

The Deflection Circuit (A4) interconnects horizontal and vertical axes information from the plug-in(s) to and from the Memory Board (A6), and also processes the horizontal and vertical signals prior to their application to the CRT display. An output for an accessory Response Recorder is provided.

Numerous display circuit functions are routed through A4, including Geometry, Astigmatism, and certain front panel controlled operations such as intensity and trace rotation. Regulation for the High Voltage Power Supply (A5) is also provided, along with focus control and CRT blanking.

Table 5-A. Model 1038-D14A PC Board Assemblies

Reference Designation	Nomenclature	Assembly Number	Schematic Dwg. (SD) No.
A1	Interface Circuit	14101	14102
A2	Interconnect	15778	15697
A3	Power Supply	14126	14127
A4	Deflection Circuit	14087	14088
A5	High Voltage Supply	14095	14096
A6	Memory Board	15527	15528
A7	Front Panel	14413	15697
A8	IEEE Interconnect	14493	15697
A9	IEEE Indicator	15709	15697
(A10)	IEEE Bus Interface (Option 04)	15765	15766

The High Voltage Power Supply (A5) converts dc low voltage to the several high voltage potentials (1.55kV dc maximum) utilized by the CRT in the display section of the system.

The Memory Board (A6) receives analog horizontal and vertical (A and B) signals, converts them to digital format, and stores them for further use by the display. Vertical signals are quantized to 256 points and horizontal signals to 512, to assure faithful signal reproduction.

The CRT provides a 4 x 5 inch display with an internal 8 x 10 division graticule. It operates with a single beam, and has a type P31 phosphor coating.

5.3 INTERFACE CIRCUIT PC BOARD (#A1)

(See SD 14102 on page 8-7)

This circuit provides the interconnection from the plug-in(s) to the rest of the mainframe. There are three primary inputs (one horizontal and two vertical), and one primary output that connects to the deflection circuitry of board A4.

The main signals that are coupled to A4 include:

- Differential A and B channel
- Differential horizontal channel
- Display logic to select A or B

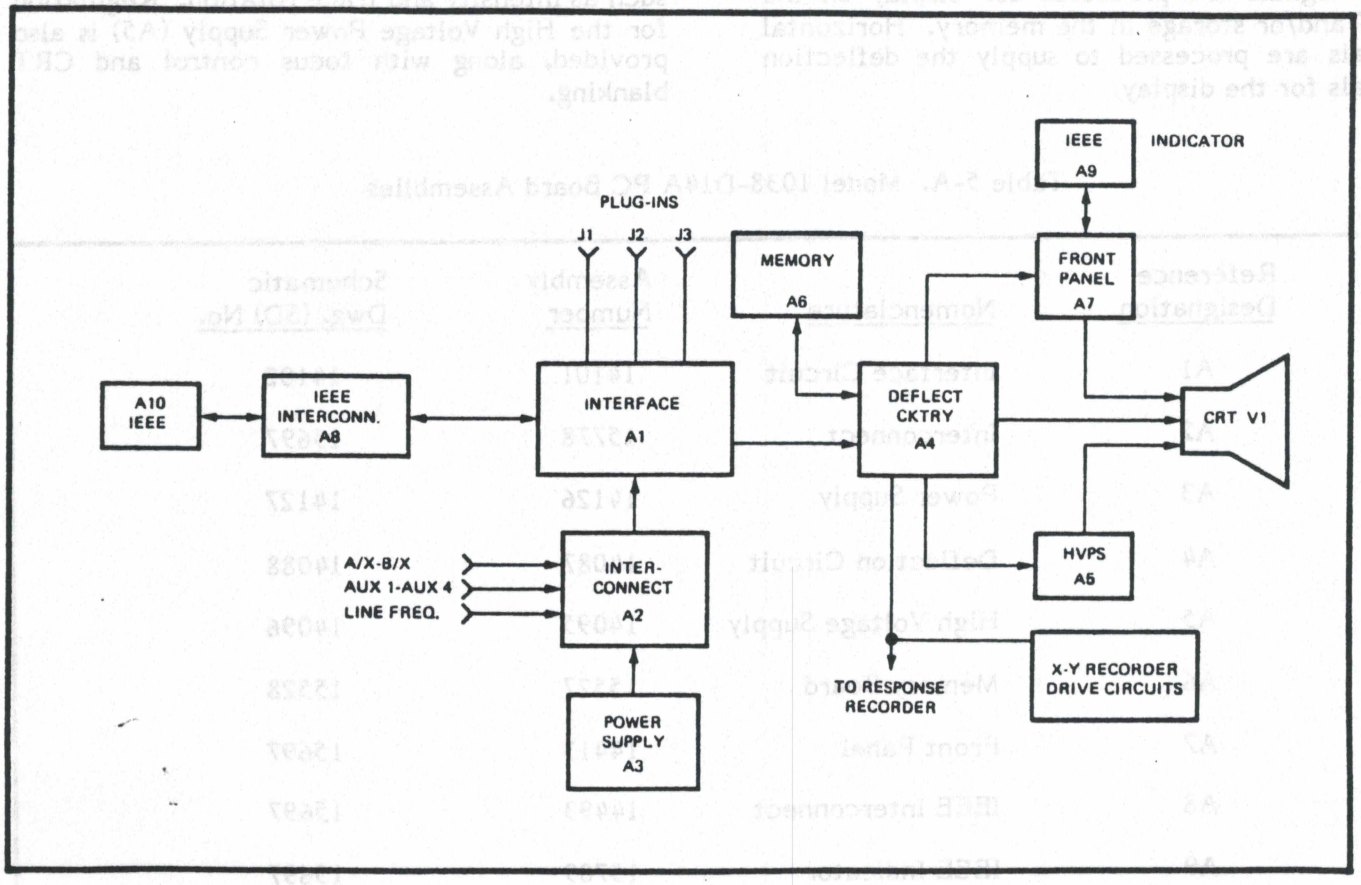


Figure 5-1. Functional Block Diagram

- Retrace blanking from the plug-in(s)
- Intensity (Z-axis) control

Amplifier stages A1U1A and A1U1B drive the ratio input connections to the vertical signal conditioning section of the plug-in(s), and to the (optional) IEEE Interface Board. In addition to A and B, the following secondary outputs also feed the IEEE Board:

- Data bus 0 through 3
- Input ratio A and B
- Differential horizontal channel
- Data bus 4 and 5

5.4 INTERCONNECT PC BOARD (#A2)

(See SD 15697 on page 8-5)

This circuit serves primarily to connect power supply potentials to points throughout the mainframe and plug-in(s). Connections are also made to the rear panel Input/Output connector, and include auxiliary signal paths to and from the plug-in(s).

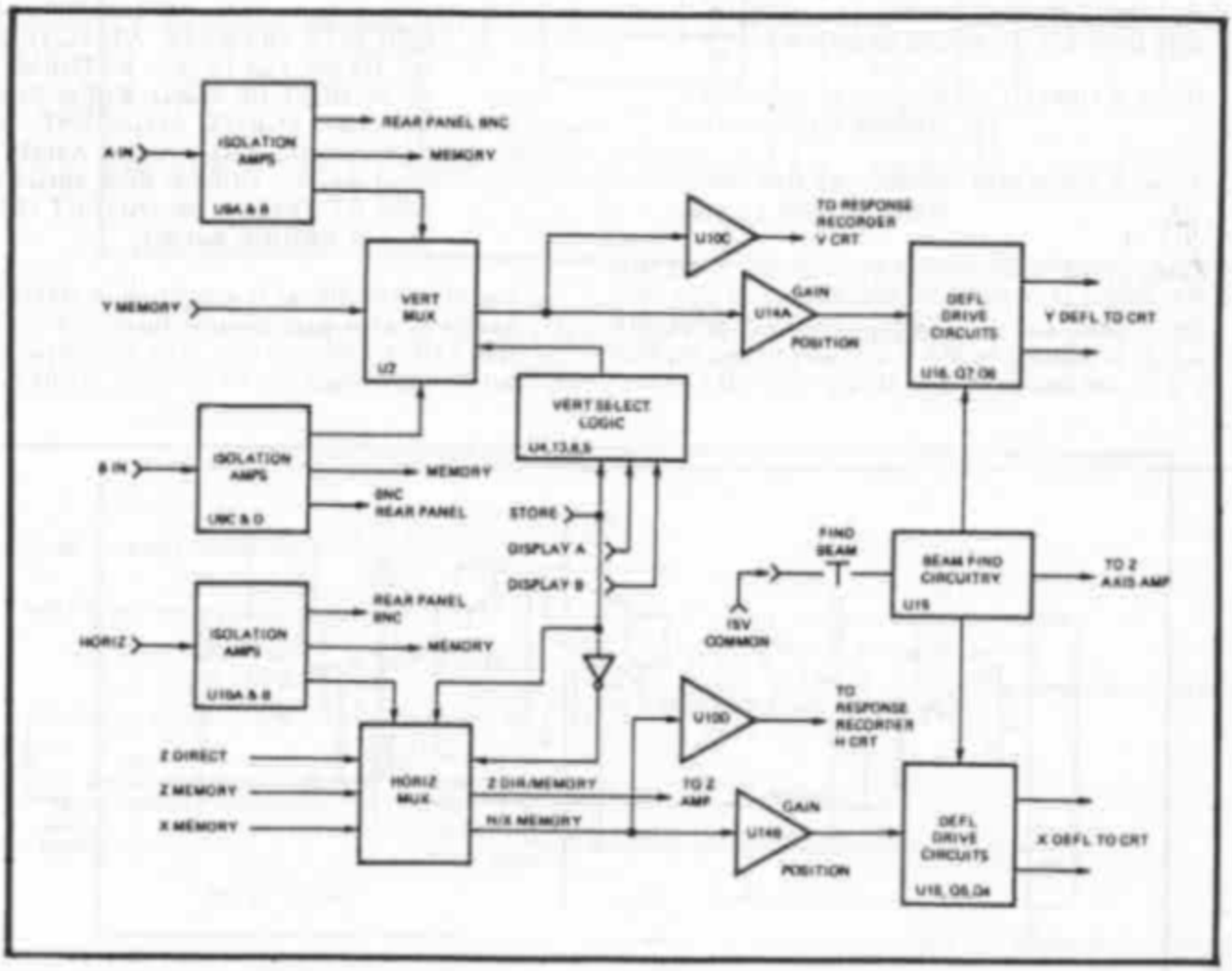


Figure 5-2. X-Y Deflection Block Diagram

The full-wave bridge rectifier, CR1, receives alternating current from the 15.6V center-tapped secondary winding of transformer T1 to provide the power supply with unregulated (but filtered) voltage for the ±15V power supply.

5.5 POWER SUPPLY PC BOARD (#A3)

(See SD 14127 on page 8-9)

Unregulated voltage enters the Power Supply board and goes to the emitters of transistors A3Q4 and A3Q7 which are, respectively, the series pass regulators for the +15V and -15V supplies. Transistors A3Q5 and A3Q6 drive the pass regulators with voltage furnished by ICs A3U2A and A3U2C. Sensing voltage is applied to the +15V amplifier from the voltage divider circuit consisting of A3R24, A3R23, and A3R22, while the path for the -15V is from divider circuit A3R36, A3R37, and A3R38. Zener diode A3CR10 provides a 6.2V reference input to the -15V offset amplifier A3U2A, while the +15V circuit (A3U2A) uses the -15V as a reference. Current limiting is provided at approximately three amperes by A3U2B and A3U2D.

The +5V circuit receives unregulated voltage from the 6.8V rms winding of the transformer and full-wave bridge rectifier, as shown in the top, left section of SD 14127. Series pass regulator A3Q3 is driven by A3Q2, with control voltage furnished by A3U1B. The sensing input is applied to the amplifier via voltage divider A3R12 and adjustment A3R13, and is zener referenced by A3CR2 at 4.3V. A low value (0.05 ohms) series resistance consisting of A3R3 and A3R15 in parallel causes a voltage proportional to the load current to be developed which, in turn, causes A3U1A and A3Q1 to shut down drive amplifier A3U1B if the output current exceeds seven amperes. Additionally, the 5V supply is protected with a 10A rated fuse.

5.6 DEFLECTION CIRCUIT PC BOARD (#A4)

Figure 5-2 provides a simplified block diagram of the portions of SD 14088 (on page 8-13) that relate to electron beam steering in the CRT. Generation of the cursor is a function of the Memory Board, and is explained in Section 5.8.6 on page 5-12.

5.6.1 Vertical Channel Circuitry

Vertical input signals from both channel A and channel B are processed in nearly identical fashion. Differential A channel input is applied through A4J3 pins 8 (-) and 9 (+) to A4U9B, pins 6 & 5, and A4U9A, pins 2 & 3. The single-ended output at A4U9B, pin 7, furnishes channel A signals to the memory (via A4J2, pin 7), and to CMOS switch A4U2, pin 3. The other single-ended output at A4U9A, pin 1, furnishes channel A signals to the response recorder output at A4J5, pin 5, as well as to a BNC connector on the rear panel of the D14A.

The single-ended channel B signal from A4U9D enters CMOS switch A4U2 at pin 6. The third switch input at pin 11 is the Y MEMORY signal at A4J2, pin 9. The outputs of all three switch segments are tied in common and feed deflection driver A4U14A (see Section 5.6.3). Selection of channel A or channel B is determined by NOR gates A4U4B and A4U4A, respectively. The Q and not-Q outputs at A4U13 enable the selected NOR section, unless the not-MEMORY ON line is activated (from the front panel). In that event, the high level from inverter A4U7E provides a negated output from both NOR gates and enables A4U2, through pin 9, to close the Y MEMORY switch segment. When the not-MEMORY ON switch is open, the +5V through A4R53 is inverted in A4U7E disabling the Y MEMORY path, and places a low on the inputs to each NOR gate.

Operation of the A/B selector flip-flop A4U13 is via the clock input from inverter A4U7D (driven by A4U6B and A4U6D), or can be from the set and clear inputs. Input to A4U6B via inverter A4U7B is from the NOR output of A4U5B which has three active inputs. These inputs are the not-DISPLAY A, the not-DISPLAY B, and the MEMORY ON (or +5V via A4R53 inverted by A4U7E).

When any input is high, A4U5B is low. If the High input is not-DISPLAY B a low logic level at A4U6A or A4U6C actuates the clear or preset input at A4U13 (after inversion by A4U7A or A4U7C).

5.6.2 Horizontal Sweep Channel Circuitry

The processing of horizontal data is nearly iden-

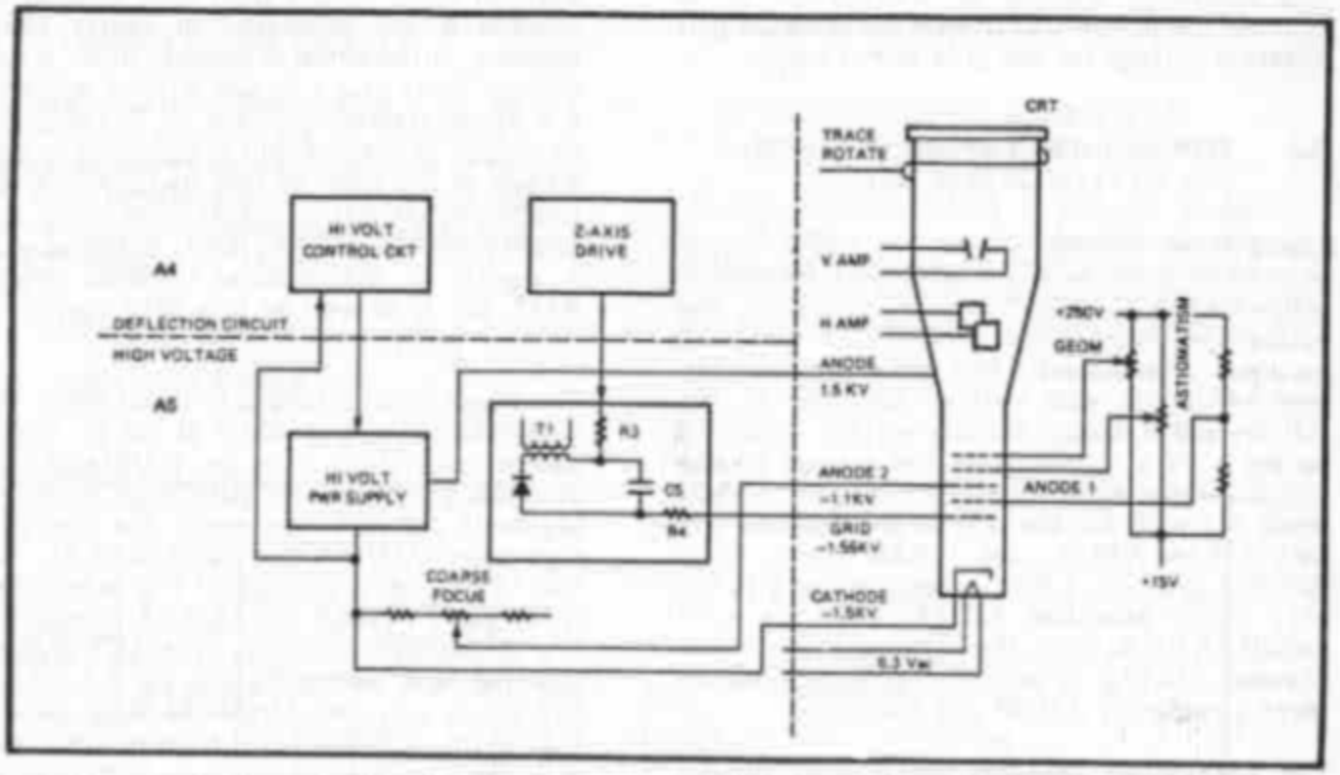


Figure 5-3. High Voltage CRT Circuitry

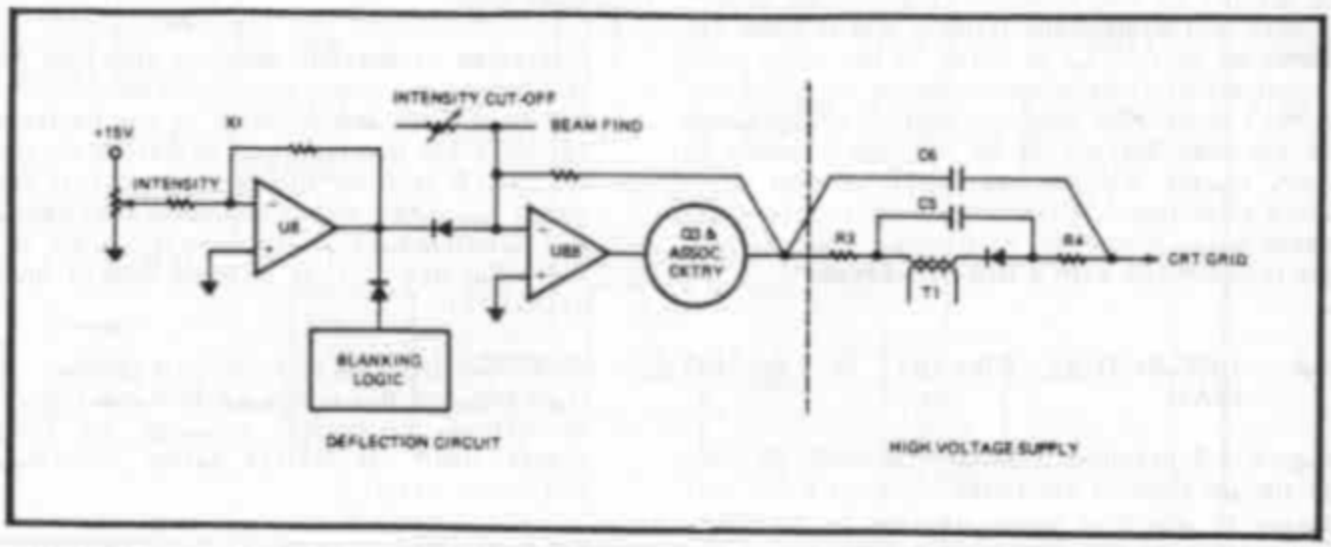


Figure 5-4. Z-Axis Amplifier Circuitry

tical to the processing of channel A or B vertical signals. The single-ended output at A4-U10B, pin 7, furnishes horizontal signals to the memory via A4J2, pin 10, and to CMOS switch A4U3 at pin 3. The other single-ended output at A4U10A, pin 1, applies horizontal signals to the response recorder output through pin 9 of A4J5, as well as to a BNC connector on the rear panel.

The other three inputs to the multiplexer switch A4U3 are Z DIRECT (pin 6), X MEMORY (pin 11), and Z MEMORY (at pin 14).

The H and X MEMORY switch segments have their outputs tied in common. The Z DIRECT and Z MEMORY switch segments also have their outputs tied in common. The switch-enable lines are connected as follows:

H and Z DIRECT	Enabled by false not-MEMORY ON function
X and Z MEMORY	Enabled by true not-MEMORY ON function

Thus, either a horizontal input or the X MEMORY signal is applied to the deflection circuitry for X axis, and a Z DIRECT or the Z MEMORY signal is applied to the Z axis amplifier, depending on the current state of not-MEMORY ON.

In summary, the multiplexing action of A4U2 and A4U3 provides for the selection of either direct or memory-stored signals to be applied to the CRT on the X, Y, and Z axes. Selecting MEMORY ON from the front panel sends the Y MEMORY (A or B) signal to the vertical deflection circuitry and the X MEMORY signal to the horizontal deflection circuitry. The selected X and Y axes signals are also furnished (as VCRT and HCRT) to the response recorder via A4-U10C and A4U10D through A4J5, pins 11 and 12.

5.6.3 Deflection Drive PC Board Circuitry

(See Figures 5-3, 5-4, 5-5 of this section, and SD 14088 on page 8-13)

DANGER: THE DEFLECTION DRIVE CIRCUITS OPERATE AT POTENTIALS UP TO 250 VOLTS DC. EXTREME CAUTION MUST BE USED WHEN PROBING CIRCUIT POINTS ADJACENT TO A4-U15, A4U16, A4Q3, A4Q4, A4Q5, A4Q6, AND A4Q7. CHECK FOR HIGH VOLTAGE AT TP420, THE OUTPUT OF RECTIFIER BRIDGE A4CR1.

The selected signal is amplified in A4U14A and A4U14B, with gain control furnished by A4R77 and A4R88 respectively. The non-inverting input to each stage can be dc-level set by A4R85

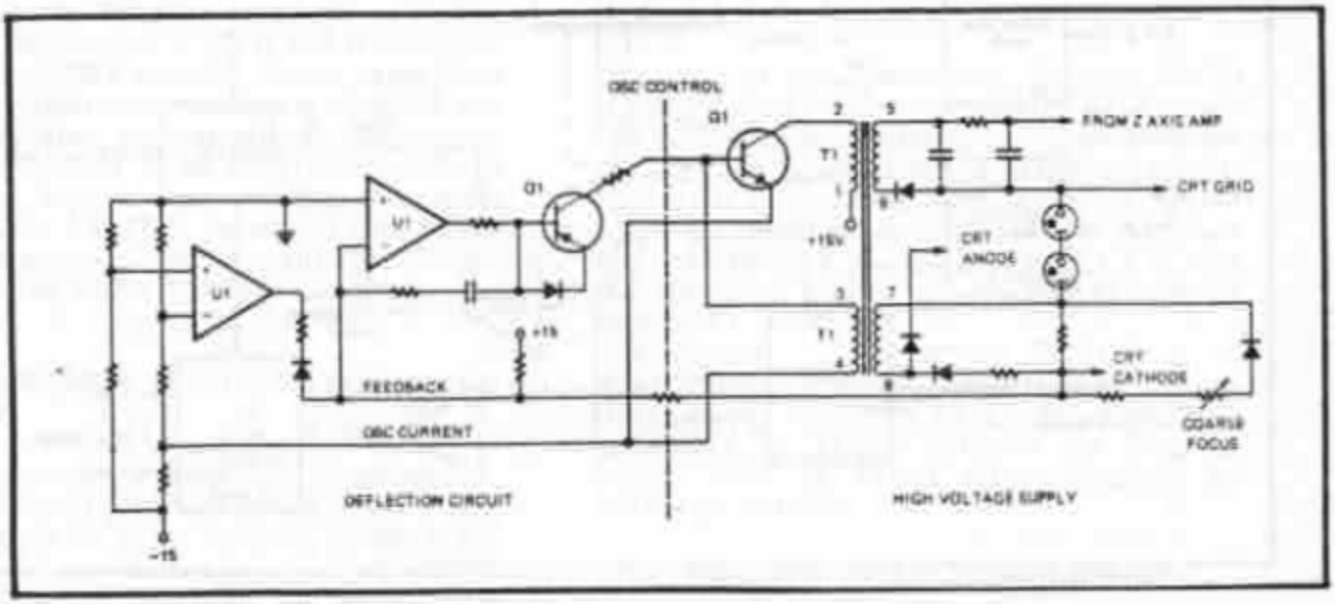


Figure 5-3. High Voltage Circuitry

and A4R96 for VERT POSITION and HORIZ POSITION adjustments. Processed deflection signals are push-pull amplified by A4U16A&B to produce the differential drive for final stage amplifiers A4Q7/A4Q6 (vertical or Y deflection), and A4Q5/A4Q4 (horizontal or X deflection).

Scale factors for Y and X deflection are 15V/-DIV and 30V/DIV, respectively. The differential deflection drive provides for beam positioning up or down and left or right of a mid-point position on the face of the CRT. Resistors A4R77 and A4R88 (at A4U14A pin 3 and A4U14B pin 5, respectively) set the scale factors.

The maximum deflection signal is reduced when the FIND BEAM (Rec Cal) switch (A7S1-3A) on the front panel is pressed. Transistor stage A4-U15D provides this signal when A7S1-3A is grounded (pressed) to provide base drive at A4-U15D, pin 12. Negative voltage at the collector (pin 14) produces conduction in A4CR6, causing base drive at A4U15A and A4U15C to be reduced, and their collector currents to drop until the pushbutton is released. These stages normally furnish constant current drive to A4U16B, and are regulated by A4U15B. The negative A5-U15D collector voltage also drives the Z axis amplifier through A4R52 to increase intensity when the FIND BEAM function is active.

5.7 HIGH VOLTAGE SUPPLY PC BOARD CIRCUITS

The remaining portions of SD 14088 (page 8-13) are described in this section, since they control the circuitry shown on SD 14096, High Voltage Supply (page 8-11). The H. V. supply circuits produce the high voltage potentials, and provide the control circuits necessary for operation of the CRT. The Z-axis amplifier that sets the intensity of the CRT display is also included. Figure 5-3 shows a simplified block diagram of the high voltage CRT circuitry.

5.7.1 High Voltage Circuitry

Refer to Figure 5-5 on page 5-6 and SDs 14096 (A5) and 14088 (A4) to better understand the following discussion.

The oscillator circuit consists of A5Q1, A5T1, and associated circuitry. The primary of A5T1 (pins 1 and 2) is tuned to approximately 30kHz by A5C1. The (positive) feedback winding is 2 turns (pins 3 and 4) coupled to the base of A5Q1 by A5C2. The base drive current for A5Q1 is obtained from A4Q1 on the deflection PC board (#A4). The feedback for the H. V. regulation is through A5R12 to the summing junction of the control amplifier A4U1, pin 2. Reference current is obtained from +15V through A4R114. A4R116 provides a voltage proportional to the dc current of the oscillator. At a level of approximately 360mA, A4U1A becomes active and takes control of the oscillator drive, which limits the current and prevents damage to the oscillator.

5.7.2 Z-Axis Amplifier

Refer to Figure 5-4 and SD 14088 (A4) to better understand the following discussion.

Unity gain stage A4U8A furnishes current drive at pin 7 to the input of shunt-feedback operational amplifier A4U8B/A4Q3. The feedback path is from A4U8B, pin 1, through the A4Q3 collector to the input at pin 2 of A4U8B. The linear output voltage provides the drive signal to control the CRT intensity level through the control grid circuit of PC board A5, High Voltage Supply.

The output level of the Z-axis amplifier is established by the voltage drop across A4R119 in reference to virtual ground at A4U8B, pin 2, which is the summing point of the operational amplifier. The current through A4R119 is determined by the input current from any combination of several sources. These sources are as follows:

1. Input at pin 4 of A4J8, established by the setting of the front panel INTENSITY control

2. Blanking from A4U4D, pin 1, which can originate with:

   a) Plug-in blanking signal at pin 4 of A4J3

   b) External BLANKING IN signal from the rear panel BNC at pin 1 of A4J5 (level should exceed 3.4V)

c) MEM BLANKING signal at pin 13 of A4J2

d) Z MEMORY signal (applied to A4-U8A through A4R42) when not-MEMORY ON line is active

3. FIND BEAM signal (applied to A4U8B through A4R52)

Resistors A4R48 and A4R50 are adjustable, to set the range of the front panel INTENSITY control.

5.7.3 High Voltage Outputs

Transformer A5T1 has two secondary high voltage output windings that provide the potentials required by the CRT for the cathode, control grid, and anode. The -1500 volt accelerating potential for the cathode is supplied by half-wave rectifier A5CR3. The cathode heater voltage is raised to the cathode potential through A5R10. Half-wave rectifier A5CR2 provides the +1500 volts required by the anode.

Half-wave rectifier A5CR1 provides about -1350 volts to establish bias voltage on the CRT control grid. This voltage, as well as the CRT beam current, is controlled by the Z-axis amplifier which includes the INTENSITY control, blanking inputs, and intensification of the FIND BEAM. A4R48 (INTENSITY LIMIT) and A4R50 (INTENSITY CUTOFF LEVEL) on the deflection board provide a fine adjustment of the quiescent grid voltage, to bias the CRT just below cutoff with the front panel INTENSITY control set counterclockwise and no FIND BEAM or blanking inputs. Neon bulbs A5DS1 and A5DS2 give protection to the CRT if the voltage difference between the control grid and the cathode exceeds about 120V.

5.7.4 CRT Control Circuits

In addition to using the INTENSITY control discussed above, an optimum CRT trace display can be achieved by proper adjustment of the front panel FOCUS control (A7R3) and internal astigmatism controls. Control A7R3 adjusts the focus by providing the correct voltage for the second anode, while A4R145 (shown on SD 14088) will adjust the spot size and shape by providing the correct voltage to the third anode. Interaction between the controls requires adjustment of both for optimum spot shape. A4R148 (GEOMETRY) varies the positive level on the geometry electrode of the CRT. The screwdriver-adjustable front panel TRACE ROTATE control (A7R2) adjusts the current on beam rotation coil L1 to align the display parallel with the X-axis lines on the CRT graticule.

5.8 MEMORY PC BOARD CIRCUITRY

The 1038-D14A incorporates a refresh memory to provide a clear, flicker-free display even when sweeping at slow speeds. Data relating to two traces is stored in the digital memory, providing 512 discrete horizontal address locations with 1024 vertical steps per trace. Vertical information for both the A and B channels can be displayed with the B channel appearing as either a dashed or solid line, depending on which mode has been selected. The digitally refreshed, filtered memory presentation provides connected and smoothed data points with each sweep. Thus, data from even such slow swept measurements as filter response are shown with a bright, flicker-free display. The front panel SAVE control permits stopped action oscilloscope photos of stored data to be made from the display. Stored data from the memory updates the display completely during each sweep so that a continuous display is generated at the same time new data is being written into the memory.

To better understand the following discussion, refer to Figure 5-6 on foldout page 5-9 and SD 13528 on page 8-15. All component reference designations in the discussion should technically be preceded by "A6" but, for better clarity and easier comparison with the SD, the "A6" is omitted.

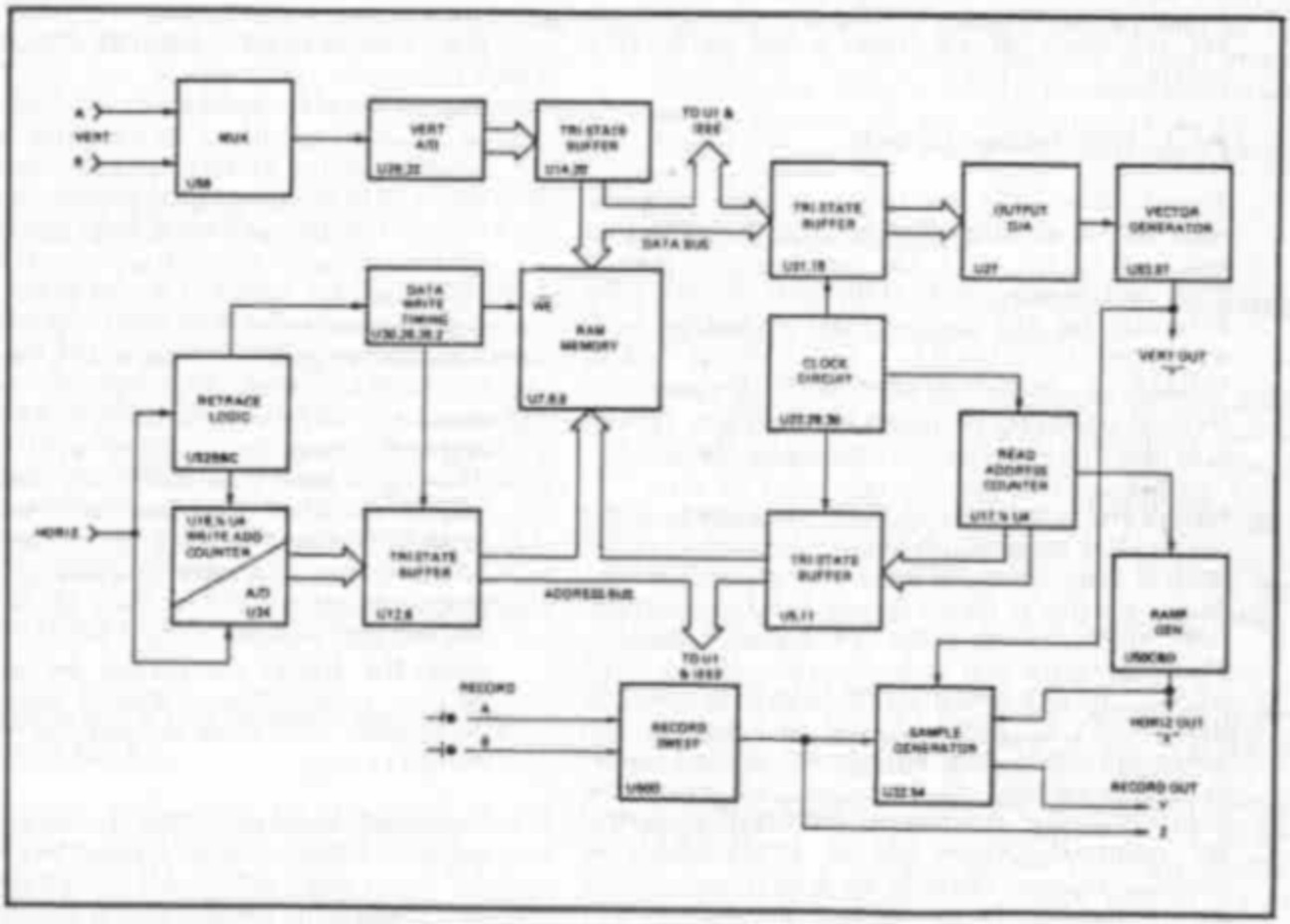


Figure 5-6. Refresh Memory Block Diagram

5.8.1 Decoding the Read/Write Priorities

Incoming A and B channel signals enter the memory board at pins 13 and 12 of J3, and are multiplexed through U56A. U59A&B serve as buffers to isolate signals coming back from switch U56A. This prevents any unwanted signals from getting back to the deflection board and disturbing the real-time display. The multiplexed signal from U56A goes into U57B. U57B is an amplifier to correctly scale the signal for application to U25. U25 is a 12-bit successive approximation register (SAR). Whenever U25 triggers, in conjunction with the digital to analog converter (DAC) U26, it develops a digital word corresponding to the input signal. This action is clocked by a 2MHz signal coming from pin 9 to U29. U25 converts channel A first, then channel B, and then transmits the signal to the random access memory (RAM) data bus through hex bus drivers U14 and U20. These hex bus drivers are enabled by the write-address pulse coming from pin 6 of U19A. This is a brief pulse that occurs for one-half microsecond to allow the signal to get on the RAM address bus and data bus, and write the data. The one-half microsecond pulse is triggered by a memory request input from U31B. As soon as the data conversion is completed, a pulse is fed back to U46B which clears U44A. If the ramp follower is calling for another conversion, then U44A will send a pulse to U25 and another start-conversion pulse will be generated. The start-conversion pulse comes from U19B and is triggered from pin 9 of U44A. Start conversion pulses occur at a rate which is dependent on the horizontal sweep time. Start conversion will be discussed further in Section 5.8.3.

The Z Direct signal comes in through pin 20 of J3, and is applied to buffer U58A. The buffer is used to convert the high impedance input signal to a TTL output. This output is used to control marker intensity, as will be discussed in Section 5.8.2. The TTL blanking signal (input through pin 9 of J3) comes either from the plug-in currently in use in the mainframe, or from a rear connection on the mainframe. The TTL blanking signal, the plug-in blanking signal (input through pin 1 of J4) and a signal labeled "Normal Write" are fed to a bus driver and form the eleventh bit of the RAM data bus. The Normal Write function is required because the plug-in may not be perfectly adjusted, causing the horizontal signal not to go all the way to the left or right edge of the CRT display. Since information to the left or right of the point where the horizontal signal starts and ends generates a displayed trace with extraneous and unwanted indications, blanking bits are used to fill in the memory until the signal gets to the point where the trace begins. From this point on, the only thing that controls the blanking is the TTL blanking coming from either the connection on the rear of the D14A or the plug-in. These blanking signals go to pin 14 of U20, and are transferred to the RAM data bus.

5.8.2 Marker Generation Function

The Z Direct signal is used to control the intensity of the selected markers on the display trace. U43 stores the request for a marker. As soon as it is read into memory, the marker signal is cleared by a signal coming from pin 5 of U43. U43 places the marker signal into U37B through its D input. The signal is clocked through the Q input of U37B at the next increment of the least significant bit (LSB) at the write-address bus. The marker signal will then be available for writing in as a blanking bit. In the meantime, a pulse will leave the Q output of U37B and reset U43. This lowers the voltage on U37B to zero until the next increment of the LSB by the write-address bus returns U37B to its normal state, not calling for any markers. Repetition of this action guarantees that markers are transferred twice, once to the A channel location and once to the B channel location, so that markers will appear on both channel displays.

5.8.3 Start Conversion Function

A start-conversion pulse comes from pin 6 of U42A, and goes through U36D to U37A. If the "Save" function is not active, U37A will transmit a write-memory pulse through U31B to U19A. Pin 6 of U10A then sends the signal as a start-conversion pulse through U19B to U25. U25 generates a write-enable pulse that enables the hex bus drivers, U14 and U20, to send data to the RAM data bus. The data applied to the RAM data bus is both chip select and write enable, and causes the data to be written into the 1K x 4 RAMs U7, U8, and U9. Intensity blanking information and the output of the U25 SAR are all written at the same time.

5.8.4 Read Function

To cause the readout of information that has been previously written into the RAM, crystal clock U23 generates an output which is immediately counted down by U29 (8-bit counter), and fed to decoder U30. The decoder establishes a window during which it will be possible to read. It also signals the write function that a read action is about to take place so that writing will not be initiated, unless it can be completed before reading occurs. As U29 counts, the following states will be present at U30:

2 - Read advance. Causes the read register to advance one increment on the read address bus.

3 - Signal generated to reset the cursor. Has nothing to do with priorities or coding.

4 - Generates a signal which is applied to U31B to inhibit any further transmission of a write request. U37A's Q output is stopped from propagating any information to U19A. This holds up the writing process until the read action is completed.

5 - This count is also applied to U31B so that writing is prohibited during states 4 and 5. U37A will hold any request for writing until U31B allows signal transmission. The read process takes place when the count is at state 5.

To reiterate the previous actions, state 4 makes a new write cycle impossible to trigger. However, if a write cycle were triggered just prior to U30 entering state 4, there will be time for the cycle to finish before U30 enters state 5. State 5 is the actual read period. The memory is read during state 5, but a new write cycle was prohibited starting with the beginning of state 4. The current write cycle has all of the state 4 time period to complete itself. In this way, there is never any possibility of the read and write functions getting mixed up. During state 5, whatever information is in the memory will be transferred to the 1 output register (U21 and U15).

During the read cycle, the output of the RAM is connected to the RAM data bus which, in turn, is connected to U15 and U21. At the same instant, a signal is fed from U36 which is derived from the read period, data is clocked into U21, and then data will be provided to the 10-bit DAC, U27. The DAC furnishes the vertical signal to the CRT through vector generated data that is first stored on C49. Then, at the next cycle, there will be a difference between old data (stored briefly on C49) and the data from the DAC. This difference will be integrated by U57, and will cause a rate of change in the output signal that is proportional to the difference between the old and new data samples. The result is that U57D has an output that moves from the point corresponding to the new sample in a linear fashion (straight line between the two points). If the data output signal were not slewed in this manner, the vertical display on the CRT could end up as a series of dots rather than a straight line. In addition, a low pass filter (C50 and R33) smoothes the signal by eliminating any high speed glitches coming from the vector generator.

5.8.5 Write Function

Horizontal signals enter the memory board through pin 10 of J2, and are applied to DAC U24. U24 is a ramp follower controlled by comparator U51A. Anytime the horizontal input exceeds the value out of the DAC, U51A will call for an additional pulse to be clocked into the counter that will increment the DAC to the correct address bus. The counter that sets the horizontal address is fed through U44A. Every time pin 1 of U51A goes positive, the clock on pin 9 of U44A will increment the address counter. There are two modes of operation, the normal and the fill mode. In the normal mode, as the signal increments, it causes U42B to transmit the signals from U44A as address increments. In the fill mode, U44A sends a 0.5MHz clock signal directly to the horizontal address register. This fills the blanking bit until the counter catches up with the point where the signal is located and then increments. The circuit stays in the fill mode only a brief period of time. This is because the fill mode corresponds to just those locations beyond the CRT display graticule lines on the left and right edges. There are 512 memory locations, 500 of which are located within the calibrated portion of the

CRT screen. If the instrument were in perfect adjustment, this would leave six pulses on the left and six pulses on the right of the screen. U22 forces the counter to clear itself at the start of the retrace period so that a zero count starts slightly to the left of the edge of the screen.

The retrace detector consists of U52B&C which are used to differentiate the input signal. For the periods when the input horizontal signal is retracing, U52 generates a pulse that indicates blanking should be called for, the memory cannot be loaded, and that it is time to reset. The re-triggerable one-shot, U49A, determines the interval between retraces. If the interval between successive retrace pulses is longer than once per second, U49A causes a new data indication to be shown on the screen. This new data indication is shown as an intensity marker that moves along with the sweep. If the sweep is faster than once per second, it is automatically turned off. The latch on U43A is set when retrace occurs. It is not possible to clear the latch until the horizontal signal has returned to within approximately one-half division of the left edge of the screen. This prevents any glitches from resetting the retrace cycle prematurely.

5.8.6 Cursor Generation Function

U55 is a multiplexer that selects the signal source for the X and Y outputs of the memory. In the normal mode, when the memory is on, the Y axis input will come from the memory data bank, and the X axis input will come from the memory ramp generator, U52D. U56B closes once every 8msec and shorts out C81. C81 recharges during the next period and generates the ramp. This gives a continuous horizontal sweep which is applied to the X axis of the CRT. After U56B shorts C81 twice (once for A channel and once for B channel, or two sweeps of the same channel if only one channel is in use), then switch U55 is driven over by information fed from the counter (U4 and U17). As soon as B channel is read, U55 switches and connects the Y axis to a rapid sweep generated by U54A and U50A. This causes a vertical line to be generated whose position is controlled by a "Cursor Position" signal from the plug-in. This signal enters the board at pin 15 of U55, and connects directly to the X axis of the CRT during the period when the cursor is displayed. The sequence of events that occurs then becomes: (1) display of A channel; (2) display of B channel; and, (3) display of the vertical line at the selected cursor location. When the sequence is completed, the counter resets and the sequence repeats.

5.8.7 X-Y Plotter Interface

A horizontal ramp is generated by U50D in conjunction with switch U56B. When either the "A" or "B" record switch is pressed on the front panel of the D14A or a signal comes in over the IEEE Bus (record A or record B), the information is latched into U22C to hold the indication of which channel is to be recorded after the button is released. In addition, when either button is pressed, a signal comes through U16C, U10C, and U45B that will initiate the recorder sweep by triggering the X axis of the recorder. A delay of one-half second allows the recorder pen to move from its rest position at the vertical center over to the write position. At the end of the one-half second interval, U56C is closed which starts the sweep recording. It takes about 30 seconds to charge C84 and, when the output of U50D gets up to 10V, U58D will detect this and feed the logic low back to U45. This starts another one-half second interval, allowing the recorder pen time to lift before the start of the retrace cycle. When this one-half second interval at the trailing edge of the sweep is completed, U56C is closed, U54C is opened, and the sweep will discharge back to ground. The output of the sweep generator goes to the recorder through R105 and R120 which attenuates the signal from 10V to 1V to give the 100mV/DIV required at the output.

U32B is designed to generate a pulse when there is coincidence between the slow sweep that drives the recorder, and the rapid sweep that drives the CRT. Both signals are applied to U32B, the rapid sweep coming from U52D through R79, and the slow sweep coming through R99 as a "Record Sweep" signal. Whenever there is coincidence between the slow and fast sweep (every 8msec at successive points along the sweep), a sample is taken. The sample is transmitted from U50 by U54B which goes to the vertical signal from the memory. The vertical signal is stored on C74, and also fed to the recorder using U50B as a buffer. R65 and

R66 are attenuators to derive the required 100mV/DIV from the ±4V present at U50B. During periods when the sweep is idle, the other part of U54B shorts C74 to ground through R19. This causes the vertical signal to stay at zero volts when the recorder is not recording.

5.9 FRONT PANEL

This minor assembly contains the CRT control elements described earlier, all of which interface with the display via the deflection assembly, A4. The single exception is the not-MEMORY ON/SAVE control, which routes a negative true or ground connection to the memory board when active.

Actual circuit functions pertaining to the front panel are described in earlier sections, and are shown schematically on SD 15697.

5.10 IEEE INTERCONNECT AND INDICATOR

This facility is installed on all standard versions of the mainframe, and provides the ability to equip the unit to be operated over the IEEE General Purpose Interface Bus (GPIB) when option 04 is ordered.

This feature is a customer-selected option, and is covered in detail in Section 4 of this manual. The indicator portion is comprised of three LED displays on the front panel, situated under the heading "GPIB", which will illuminate appropriately to indicate bus status. This feature can be added at some point after the purchase of the instrument, if so desired, due to the design of the 1038-D14A Mainframe

6. PERFORMANCE VERIFICATION TESTS

6.1 PURPOSE

Information in this section is useful for periodic evaluation of the performance of the Model 1038-D14A Mainframe. If the instrument fails to meet one or more of the criteria listed here, refer to Section 7.2, CALIBRATION, for making the necessary adjustments.

These Performance Tests can also be used for incoming inspection if a mainframe is received without plug-in units. (Refer to Section 3.4.4 on page 3-7 for parallel procedures to be used for incoming inspection when plug-in units and detectors are available.)

6.2 EQUIPMENT REQUIRED

The only item of equipment required to make these performance checks is the Model 1038-C10 Calibration Unit, W-PMI P/N 15472.

6.3 DISPLAY SYSTEM CHECKS

Step 1: With the D14A power switch OFF, install the C10 Calibration Unit per Section 2.2 of the C10 Instruction Manual. After the C10 has been properly installed, be sure that the D14A is connected to an ac power source that agrees with the rating on the input power connector, and then turn ON the D14A and allow it to warm up for at least 10 minutes.

Step 2: Set the switches on the front of the C10 unit as follows:

a) HORIZONTAL to ZERO

b) VERTICAL A to ZERO

c) VERTICAL B to ZERO

d) GPIB/REF to OFF

Step 3: Turn the D14A's INTENSITY control fully counterclockwise, noting that the spot on the CRT screen (if visible) disappears.

Step 4: Turn the INTENSITY control clockwise, and note that the spot can be made to de-focus or "bloom". Reduce the intensity until a dim spot is displayed.

Step 5: Adjust the focus control, noting that a sharp, well-defined spot can be obtained. Re-adjust the INTENSITY and FOCUS controls as required to suit the preferred viewing level.

Step 6: On the front of the C10 unit, press VERTICAL A CAL (6 DIV). On the D14A, press the FIND BEAM button. The spots at + and - 3 divisions should brighten noticeably, and move slightly toward the center line of the CRT graticule. Release the FIND BEAM button.

6.4 DEFLECTION SYSTEM CHECKS

Step 1: On the front of the C10 unit, press VERTICAL A ZERO and VERTICAL B OFF. The beam should be in the center of the CRT within 0.1 major division both horizontally and vertically.

Step 2: Press VERTICAL A CAL (6 DIV). Two spots should appear at 3 $\pm$0.03 major divisions above and below the center line of the graticule.

Step 3: Press VERTICAL A ZERO and HORIZONTAL CAL (8 DIV). The two spots must be 4 $\pm$0.04 major divisions on each side of the vertical center line of the CRT graticule.

This completes the Performance Verification Tests for the Model 1038-D14A Mainframe.

7. MAINTENANCE

7.1 PERIODIC MAINTENANCE

The following maintenance should be performed once each year unless the instrument is operated in an extremely dirty or chemically contaminated environment, or is subjected to severe abuse (such as being dropped). In such cases, more frequent maintenance is required (immediate, if abused or dropped).

a. Blow out all accumulated dust with forced air under moderate pressure.

b. Inspect the instrument for loose wires and damaged components. Check to see that the PC boards are properly seated in their sockets, and that all wire lead connectors are properly mated and secure on their PC board pins.

c. Using a cloth dampened in mild detergent solution, clean the exterior of the equipment enclosure. Do not use abrasive cleaners, scouring powder, or harsh chemicals. Wipe the soap residue off with a clean damp cloth, and then dry with a clean dry cloth.

d. Make a performance check in accordance with the procedures of Section 6. If the performance is within required specifications, no further service is required.

7.2 CALIBRATION

The Model 1038-D14A employs solid state components throughout (excluding the CRT). Consequently, there is very little drift due to component aging, and adjustments to the instrument are rarely required. If measurements indicate that an adjustment is set within the range of the given specification, do not attempt to put it "right on". It is often the case that variations in the equipment used to make the test account for small differences in measured values. Since some adjustments can be interactive, **be absolutely sure that an adjustment is really required before making it.**

If a component is replaced, only the minimum of calibration steps should be performed, depending on where the component is located in the circuitry.

7.2.1 Test Equipment Required

1. Digital Voltmeter (DVM), Fluke 8600 or equivalent
2. Oscilloscope (scope) with 15MHz bandwidth and 50mV/DIV sensitivity
3. Model 1038-C10 Calibration Kit, W-PMI P/N 15472

7.2.2 Power Supplies (Low Voltage)

The three power supplies that constitute PC board #A3 are located to the rear of the instrument. After gaining access to the interior of the unit per Section 7.3.3 on page 7-4, perform the following procedures:

A. Install the C10 Calibration Unit per the instruction given in Section 2.2 of the C10 Instruction Manual.

B. Connect the DVM to the "DVM" BNC connector on the front of the C10.

C. Press the -15V button on the C10

1. If necessary, adjust A3R37 (-15V ADJ) for DVM reading of -15V ±10mV

Note: When performing adjustments on the low voltage supplies of the D14A, always start with the -15V supply.

D. Press the +15V button on the C10.

1. If necessary, adjust A3R23 (+15V ADJ) for DVM reading of +15V ±10mV

E. Press the +5V button on the C10.

1. If necessary, adjust A3R13 (+5V ADJ) for DVM reading of +5V ±50mV

7.2.3 CRT Calibration

DANGER: HIGH VOLTAGE POTENTIALS EXIST WITHIN THE INSTRUMENT WHEN POWER IS APPLIED. ALWAYS EXERCISE SPECIAL CAUTION TO SAFEGUARD BOTH PERSONNEL AND TEST EQUIPMENT.

The operating voltages supplied to the CRT are generally very stable, as is the CRT itself. That is, all spacings between grids and electrodes that determine the performance of the CRT are based upon a rigid glass and metal structure. Consequently, it is unlikely that any adjustments will be required unless the CRT (or a component closely associated with the CRT) has been replaced.

After gaining access to the deflection and high voltage power supply circuits, perform the following procedure:

A. Be sure that the procedure given in Section 7.2.2 has been performed.

B. Install the C10 and set the switches as follows: Press VERTICAL A ZERO, VERTICAL B ZERO, and HORIZONTAL ZERO.

C. Turn the D14A power switch ON, and allow at least 15 minutes warm-up time. Be sure the D14A is in the real time mode by releasing the MEMORY ON switch on the front panel.

D. Set the front panel FOCUS control to mid-range. Turn the INTENSITY control clockwise to check that a spot can be seen on the CRT screen, and then turn the control fully counterclockwise.

E. Locate the deflection circuit adjustment panel (near the handle on top of the housing), and turn A4R48 (INTENSITY LIMIT) fully clockwise using an insulated screwdriver. Adjust A4R50 (INTENSITY CUT-OFF LEVEL) until the dot on the CRT screen just disappears.

F. Turn the front panel INTENSITY control fully clockwise. A dot should appear on the screen. Adjust A4R48 slowly counterclockwise until the dot just starts to bloom or enlarge.

G. Verify the proper setting of the Z-axis amplifier by turning the front panel INTENSITY control fully counterclockwise, noting the disappearance of the spot. Setting the control to mid-range should give normal viewing brightness, and turning the control fully clockwise should cause the spot to become very bright with some blooming.

H. Ensure that the front panel FOCUS control is set to mid-range. Gain access to the high voltage power supply, using Figures 7-2 and 7-3 on pages 7-13 and 7-14 as a guide, and adjust A5R14 (FOCUS CENTER) for the sharpest focus. (A4R14 is located to the right of the instrument handle, near the rear of the unit.)

I. On the deflection circuit, locate the four deflection transistors (A4Q4, A4Q5, A4Q6, and A4Q7) by removing the adjustment panel near the handle on top. Measure and record the voltages on the collectors or cases of these transistors. Find the average of the four values, and adjust A4R148 (GEOM) until the voltage on its wiper measures the average value, ±5V.

Note: A4R148 and A4R145 (ASTIG) are located below the horizontal and vertical gain and position controls.

J. Rotate the front panel FOCUS control through its whole range while observing the dot. Adjust A4R145 (ASTIG) until the dot remains as round as possible throughout the entire range of FOCUS adjustment.

7.2.4 Deflection Circuitry

DANGER: THIS CIRCUIT BOARD CONTAINS +250V DC WITH A HIGH CURRENT CAPABILITY, AND IS POTENTIALLY LETHAL! BE ABSOLUTELY CERTAIN THAT ALL CONNECTIONS TO THE BOARD ARE PROPERLY MADE BEFORE STARTING CALIBRATION, AND ALWAYS USE EXTREME CAUTION WHILE TESTING.

A. Be sure that the procedures given in Sections 7.2.2 and 7.2.3.A, B, and C have been performed before starting at this point.

B. Adjust A4R85 (VERTICAL POSITION) so that the spot is centered vertically on the CRT screen.

C. Press VERTICAL A CAL (6 DIV) on the front of the C10.

1. Adjust A4R77 (VERTICAL GAIN) so that the two spots are three divisions on each side of the center line.

2. Repeat B and C as required

D. Press VERTICAL A OFF and VERTICAL B ZERO on the C10.

1. Adjust A4R14 (B CHANNEL BALANCE) so that the spot is on the center line.

2. Adjust A4R96 (HORIZONTAL POSITION) so that the spot is centered horizontally.

E. Press HORIZONTAL CAL (8 DIV) on the C10.

1. Adjust A4R88 (HORIZONTAL GAIN) so that the two spots are four divisions on each side of the center line.

F. Press HORIZONTAL ZERO on the C10.

1. Repeat Steps D.2 and E as required.

G. Press HORIZONTAL SWEEP 10ms.

1. Adjust TRACE ROTATE on the front panel for the best parallel alignment along the center line of the CRT graticule.

7.2.5 Memory Board Calibration

A. Press HORIZONTAL SWEEP 10ms, VERTICAL A ZERO, and VERTICAL B OFF on the C10. The display should be switched from real time to memory by pressing the MEMORY ON button on the front panel.

B. Connect the scope to TP2 (on the low side of the chassis).

1. Adjust A6R76 (HORIZ CTR) for a scope display of exactly -5.1V at the negative peak of the sawtooth waveform.

2. Adjust A6R88 (SWEEP AMP) for exactly +5.1V at the positive peak of the sawtooth waveform.

3. Disconnect the scope.

C. Adjust A6R34 (VERT BAL) so that there is no vertical movement of the CRT trace when switching from MEMORY ON to off with the front panel switch.

D. Press VERTICAL A CAL on the C10.

1. Adjust A6R38 (VERT GAIN) so that the amplitude of the square wave is the same when the MEMORY ON button is switched on and off.

E. Press VERTICAL A RAMP on the C10 and set the MEMORY ON button to off.

1. If there is a change of position or slope of the ramp, slightly readjust A6R76 (HORIZ CTR) or A6R88 (SWEEP AMP) until there is no change.

F. Note that the cursor (vertical line the full height of the display) is not more than two divisions to the left of the center line, ±1 minor division.

G. Press the VERTICAL B CAL on the C10 and note that both a ramp and a square wave are displayed on the CRT.

H. Press the RECORD A button on the front panel, and note that the square wave is no longer displayed. After 30 seconds (denoting the recorder sweep time), the square wave should return to the display.

I. Press the RECORD B button on the front panel, and note that the ramp is no longer displayed. After 30 seconds (denoting the recorder sweep time), the ramp should return to the display.

This completes the calibration procedure.

7.3 TROUBLESHOOTING

Information provided in this section should enable a technician to locate a malfunction, and determine the cause. References to the appropriate paragraphs of Section 5, Electrical Description, are provided as an aid to understanding detailed circuit functions.

7.3.1 Test Equipment Required

The following items are required for the servicing of a malfunctioning D14A mainframe:

1. Appropriate hand tools for disassembly, repair, and reassembly.

2. A DVM Multi-meter with 4.5 digit resolution, and ranges from 1V to 1kV with 10 megohm input impedance.

3. An oscilloscope (scope) with 15MHz bandwidth and 50mV/DIV sensitivity.

4. A Volt-Ohm-Milliameter (VOM) with a full scale range of 5kV (minimum) and 20,000 ohms/volt input impedance.

5. The Model 1038-C10 Calibration Kit (W-PMI P/N 15472).

7.3.2 Initial Setup and Preliminary Checks

Step 1: Connect the instrument to an ac power source that meets with the selected rating on the input (power cord) connector. Do not turn on.

Step 2: Rotate the front panel INTENSITY control fully counterclockwise.

Step 3: Perform the preliminary checks given in Table 7-A on page 7-7.

7.3.3 Detailed Troubleshooting

Any malfunction noted during the performance of the preliminary checks could be due to incorrect setting of the dc power supplies. Gain access to the low voltage power supply assembly (A3) by removing the right-hand top/side cover panel from the housing. Figure 7-1 on page 7-12 shows the partially disassembled unit, with the three adjustment potentiometers (pots) and test points (TP) along the top of the A3 PC board (near the right edge of the photo). Follow the procedures given in Section 7.2.2 on page 7-1 to measure the voltages and make any necessary adjustments.

The 250V power supply can be checked on the deflection circuit assembly, PC board A4, at TP611. Since this supply is unregulated, its value depends on the line voltage and load current.

Table 7-B on page 7-8 provides further guidance in isolating the cause of power supply failure. The regulated supplies are similar, and are described in general terms.

Another possible malfunction can be the absence of the trace from the CRT display. Assuming that the low voltage power supplies measure within specifications, the beam appears only if the following conditions are met:

- Electrons are emitted by the cathode.

- The control grid is not too negative with respect to the cathode.
- The focus electrode has suitable voltage applied to it.
- The horizontal and vertical deflection electrodes have equal or nearly equal potentials.
- The 1.5kV power supply potentials are correct.

Table 7-C on page 7-10 provides further guidance in isolating the possible causes of absence of trace.

> Note: With the power OFF, remove the metal housing labeled DANGER HIGH VOLTAGE (shown in Figure 7-2 on page 7-13) to gain access to the high voltage power supply PC board, A5. Figure 7-3 on page 7-14 shows the supply with the cover removed.

Certain faults can occur with a trace still visible on the CRT display, as enumerated in Table 7-D on page 7-11. In addition, it may be possible to isolate the fault to a specific vertical, horizontal, or intensity control circuit by observing if the operation is normal with respect to a given direction or intensity. If the performance is near normal, but still out of limits after repair, perform a full calibration per Section 7.2 on page 7-1.

7.3.4 CRT Replacement

> **Warning: Use extreme care when handling a CRT. Avoid striking the tube on any object or surface that might cause it to crack or implode. When storing a CRT, place it in a protective carton or, temporarily, place it face down in a protected location on a smooth surface, with a soft mat to protect the faceplate from scratches.**

The display CRT for the D14A is replaceable in the field by qualified service personnel. The metal housing or shield for the CRT has been designed to assure the proper positioning of the tube after it has been replaced.

7.3.4.1 CRT REMOVAL PROCEDURES

1. Turn the POWER switch OFF and disconnect the power cord.
2. Locate the tube socket connector on the base of the CRT neck, and remove it by pulling it off.
3. Locate the tube clamp protruding from the neck of the CRT, and loosen it with a screwdriver.
4. Locate the anode high voltage connector near the front of the CRT, and disconnect it.
5. Remove the two screws securing the bezel to the CRT per Figure 7-5 on page 7-16. Remove the bezel and light filter.
6. Gently push on the base of the tube, guiding the tube out through the front panel, using one hand to support the front of the tube.

Note: At this time, just disengage the tube from its seating and remove about half way to enable access to the trace rotation coil attached to the tube.

7. Remove the tape strips securing the trace rotation coil to the wide segment of the neck of the CRT. Leave the coil in the CRT shield.
8. Complete the removal of the CRT, observing the **Warning** given at the beginning of this section.

7.3.4.2 CRT INSTALLATION

Installation of the replacement CRT essentially consists of the reversal of the preceding removal procedures. Some notes of precaution include:

1. Ensure that the CRT anode is properly oriented to allow re-connection of the high voltage lead.
2. If the tape securing the trace rotation coil appears to lack adhesive, replace

it with new (equivalent) tape.

3. DO NOT OVER-TIGHTEN the CLAMP on the neck of the CRT. (Later models may have a spacer installed to prevent over-tightening.)

7.3.5 Replacing Other Components

Illustrations specified in this section should be helpful in disassembling the unit to replace various electronic components.

7.3.5.1 POWER SUPPLY PC BOARDS (A3 AND A5)

The low voltage power supply, PC board #A3, can be removed by removing the right panel cover from the housing, per Figure 7-1. Before disconnecting the assembly from its plug-in connector, it is necessary to remove the three phillips-head screws located vertically in line above the AUX 2 BNC connector, inside the fins of the heat sink, on the D14A rear panel.

If it is necessary to service other elements of the low voltage power supply system, the entire lower half of the rear panel of the instrument can be disassembled. Remove the eight phillips-head screws (six at the top and bottom edges and two at the sides) around the perimeter of the panel and allow it to swing down, as shown in Figure 7-5 on page 7-16.

The high voltage power supply assembly, PC board #A5, can be removed by removing six phillips-head screws from the upper half of the rear panel (reference the top of Figure 7-5). Remove the pan-head phillips screw that secures the high voltage power supply cover, and allow the entire upper panel to swing down as shown in Figure 7-6 on page 7-17.

Table 7-A. Preliminary Checks for Troubleshooting

	Test	Indication	Remarks and Probable Cause of Malfunctions
1.	Press POWER switch ON	Red POWER indicator should illuminate	1. Rear panel fuse, F1 2. Defective power cord 3. Wiring between switch and rear panel 4. Power switch defective 5. POWER indicator lamp faulty 6. Rear panel line voltage selector set to incorrect voltage
2.	Advance intensity control clockwise; set focus as required	After 3 minute (maximum) warmup, a dot should appear at center screen. It should be possible to achieve proper focus	See detailed troubleshooting information in Section 7.3.3 and Tables 7-B and 7-C
3.	Go through the performance checks, Sections 6.3 and 6.4	As specified in Sections 6.3 and 6.4	Vertical or horizontal deflection more or less than 3 divisions; adjust vertical or horizontal gain per Section 7.2.4

Table 7-B. Power Supply Troubleshooting

Indication	Remarks and Probable Causes	Further Checks and Remedys
250V Supply		
+250V reads low or 0	1. Wrong line voltage	Reset switch at the power cord input to correct voltage
	2. Rectifier A4CR1	Check diode front/back ratio, replace entire bridge if bad
	3. Filter capacitor A4C1	If ripple greater than 5V p-p, replace
All low voltage supplies		
Low output voltage	1. Wrong line voltage	Reset switch at power cord connector input to correct voltage
	2. Filter capacitor	Check p-p ripple; approx values are 0.1V for +5V supply & 0.2V for ±15V supply
	3. Rectifier assembly	Measure raw, unregulated voltage
	4. If + and - supplies low	Check - supply first & adjust as required
	5. Excess load	Disconnect each wire to supply & check if fault clears
	6. Open drive transistor or series regulator transistor	See Section 5.5 on page 5-4; use ohmmeter to check further
	7. I. C. amplifier	See Section 5.5 on page 5-4
	8. Reference diode	See Section 5.5 on page 5-4
	9. Transformer T1	Check rms ac secondary voltage
High Output Voltage	1. Shorted regulator transistor	Check with ohmmeter
	2. Shorted regulator transistor	Check with ohmmeter
	3. I. C. amplifier	See Section 5.5 on page 5-4

(continued on next page)

Table 7-B. Power Supply Troubleshooting (con't.)

Indication	Remarks and Probable Causes	Further Checks and Remedys
High Output Voltage (con't.)	4. Misadjusted	Re-adjust
	5. Short to higher voltage supply	Check other supplies for same voltage
Excessive Ripple	1. Wrong line voltage	Reset to correct line voltage
	2. Filter Capacitor	Replace if raw ripple excessive

Table 7-C. Isolating the Cause of CRT Trace Absence

Test	Indication	Remarks and Possible Cause of Fault
Look at CRT near the connector end	Heater should glow red	1. Check wiring from the transformer to CRT heater **DANGER: IN STEP 2, -1500V DC IS PRESENT AT THE OTHER END OF THE CONNECTOR.** 2. Disconnect 2 wire connector from the high voltage board, going to the transformer; measure approx. 6.3V rms at the transformer end. 3. Measure heater resistance; replace CRT if open
Carefully measure 1.55kV at TP504 using H.V. range of VOM	-1.55kV ±75V	1. Check primary supply wiring 2. A5Q1 in the HVPS has failed Note: If this occurs, several other components may be defective as well and should be checked before operation is resumed. These components can include A4Q3, A4U8, A4CR12, A5R10, A5R8, A5T1, or the CRT filament
Measure collector of A4Q3 of the Deflection circuit	Vary the INTENSITY control from stop to stop. Voltage should vary approx. 85V or more	1. Intensity limit control adjust 2. See Section 5.7.1 of the manual for circuit description 3. Check A4U8
Measure voltage at A4Q6 and A4Q7 of the Deflection circuit	Should be approx. equal, and average about 130V (or "DIV")	1. Vertical deflection amplifier; See Section 5.6.3 of manual 2. Vertical preamp A4U14B or A, or push-pull A4U16A. To determine which, measure input to deflection amplifier at A4U14, pin 3. Voltages should be 0V ±0.3V. See Section 5.6.3 for circuit description

(continued on next page)

Table 7-C. Isolating the Cause of CRT Trace Absence (con't.)

Test	Indication	Remarks and Possible Cause of Fault
Carefully measure the Focus voltage at the wiper of the Focus pot with VOM on H.V. range. (See Section 7.5.3 and Figure 7-6)	Should be approx. -1100V	1. VOM may load circuit, so try varying focus control to see if voltage changes
Look for trace after long warm-up time	Dim trace or no trace	1. CRT is defective. Be sure that all preceding conditions have been met before assuming a defective CRT

Table 7-D. Troubleshooting When the Trace is Visible

Indication	Remarks & Possible Cause	Further Checks
Trace bright & off axis	1. Beam finder switch shorted	Test with VOM, replace
	2. Grid control circuit A4Q3 (Deflection)	Measure A4Q3 collector; see Table 7-C
	3. Focus control	See Table 7-C
Beam doesn't deflect when fixture switch set to +3	1. Deflection preamp	See Section 5.6.3
	2. Deflection amplifier	See Section 5.6.3
Intensity starts to brighten, then dims as INTENSITY control is rotated clockwise	CRT probably defective	
Non-linear trace	Adjust GEOM and ASTIG controls	

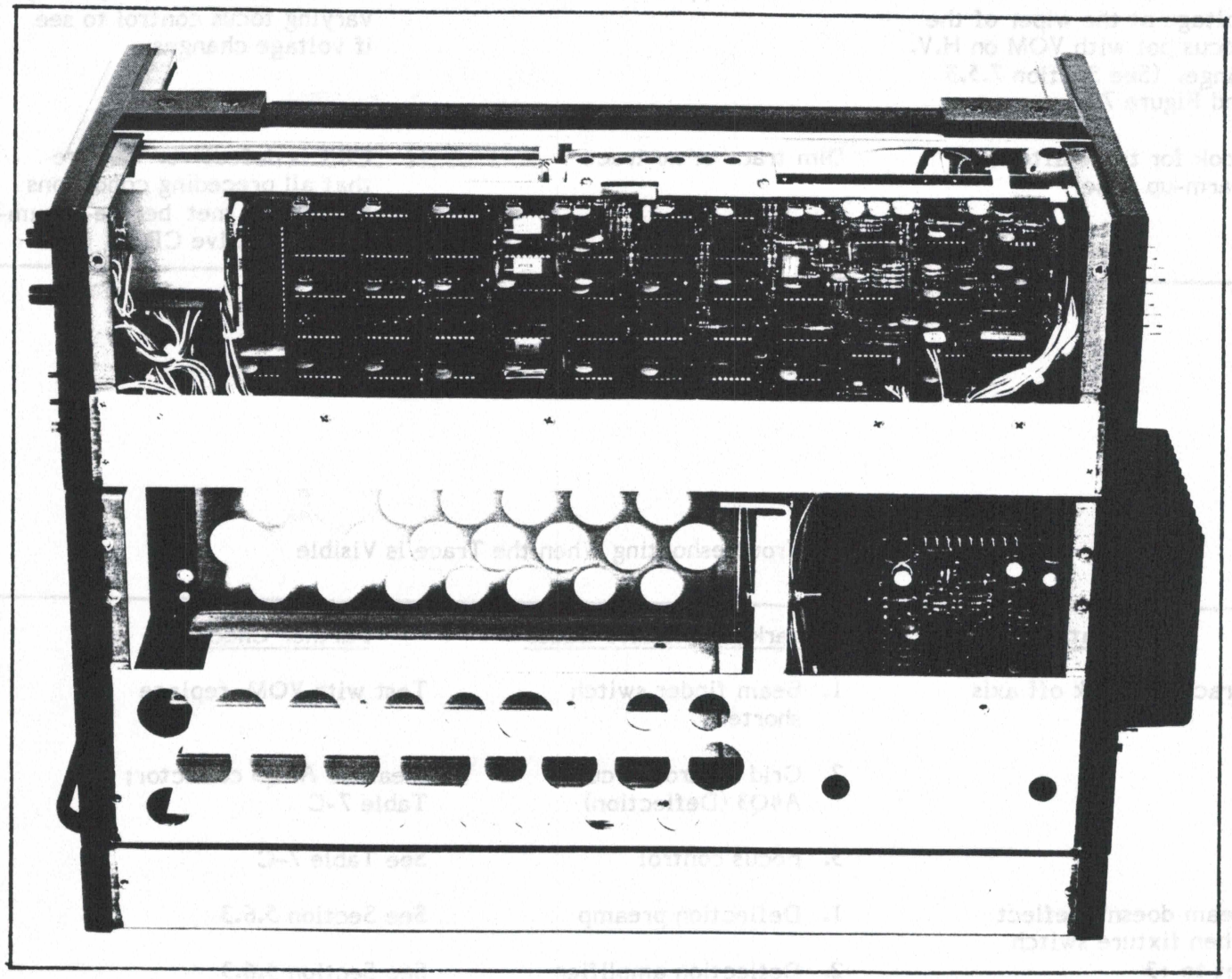


Figure 7-1. Right Side of D14A With Cover Removed

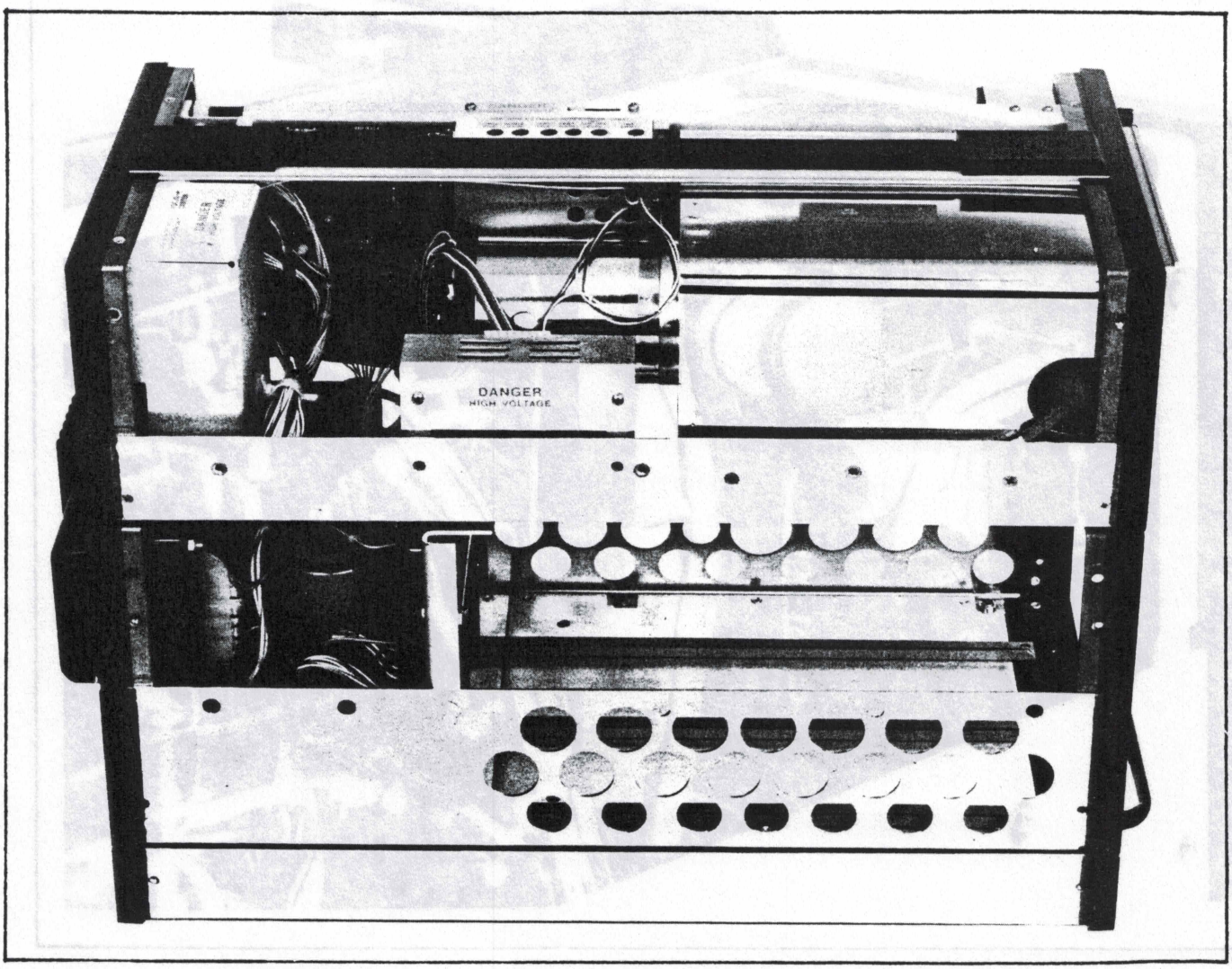


Figure 7-2. Left Side of D14A Showing the HVPS and Access to CRT

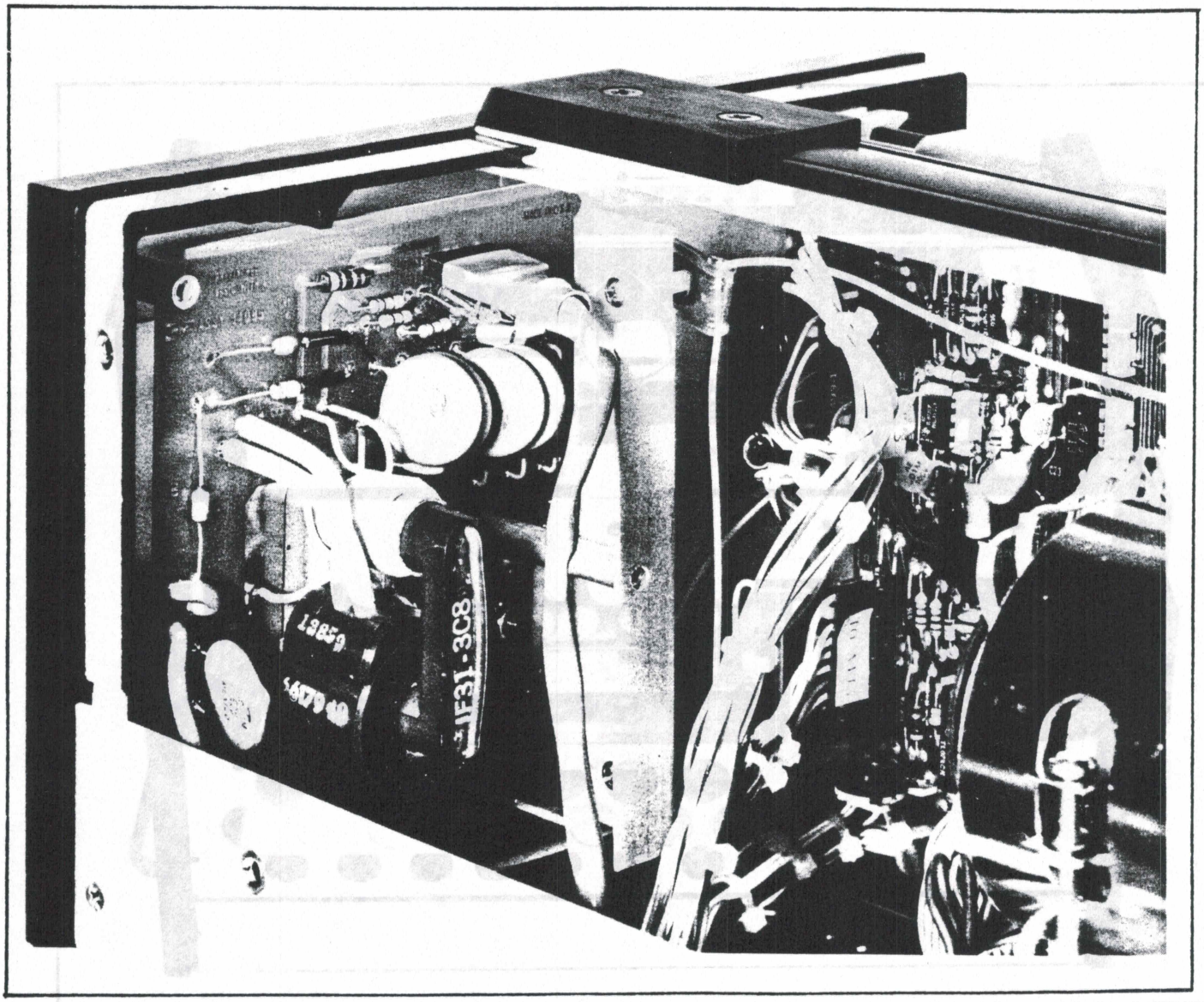


Figure 7-3. HVPS With Cover Removed

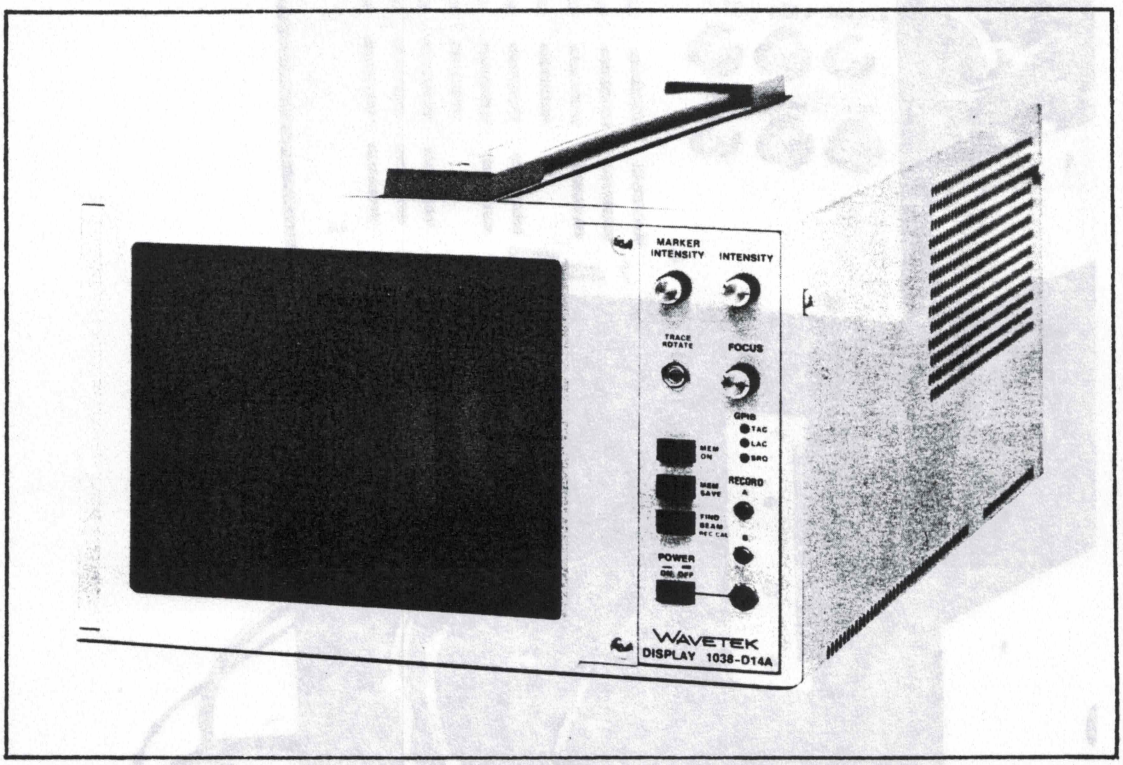


Figure 7-4. Bezel Removal and Installation
(Remove top and bottom screws on the right of the CRT)

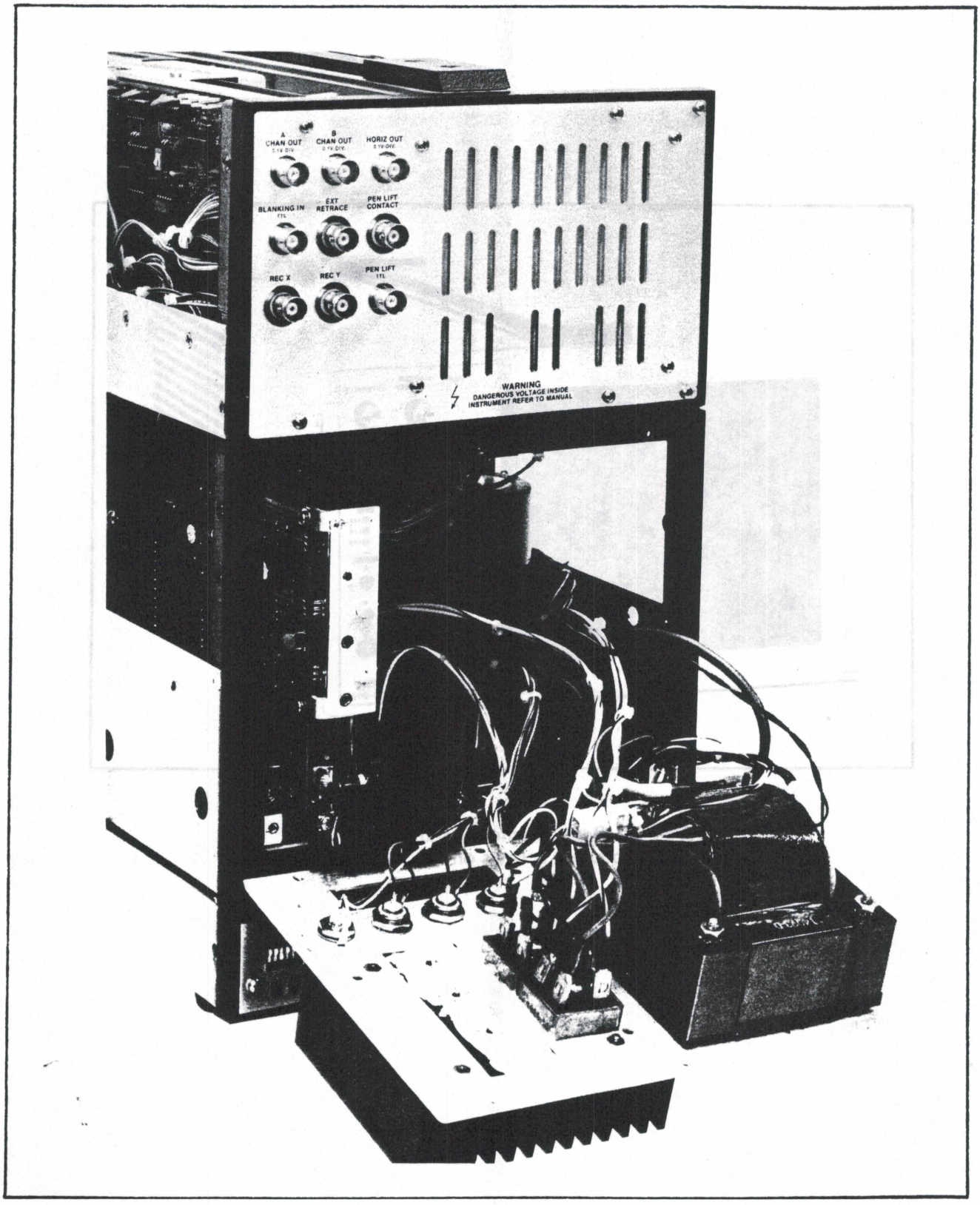


Figure 7-5. Low Voltage Power Supply (A3) Disassembled

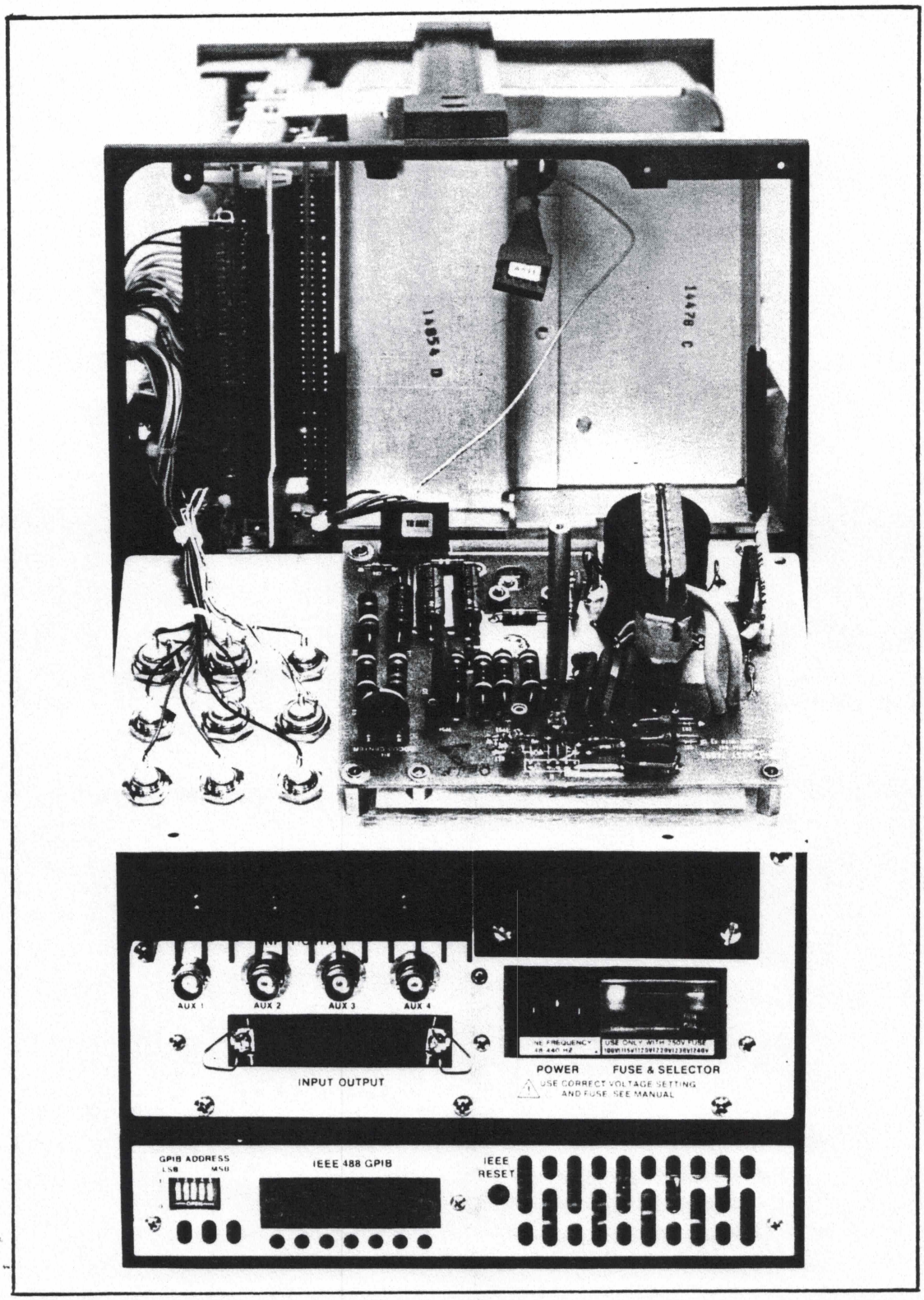


Figure 7-6. High Voltage Power Supply (A5) Disassembled

SECTION 8

SCHEMATIC DIAGRAMS & PCB ASSEMBLY DRAWINGS

PC Board Assembly Drawings showing the physical location of all of the electrical components on the boards are to the left of the folded out schematic, where applicable. The Assembly Drawing for a particular PC board will either be on the apron of the schematic for the board or on the back of the preceding schematic.

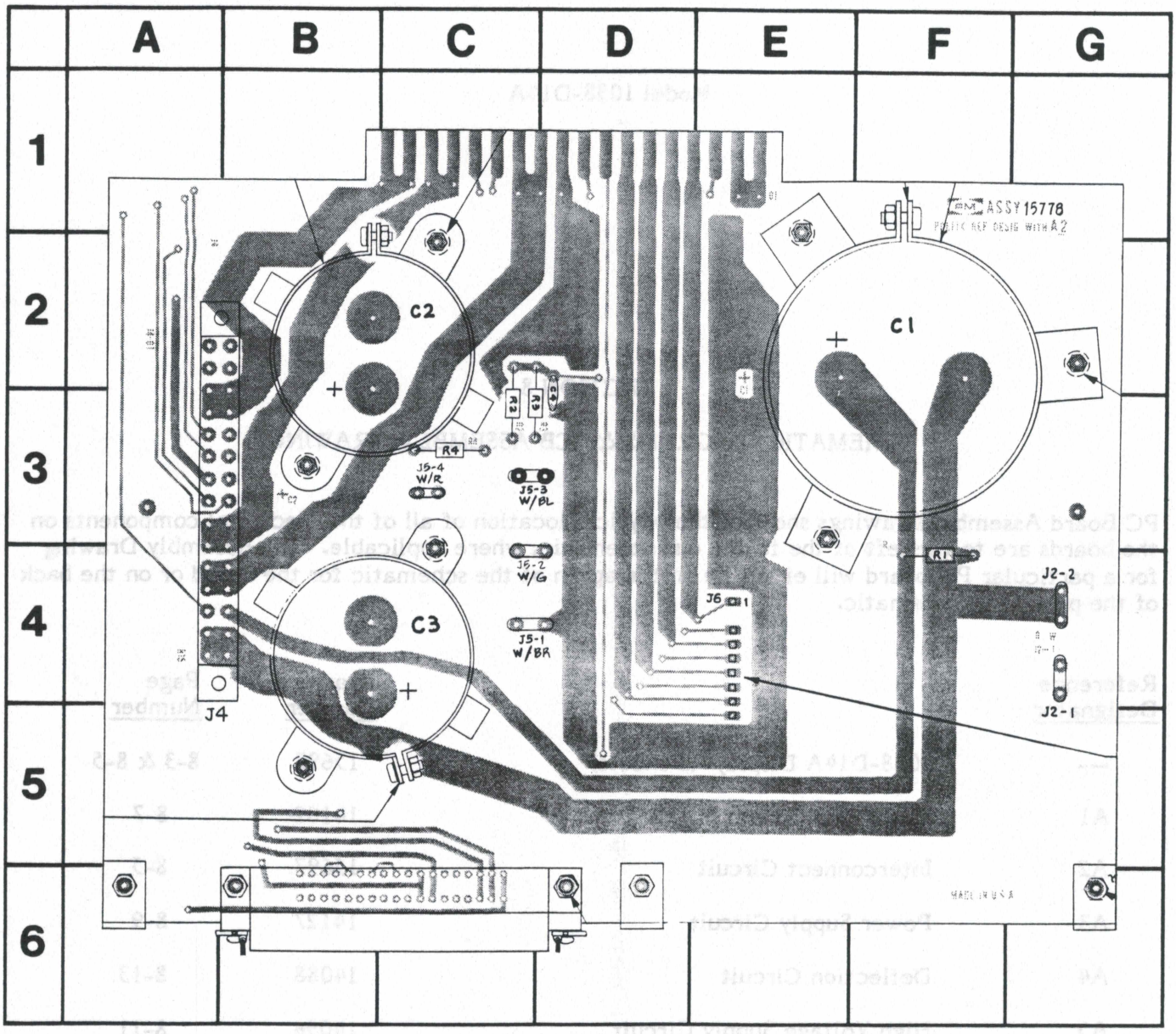


FIGURE 8-1 INTERCONNECT PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	F-2			J1	---	R1	F-3
C2	C-2			J2	G-4	R2	C-2
C3	C-4			J3	---	R3	D-2
C4	D-2			J4	B-3	R4	C-3
				J5	D-4		
				J6	E-4		
				J7	C-5		

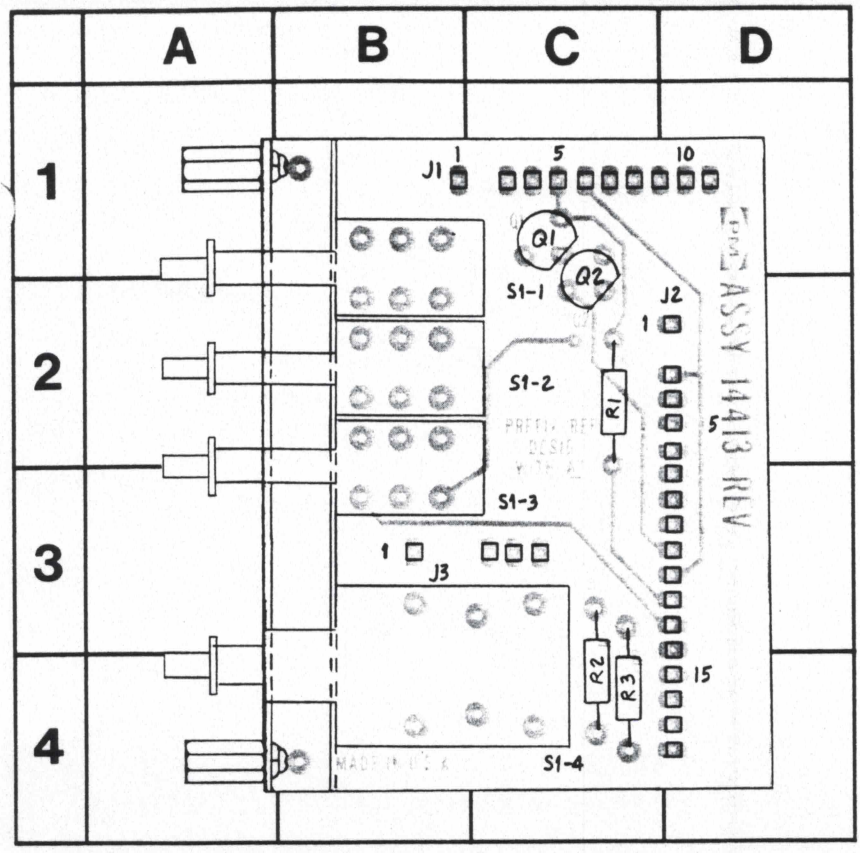


FIGURE 8-2 FRONT PANEL PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC
J1	C-1	R1	D-2
J2	D-2	R2	D-4
J3	C-3	R3	D-4
Q1	C-1	S1	A-2
Q2	C-2		

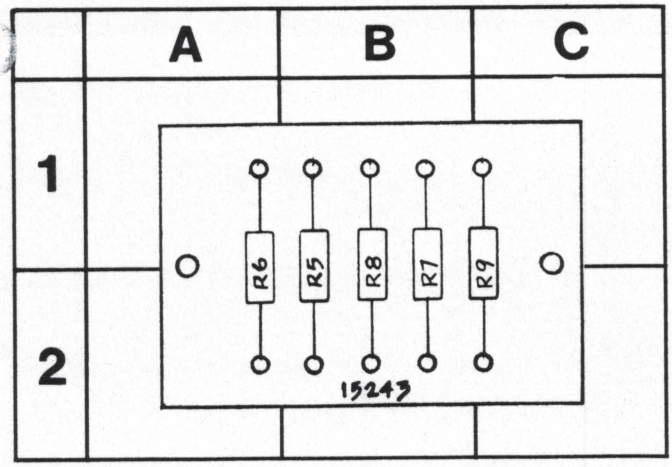


FIGURE 8-3 TERMINAL BOARD

CKT REF	GRID LOC
R8	B-1
R7	B-1
R9	C-1
R6	A-1
R5	B-1

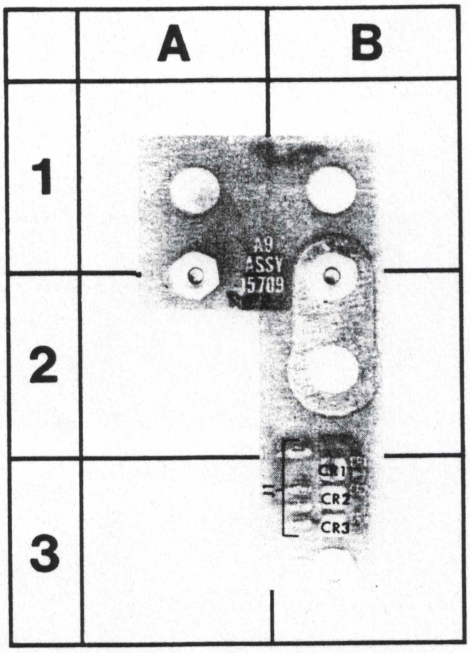


FIGURE 8-5 IEEE INTERFACE PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC
CR1	B-3	CR3	B-3
CR2	B-3	J1	B-3

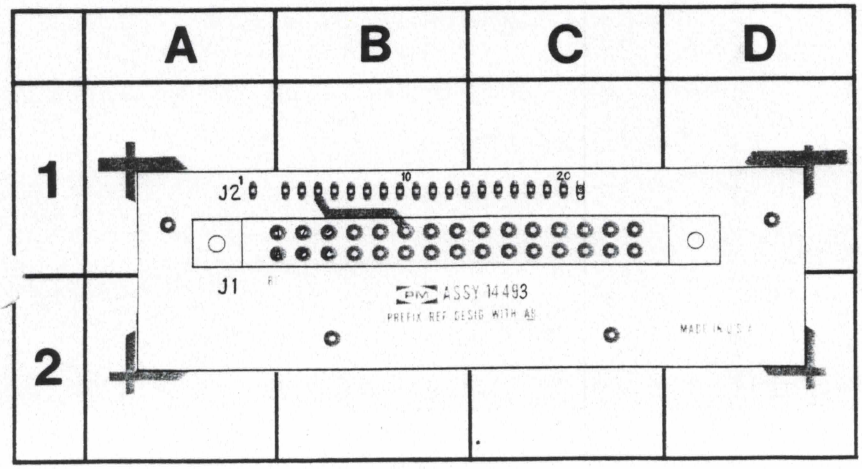
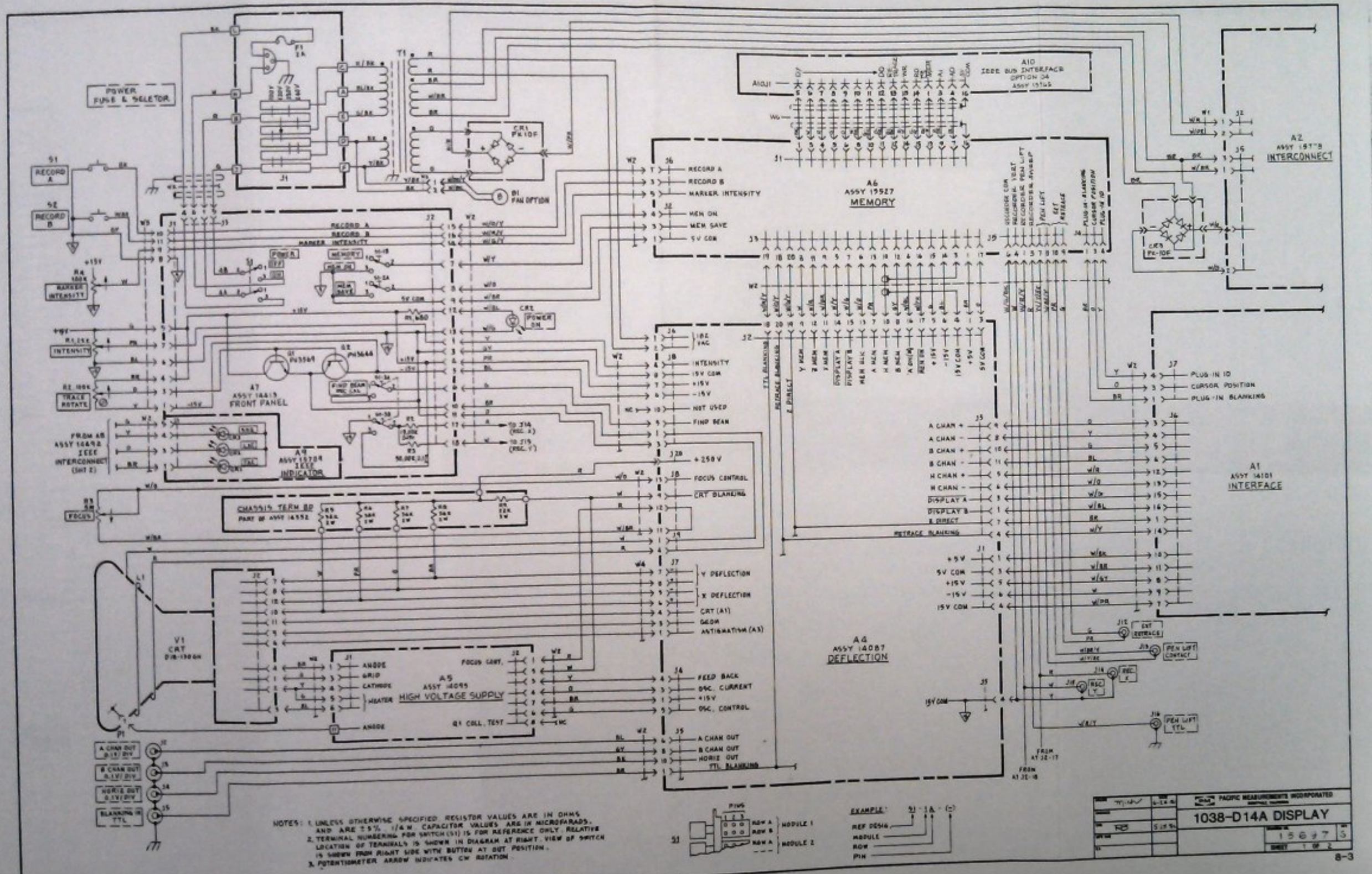
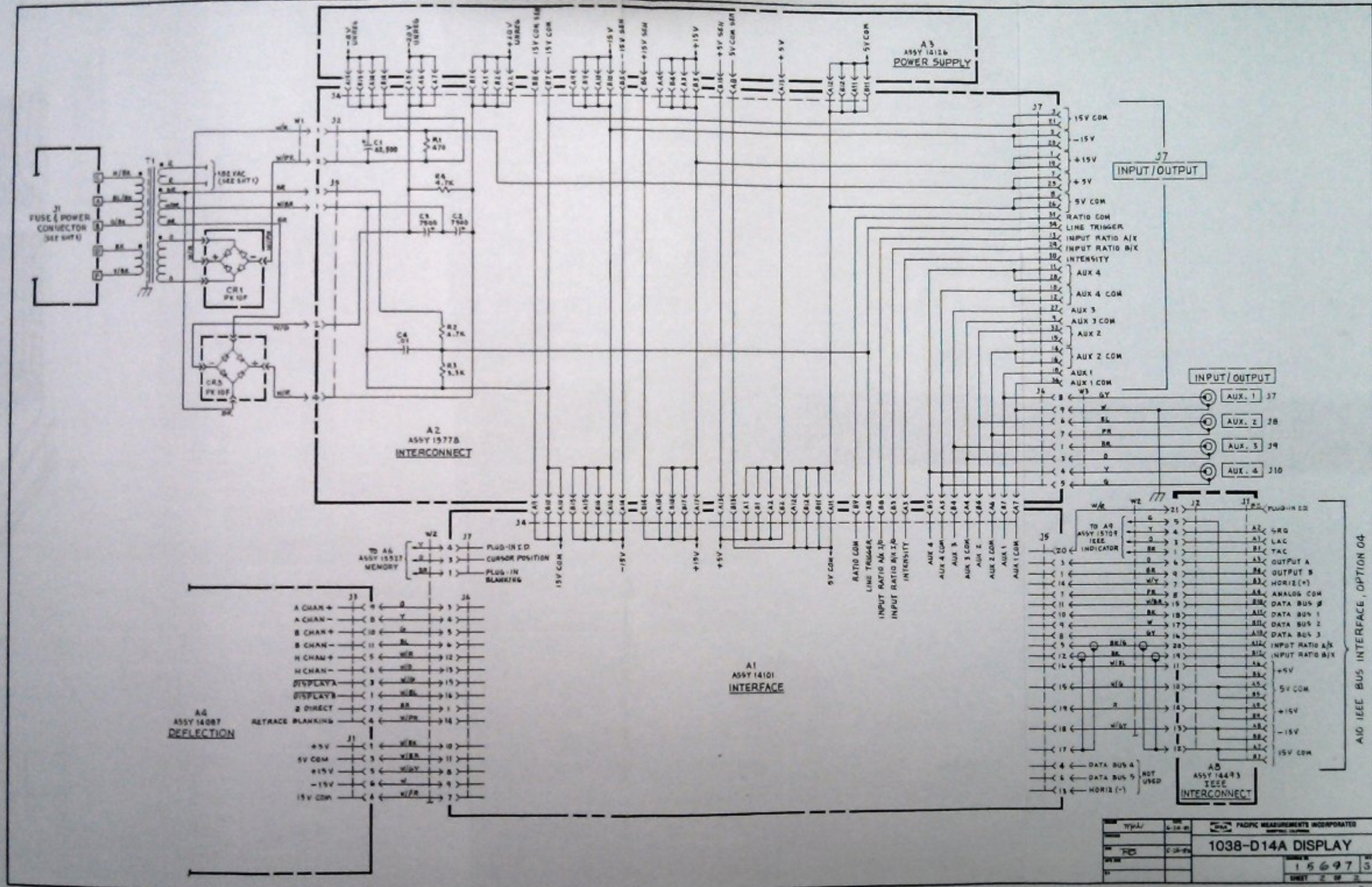
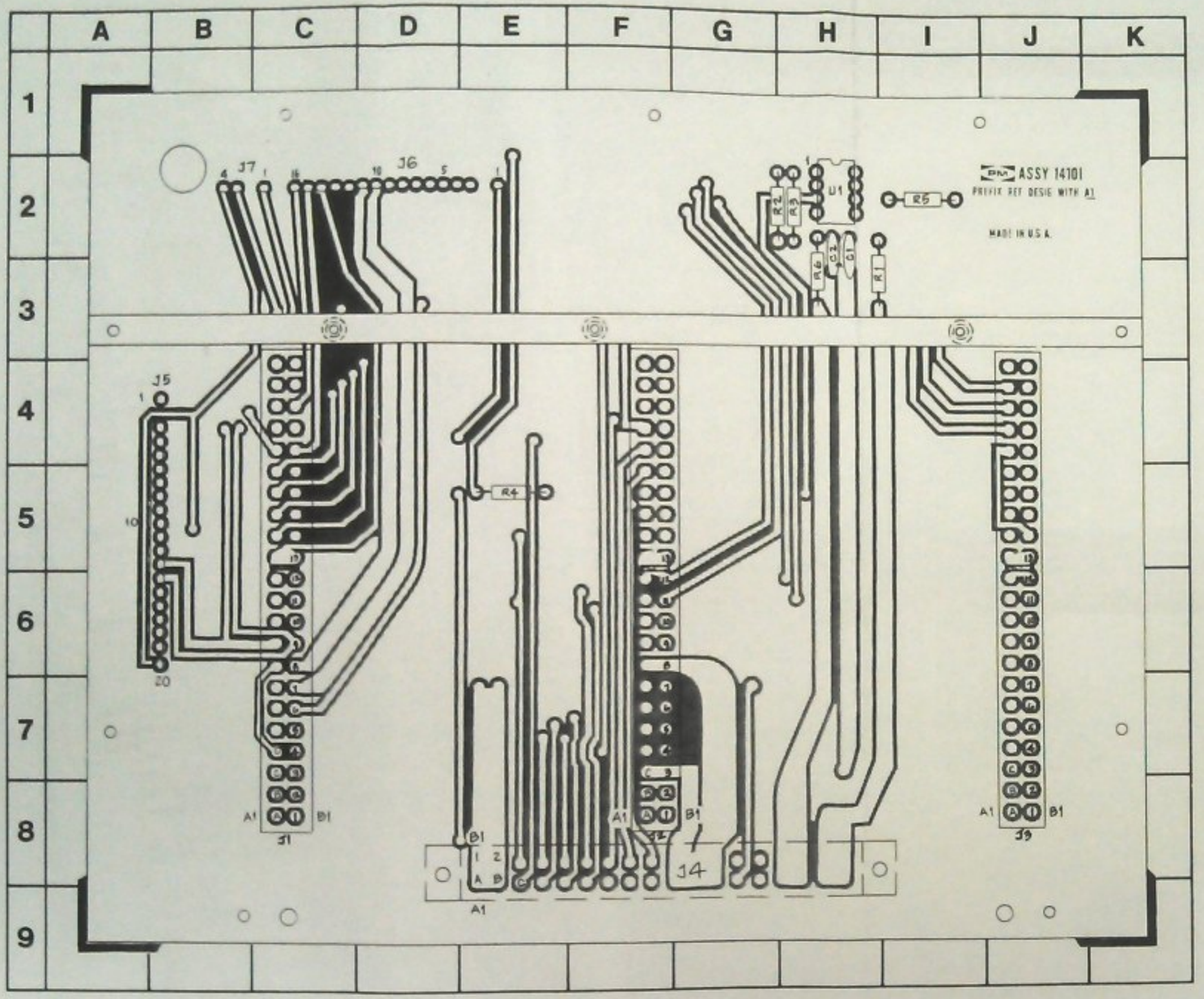


FIGURE 8- 4 IEEE INTERCONNECT PCB ASSEMBLY

CKT REF	GRID LOC
J1	B-1
J2	B-1

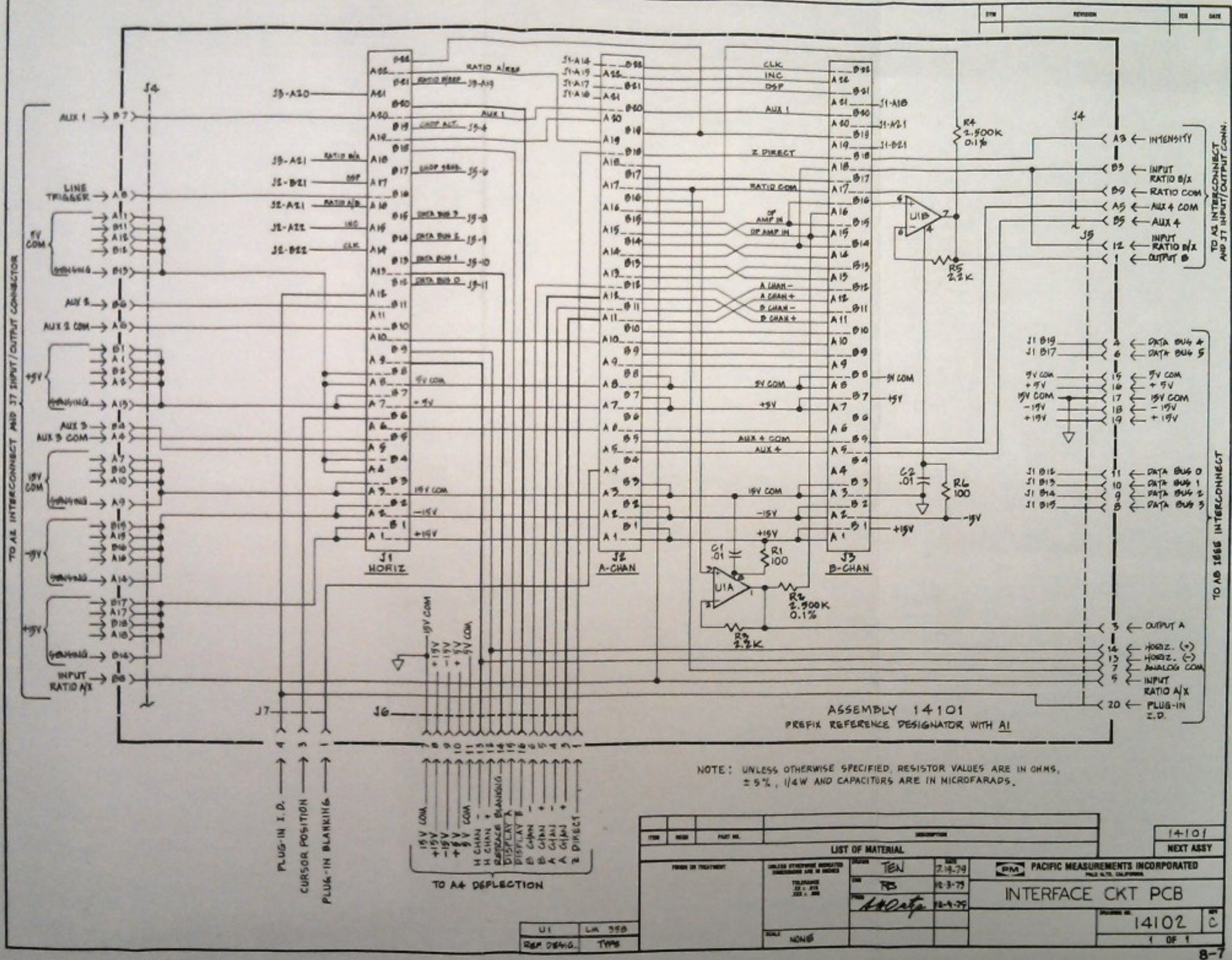

POWER FUSE & SELECTOR
F1 2A
T1
CR1 PK10F
B1 FAN OPTION
S1 RECORD A
S2 RECORD B
RECORD A
RECORD B
MARKER INTENSITY
R4 100K MARKER INTENSITY
R1 25K INTENSITY
R2 100K TRACE ROTATE
POWER
MEMORY
MEM ON
MEM SAVE
5V COM
+15V
-15V
CR2 POWER ON
Q1 PN3569
Q2 PN3646
FIND BEAM
R5 50,000Ω
A7 ASSY 14413 FRONT PANEL
FROM A8 ASSY 14492 IEEE INTERCONNECT (SHT 2)
A9 ASSY 15708 IEEE INDICATOR
CHASSIS TERM BD PART OF ASSY 14552
R9 56K 1W
R6 56K 1W
R7 56K 1W
R8 56K 1W
R10 12K 5W
R3 5M FOCUS
L1
V1 CRT D16-1300H
P1
A5 ASSY 14095 HIGH VOLTAGE SUPPLY
ANODE
GRID
CATHODE
HEATER
FOCUS CONT.
Q1 COLL. TEST
A CHAN OUT 0.1V/DIV
B CHAN OUT 0.1V/DIV
HORIZ OUT 0.1V/DIV
BLANKING IN TTL
W2
W3
W4
W5
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J14
J15
J16
J17
J18
J19
J20
RECORD A
RECORD B
MARKER INTENSITY
MEM ON
MEM SAVE
5V COM
182 VAC
INTENSITY
15V COM
+15V
-15V
NOT USED
FIND BEAM
+250 V
FOCUS CONTROL
CRT BLANKING
Y DEFLECTION
X DEFLECTION
CRT (A1)
GEOM
ASTIGMATISM (A3)
FEED BACK
DISC. CURRENT
+15V
DISC. CONTROL
A CHAN OUT
B CHAN OUT
HORIZ OUT
TTL BLANKING
A10 IEEE BUS INTERFACE OPTION 04 ASSY 13945
A6 ASSY 19527 MEMORY
A4 ASSY 14087 DEFLECTION
A2 ASSY 19778 INTERCONNECT
A1 ASSY 14101 INTERFACE
CR3 PK-10F
RECORD A
RECORD B
MARKER INTENSITY
MEM ON
MEM SAVE
5V COM
182 VAC
INTENSITY
15V COM
+15V
-15V
NOT USED
FIND BEAM
+250 V
FOCUS CONTROL
CRT BLANKING
Y DEFLECTION
X DEFLECTION
CRT (A1)
GEOM
ASTIGMATISM (A3)
FEED BACK
DISC. CURRENT
+15V
DISC. CONTROL
A CHAN OUT
B CHAN OUT
HORIZ OUT
TTL BLANKING
A CHAN +
A CHAN -
B CHAN +
B CHAN -
H CHAN +
H CHAN -
DISPLAY A
DISPLAY B
X DIRECT
RETRACE BLANKING
+5V
5V COM
+15V
-15V
15V COM
PLUG-IN ID
CURSOR POSITION
PLUG-IN BLANKING
PEN LIFT TTL
PEN LIFT CONTACT
EXT ENTRANCE
REC X
REC Y
FROM A7 J2-17
FROM A7 J2-18
S1
PINS
ROW A
ROW B
ROW A
MODULE 1
MODULE 2
EXAMPLE
REF DESIG
MODULE
ROW
PIN
NOTES: 1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4 W. CAPACITOR VALUES ARE IN MICROFARADS.
2. TERMINAL NUMBERING FOR SWITCH (S1) IS FOR REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. VIEW OF SWITCH IS SHOWN FROM RIGHT SIDE WITH BUTTON AT OUT POSITION.
3. POTENTIOMETER ARROW INDICATES CW ROTATION.
PACIFIC MEASUREMENTS INCORPORATED
1038-D14A DISPLAY
15697 5
SHEET 1 OF 2
8-3


A3
ASSY 14126
POWER SUPPLY
-8V UNREG
-20V UNREG
+20V UNREG
15V COM SEN
15V COM
-15V
-15V SEN
+15V SEN
+15V
+5V SEN
5V COM SEN
+5V
5V COM
J1
FUSE & POWER CONNECTOR
(SEE SHT 1)
T1
105 VAC
(SEE SHT 1)
CR1
PX 10F
CR2
PX 10F
C1
42,500
R1
470
R4
4.7K
C3
7900
C2
7900
C4
.01
R2
4.7K
R3
5.5K
A2
ASSY 15778
INTERCONNECT
J7
INPUT/OUTPUT
15V COM
-15V
+15V
+5V
5V COM
RATIO COM
LINE TRIGGER
INPUT RATIO A/X
INPUT RATIO B/X
INTENSITY
AUX 4
AUX 4 COM
AUX 3
AUX 3 COM
AUX 2
AUX 2 COM
AUX 1
AUX 1 COM
INPUT/OUTPUT
AUX. 1 J7
AUX. 2 J8
AUX. 3 J9
AUX. 4 J10
TO A6
ASSY 15527
MEMORY
PLUG-IN I.D.
CURSOR POSITION
PLUG-IN BLANKING
A CHAN +
A CHAN -
B CHAN +
B CHAN -
H CHAN +
H CHAN -
DISPLAY A
DISPLAY B
Z DIRECT
RETRACE BLANKING
+5V
5V COM
+15V
-15V
15V COM
A4
ASSY 14087
DEFLECTION
A1
ASSY 14101
INTERFACE
TO A9
ASSY 15709
IEEE
INDICATOR
DATA BUS 4
DATA BUS 5
HORIZ (-)
NOT USED
A8
ASSY 14493
IEEE
INTERCONNECT
PLUG-IN I.D.
SRQ
LAC
TAC
OUTPUT A
OUTPUT B
HORIZ (+)
ANALOG COM
DATA BUS 0
DATA BUS 1
DATA BUS 2
DATA BUS 3
INPUT RATIO A/X
INPUT RATIO B/X
+5V
5V COM
+15V
-15V
15V COM
A10 IEEE BUS INTERFACE, OPTION 04
PACIFIC MEASUREMENTS INCORPORATED
1038-D14A DISPLAY
15697
SHEET 2 OF 2



CKT REF	GRID LOC
C1	H-3
C2	H-3
J1	C-6
J2	F-6
J3	J-6
J4	E-8
J5	B-5
J6	D-2
J7	C-2
R1	H-3
R2	G-2
R3	H-2
R4	E-5
R5	I-2
R6	H-3
U1	H-2

FIGURE 8-6 INTERFACE CKT PCB ASSEMBLY



ASSEMBLY 14101
PREFIX REFERENCE DESIGNATOR WITH A1

NOTE: UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS, ±5%, 1/4W AND CAPACITORS ARE IN MICROFARADS.

U1	LM 358
REF DESIG.	TYPE

LIST OF MATERIAL

DRAWN	TEN 7-14-79
CHK	RB 12-3-79
APVD	12-9-79
SCALE	NONE

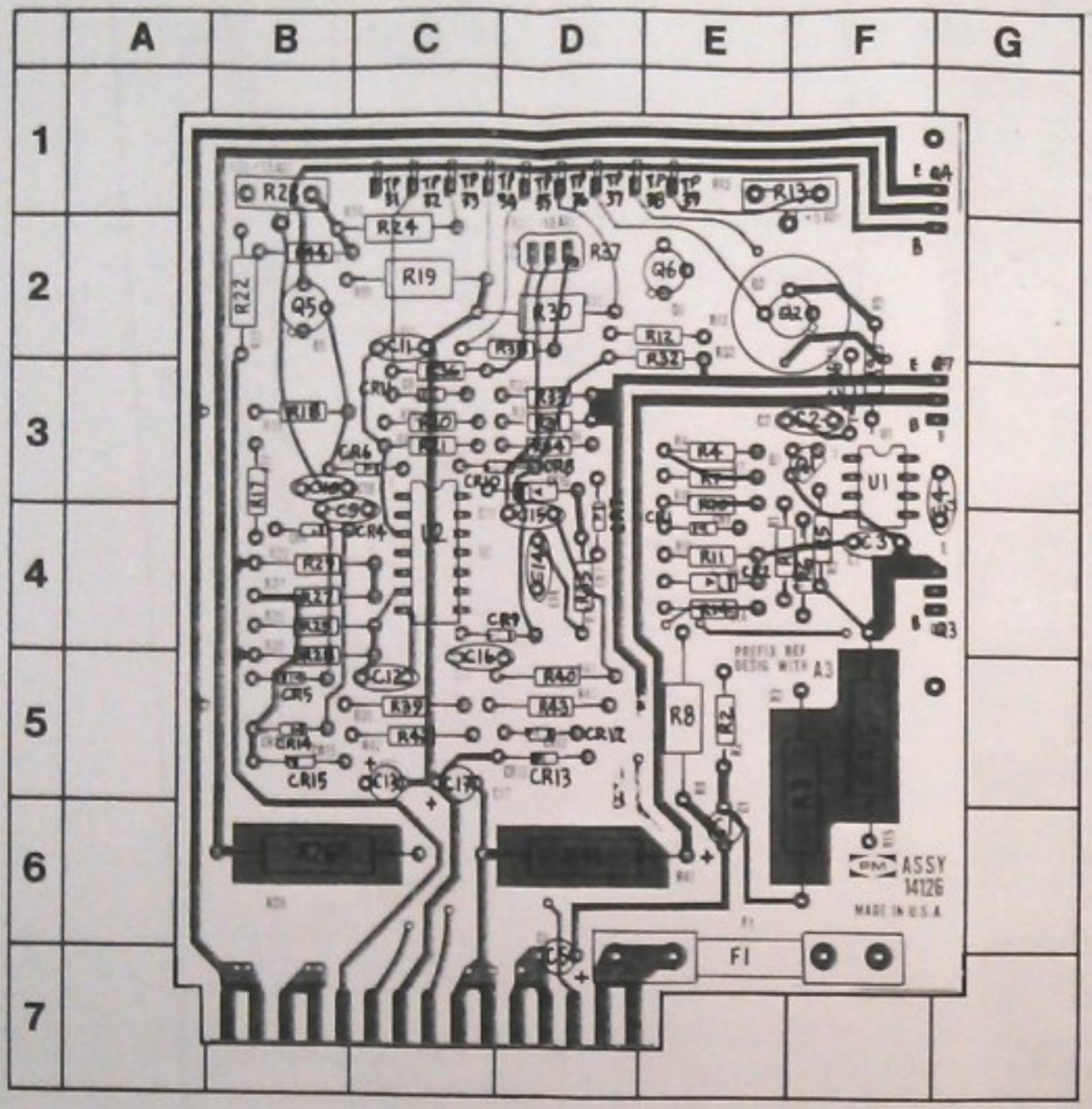
PACIFIC MEASUREMENTS INCORPORATED

INTERFACE CKT PCB

14102 C

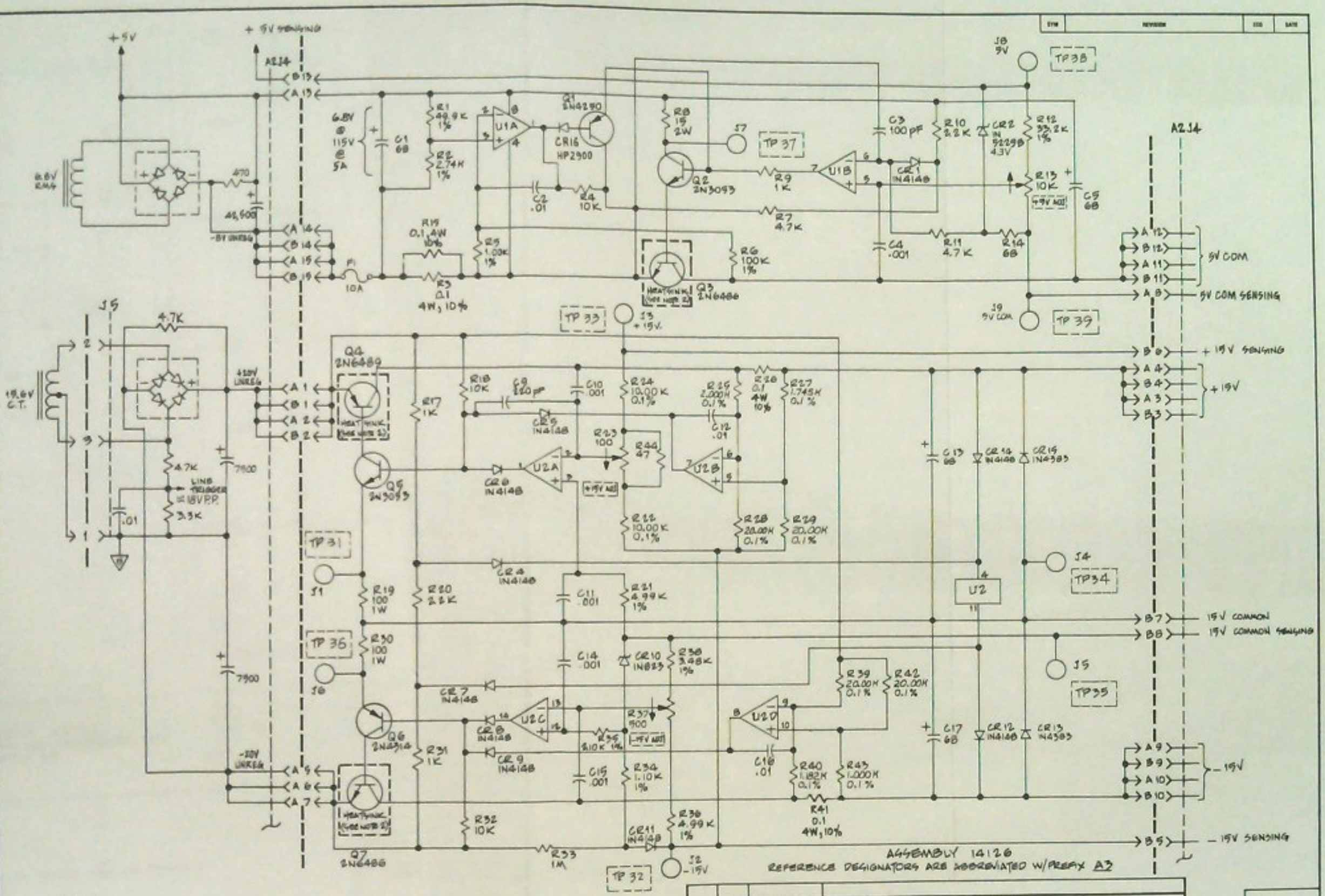
1 OF 1

14101 NEXT ASSY



CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	E-6	TP31	C-1	R1	E-4	R43	D-5
C2	E-3	TP32	C-1	R2	E-5	R44	B-2
C3	F-4	TP33	C-1	R3	E-5		
C4	F-4	TP34	C-1	R4	E-3		
C5	D-6	TP35	D-1	R5	F-4		
C6	---	TP36	D-1	R6	E-4		
C7	---	TP37	D-1	R7	E-3		
C8	---	TP38	D-1	R8	E-5	U1	F-3
C9	B-4	TP39	E-1	R9	F-3	U2	C-4
C10	B-3			R10	E-4		
C11	C-3			R11	E-4		
C12	C-5			R12	E-3		
C13	C-5			R13	E-1		
C14	D-4			R14	E-4		
C15	D-4			R15	F-5		
C16	C-5			R16	---		
C17	C-5			R17	B-3		
				R18	B-3		
		Q1	E-3	R19	C-2		
CR1	E-4	Q2	E-2	R20	C-3		
CR2	E-4	Q3	F-4	R21	C-3		
CR3	---	Q4	F-2	R22	B-2		
CR4	B-4	Q5	B-2	R23	B-2		
CR5	B-5	Q6	D-2	R24	C-2		
CR6	C-3	Q7	F-3	R25	B-4		
CR7	D-4			R26	B-6		
CR8	C-3			R27	B-4		
CR9	C-4			R28	B-5		
CR10	D-3			R29	B-4		
CR11	C-3			R30	D-2		
CR12	D-5			R31	D-3		
CR13	D-5			R32	D-3		
CR14	B-5			R33	D-3		
CR15	B-5			R34	D-3		
CR16	F-3			R35	D-4		
				R36	C-3		
				R37	D-2		
				R38	C-3		
				R39	C-5		
F1	E-6			R40	D-5		
				R41	D-6		
				R42	C-5		

FIGURE 8-7 POWER SUPPLY PCB ASSEMBLY



NOTES:

1. UNLESS OTHERWISE SPECIFIED, COMPONENT VALUES ARE AS FOLLOWS:
   - RESISTORS IN OHMS, ±5%, 1/4W.
   - CAPACITORS IN MICROFARADS.
2. TRANSISTORS ARE MOUNTED ON REAR PANEL HEATSINK.

ASSEMBLY 14126
REFERENCE DESIGNATORS ARE ABBREVIATED W/PREFIX A3

REF DESIG	TYPE
U2	LM 324N
U1	LM 358N

LIST OF MATERIAL

NEXT ASSY

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

POWER SUPPLY

DRAWN TEN 7.2.79
ENG RB 12-3-79
PROD [signature] 12-4-79
SCALE NONE
DRAWING NO. 14127 REV B
1 OF 1

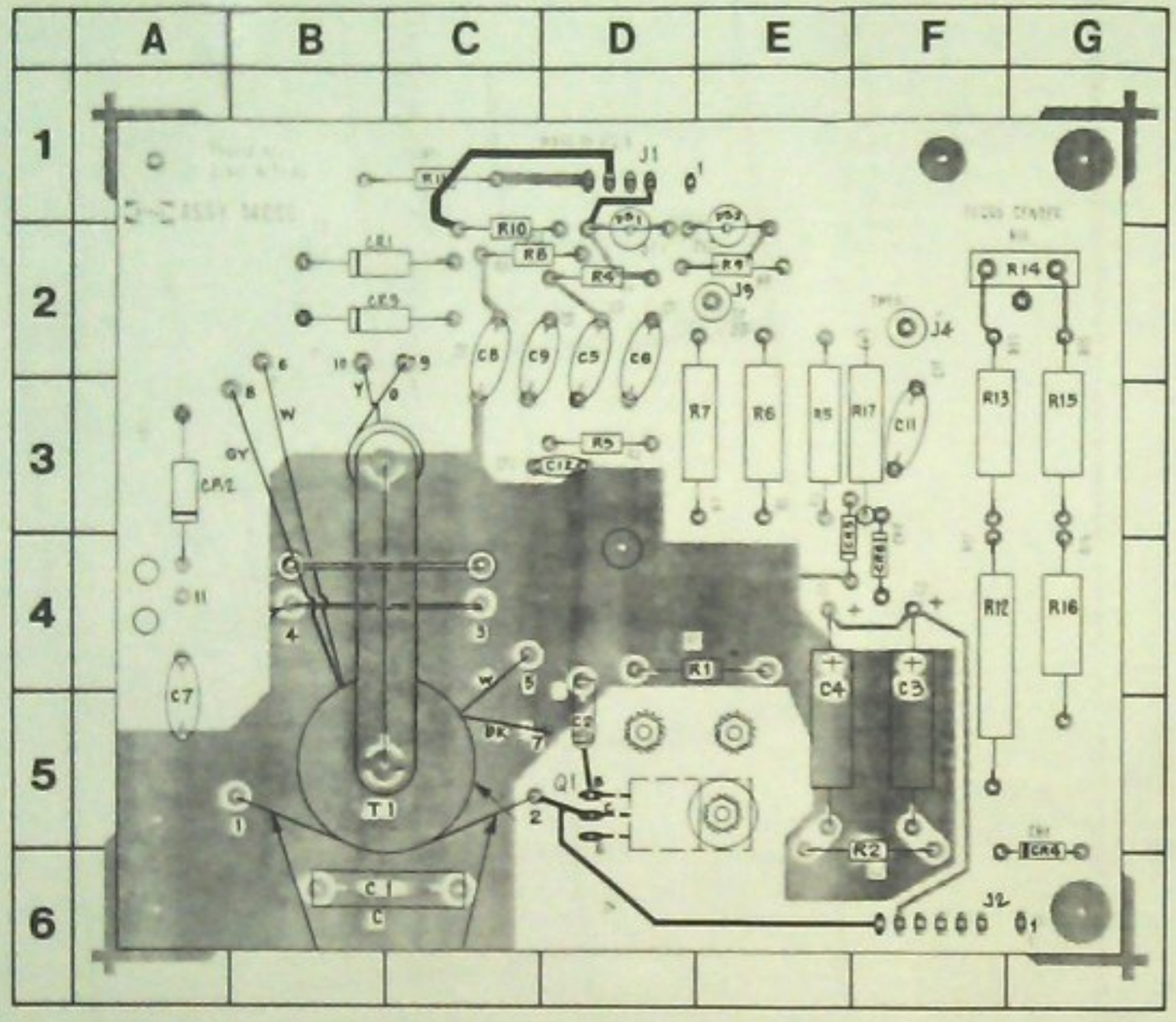
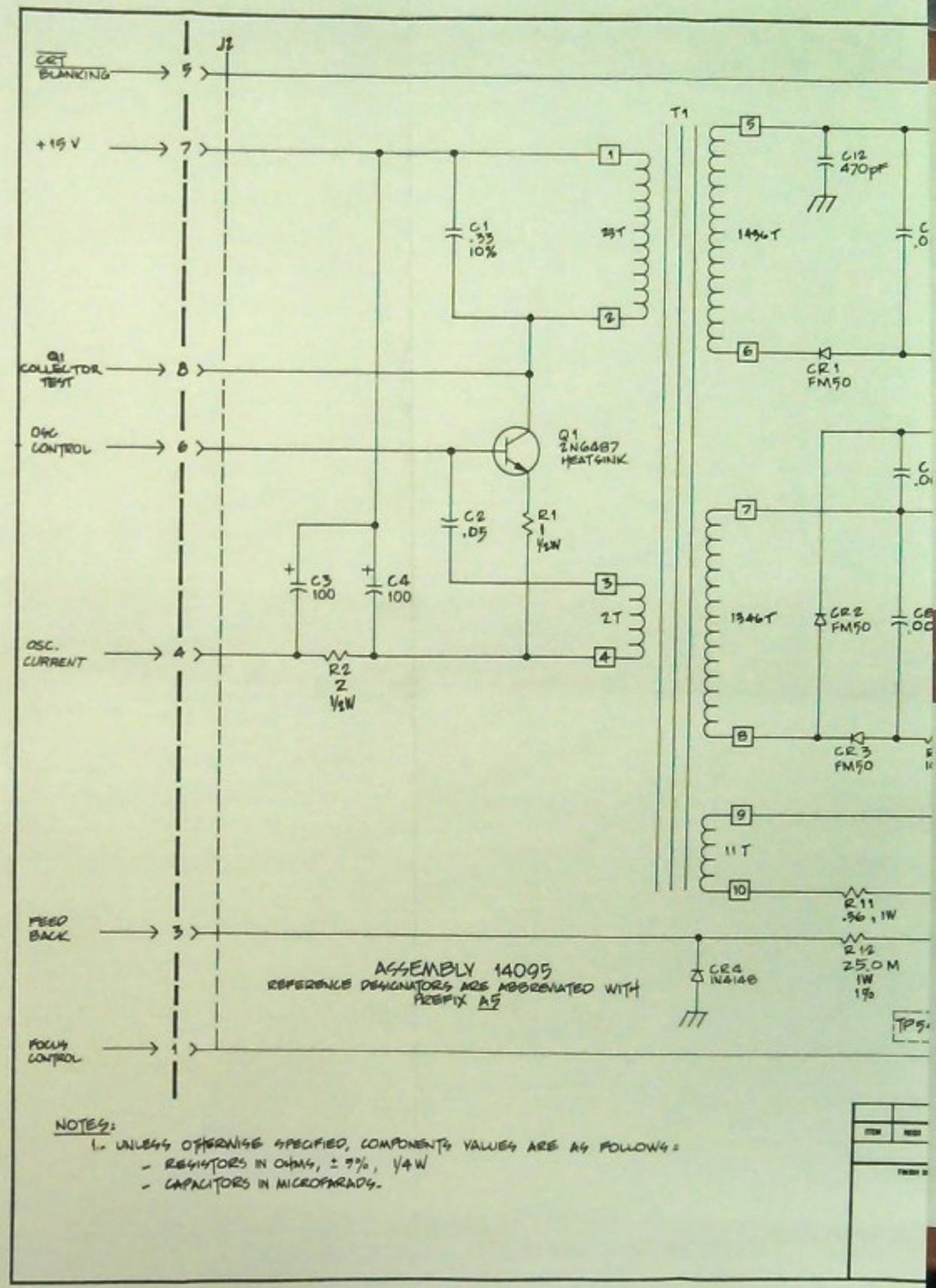


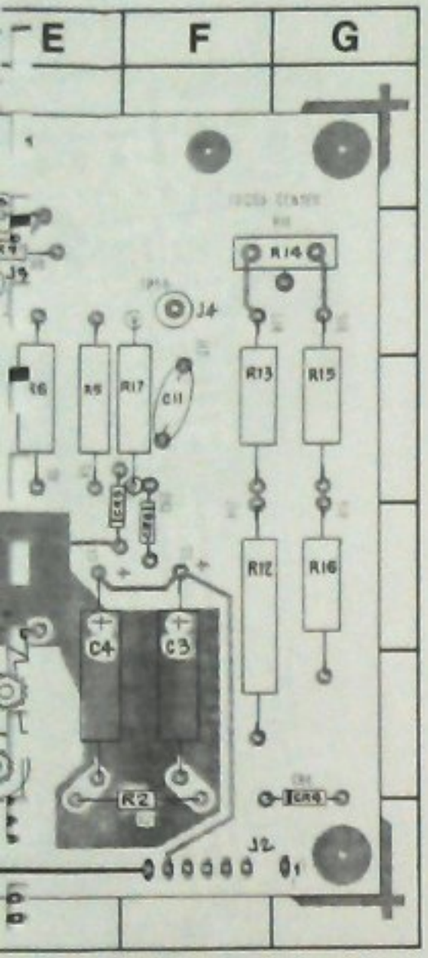
FIGURE 8-8 HIGH VOLTAGE PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	C-6	CR1	C-2	DS1	D-2	J1	D-1	R1	D-4	T1	B-5		
C2	D-4	CR2	A-3	DS2	E-2	J2	F-6	R2	E-5				
C3	F-4	CR3	C-2			J3	E-2	R3	D-3				
C4	E-4	CR4	F-5			J4	F-2	R4	D-2				
C5	D-2	CR5	E-3					R5	E-3				
C6	D-2	CR6	F-4					R6	E-3				
C7	A-4							R7	D-3				
C8	C-2							R8	C-2				
C9	D-2							R9	E-2				
C11	F-3							R10	C-2				
C12	D-3							R11	C-1				
								R12	F-4				
						Q1	D-5	R13	F-3				
								R14	F-2				
								R15	G-3				
								R16	G-4				



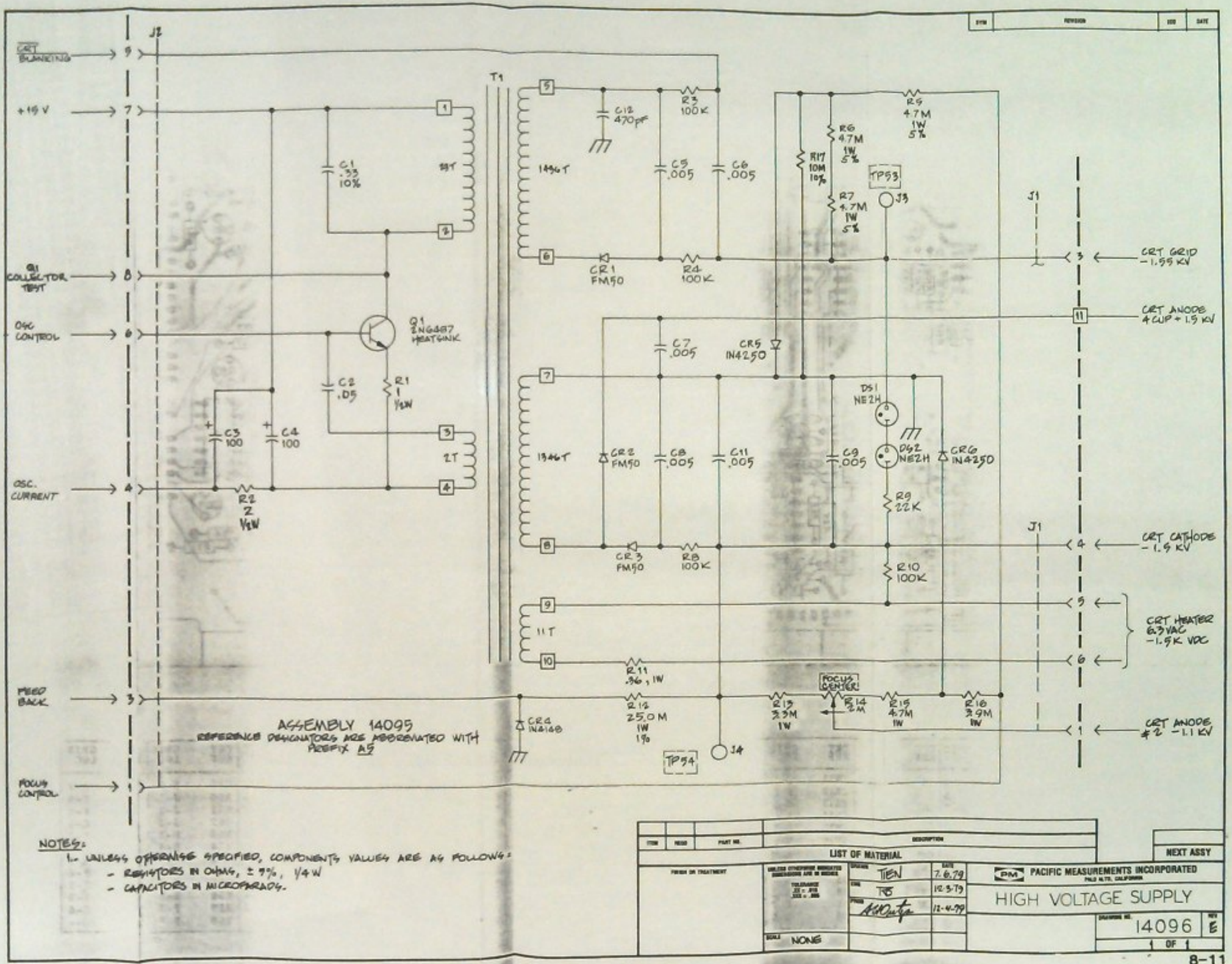
NOTES:

1. UNLESS OTHERWISE SPECIFIED, COMPONENTS VALUES ARE AS FOLLOWS:
   - RESISTORS IN OHMS, ± 5%, 1/4 W
   - CAPACITORS IN MICROFARADS.



SEMBLY

GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
D-4	T1	B-5		
E-5				
D-3				
D-2				
E-3				
E-3				
D-3				
C-2				
E-2				
C-2				
C-1				
F-4				
F-3				
F-2				
G-3				
G-4				



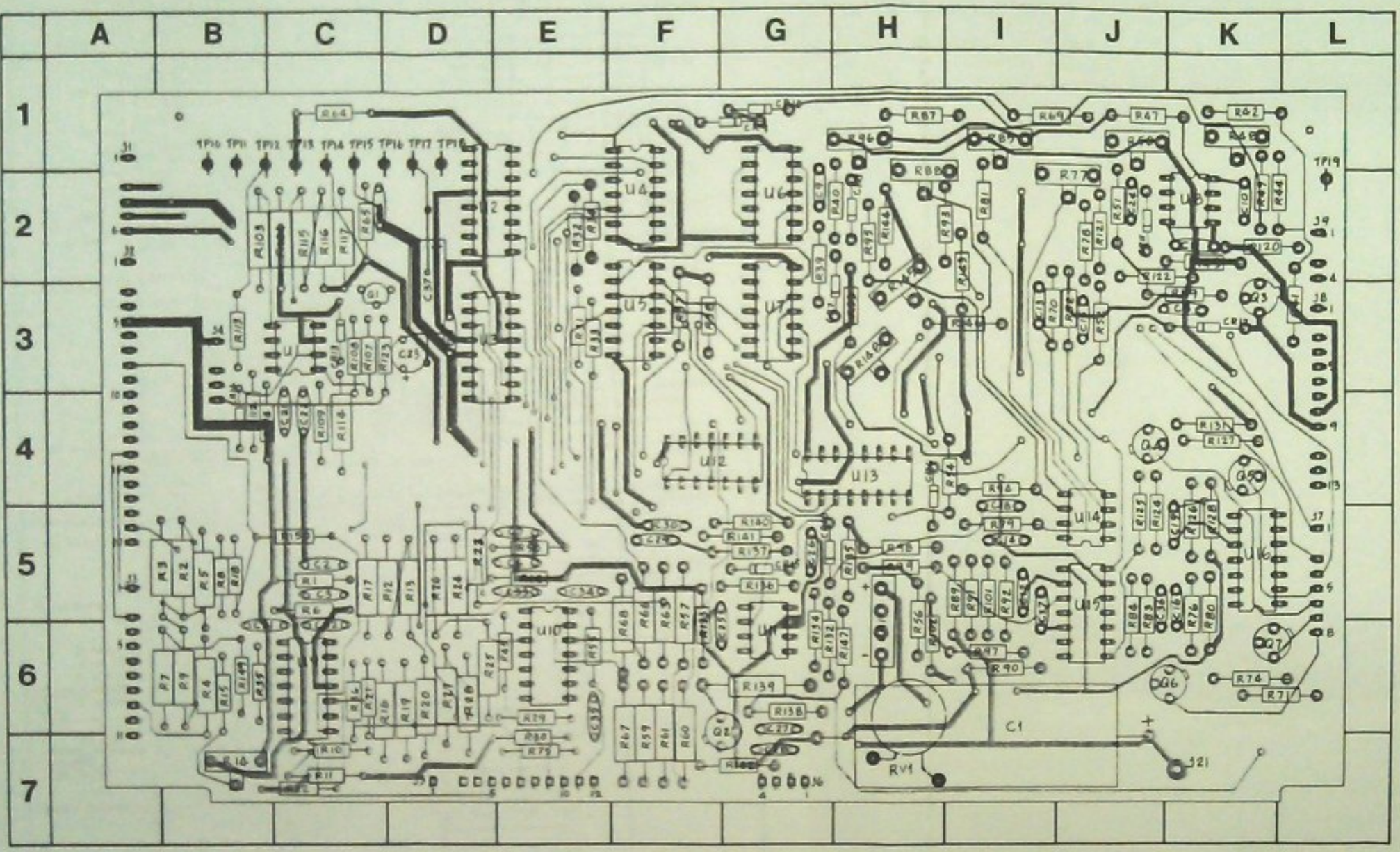
ASSEMBLY 14095
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A5

NOTES:
1. UNLESS OTHERWISE SPECIFIED, COMPONENTS VALUES ARE AS FOLLOWS:
   - RESISTORS IN OHMS, ± 5%, 1/4 W
   - CAPACITORS IN MICROFARADS.

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX = .010 .XXX = .005	DRAWN TIEN 7.6.79	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA
		ENG TIS 12.3.79	HIGH VOLTAGE SUPPLY
	SCALE NONE	PROJ 12-4-79	DRAWING NO. 14096 REV E
			1 OF 1

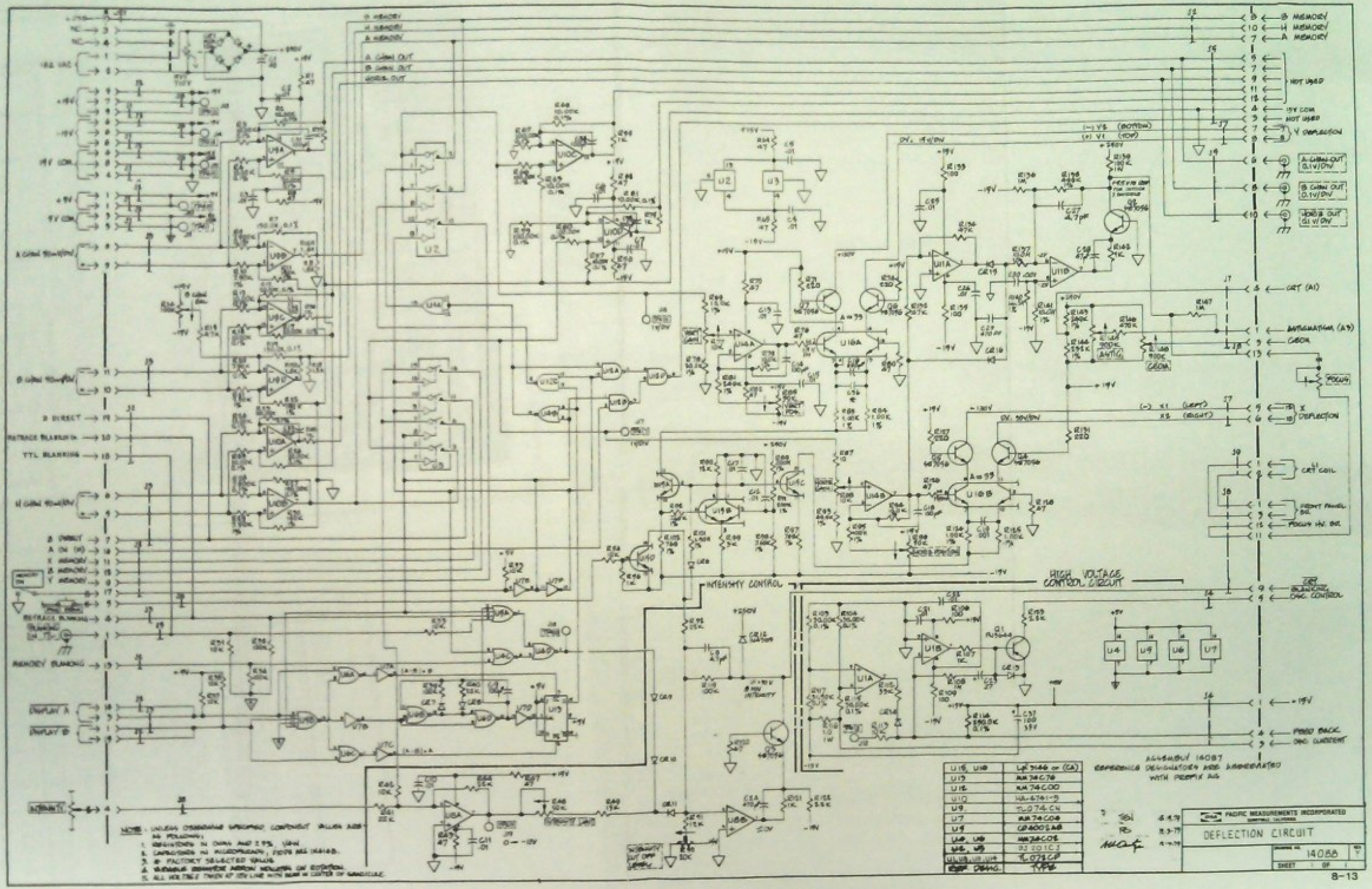
NEXT ASSY



CKT REF	GRID LOC	CKT REF	GRID LOC
R73	---	R123	D-3
R74	K-6	R124	J-5
R75	E-7	R125	J-5
R76	K-6	R126	K-5
R77	J-2	R127	K-4
R78	J-2	R128	K-5
R79	I-5	R129	---
R80	K-6	R130	---
R81	I-2	R131	K-4
R82	J-3	R132	G-6
R83	J-5	R133	F-6
R84	J-5	R134	G-6
R85	I-1	R135	H-5
R86	---	R136	G-5
R87	H-1	R137	G-5
R88	H-2	R138	G-6
R89	I-5	R139	G-6
R90	I-6	R140	G-5
R91	I-5	R141	G-5
R92	I-5	R142	G-7
R93	H-2	R143	I-2
R94	I-4	R144	H-2
R95	H-2	R145	H-3
R96	H-1	R146	I-3
R97	I-6	R147	H-6
R98	H-5	R148	H-3
R99	H-5	R149	---
R100	---	R150	---
R101	I-5		
R102	H-6	U1	C-3
R103	B-2	U2	D-2
R104	B-2	U3	D-3
R105	C-3	U4	F-2
R106	B-4	U5	F-3
R107	C-3	U6	G-2
R108	C-3	U7	G-3
R109	C-4	U8	K-2
R110	---	U9	C-6
R111	---	U10	E-6
R112	B-4	U11	G-6
R113	B-3	U12	F-4
R114	C-4	U13	H-4
R115	C-2	U14	J-5
R116	C-2	U15	J-5
R117	C-2	U16	K-5
R118	---		
R119	K-3		
R120	K-2		
R121	J-2		
R122	J-2		

FIGURE 8-9 DEFLECTION PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	I-7	C13	I-3	C25	F-6	C37	D-3	CR11	J-2	J7	L-5	TP19	L-2	R1	C-5	R13	D-5	R25	D-6	R37	F-3	R49	K-2	R61	F-7
C2	C-5	C14	I-5	C26	G-5			CR12	K-3	J8	L-4	J20	---	R2	B-5	R14	B-7	R26	D-5	R38	F-3	R50	J-1	R62	E-5
C3	C-5	C15	J-3	C27	G-7	CR1	H-6	CR13	C-3	J9	L-2	J21	K-7	R3	A-5	R15	B-6	R27	D-6	R39	G-2	R51	J-2	R63	F-6
C4	C-2	C16	K-5	C28	G-7	CR2	B-6	CR14	B-4	TP10	B-2			R4	B-6	R16	C-6	R28	D-6	R40	G-2	R52	J-3	R64	C-1
C5	D-3	C17	I-5	C29	F-5	CR3	B-6	CR15	G-5	TP11	B-2	Q1	C-3	R5	B-5	R17	C-5	R29	E-6	R41	L-3	R53	H-3	R65	C-2
C6	E-5	C18	I-5	C30	F-5	CR4	C-6	CR16	G-5	TP12	B-2	Q2	F-7	R6	C-5	R18	B-5	R30	E-7	R42	K-1	R54	H-4	R66	F-6
C7	E-5	C19	K-5	C31	B-6	CR5	B-5	J1	A-2	TP13	C-2	Q3	K-3	R7	A-6	R19	D-6	R31	E-3	R43	K-2	R55	E-6	R67	F-7
C8	K-3	C20	B-3	C32	C-6	CR6	H-5	J2	A-4	TP14	C-2	Q4	J-4	R8	B-5	R20	D-6	R32	E-2	R44	K-2	R56	H-6	R68	F-6
C9	G-2	C21	C-4	C33	E-5	CR7	G-3	J3	A-6	TP15	C-2	Q5	K-4	R9	B-6	R21	C-6	R33	E-3	R45	D-6	R57	F-6	R69	I-1
C10	K-2	C22	C-4	C34	B-5	CR8	H-2	J4	B-3	TP16	C-2	Q6	J-6	R10	C-7	R22	C-7	R34	E-2	R46	---	R58	E-5	R70	I-3
C11	K-2	C23	C-3	C35	E-6	CR9	G-1	J5	E-7	TP17	D-2	Q7	K-6	R11	C-7	R23	D-5	R35	B-6	R47	J-1	R59	F-7	R71	K-6
C12	I-5	C24	J-2	C36	K-5	CR10	G-1	J6	G-7	TP18	D-2	RV1	H-7	R12	C-5	R24	D-5	R36	C-6	R48	K-1	R60	F-7	R72	---


B MEMORY
H MEMORY
A MEMORY
A CHAN OUT
B CHAN OUT
MODE OUT
NOT USED
Y DEFLECTION
A CHAN OUT 0.1V/DIV
B CHAN OUT 0.1V/DIV
MODE OUT 0.1 V/DIV
CRT (A1)
ANTIGNATION (A9)
CATHODE
FOCUS
X DEFLECTION
CRT COIL
FRONT PANEL INT.
FOCUS HV. INT.
CRT BLANKING CKT. CONTROL
+15V
FEED BACK
CKT. CURRENT
INTENSITY CONTROL
HIGH VOLTAGE CONTROL CIRCUIT
DEFLECTION CIRCUIT
PACIFIC MEASUREMENTS INCORPORATED
14088
SHEET 1 OF 1
8-13

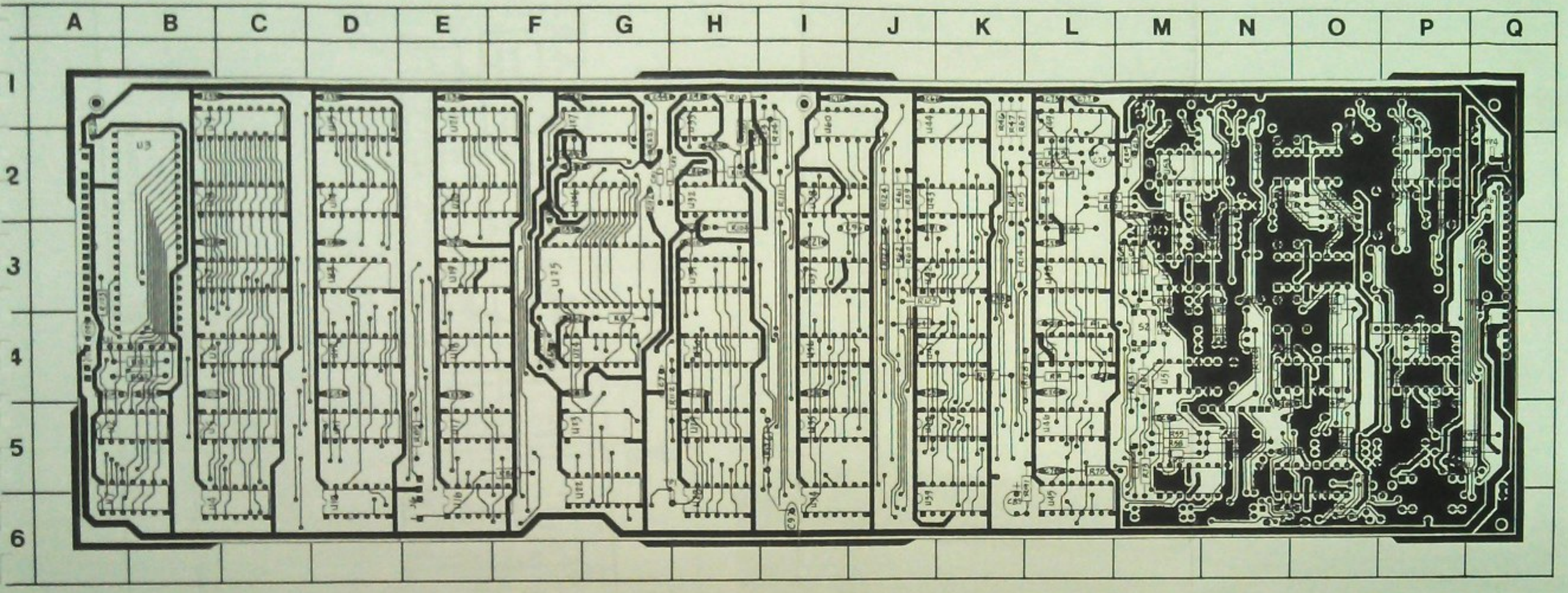


FIGURE 6-10 MEMORY PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	L-4	C20	---	C39	---	C58	---	C77	L-1	C96	O-5	J1	A-3	R9	L-4	R28	M-2	R47	K-1	R66	N-6	R85	O-5	R104	H-2	R123	A-3			U17	E-5	U36	I-4	U55	O-4
C2	---	C21	I-3	C40	---	C59	O-4	C78	L-5	C97	I-6	J2	A-4	R10	M-2	R29	M-2	R48	N-2	R67	L-1	R86	F-5	R105	N-5	R124	J-2			U18	E-4	U37	I-3	U56	O-3
C3	---	C22	E-3	C41	F-4	C60	O-5	C79	O-3	C98	K-6	J3	Q-3	R11	N-2	R30	O-2	R49	N-3	R68	L-2	R87	M-2	R106	O-2	R125	K-4			U19	E-3	U38	I-2	U57	O-2
C4	I-4	C23	---	C42	F-1	C61	J-2	C80	O-3			J4	O-4	R12	N-2	R31	O-2	R50	N-3	R69	L-2	R88	N-1	R107	O-1	R126	I-5	U1	A-6	U20	E-2	U39	K-6	U58	P-4
C5	---	C24	L-4	C43	F-2	C62	F-4	C81	N-3	CR1	G-2	J5	N-5	R13	N-2	R32	O-2	R51	N-3	R70	L-5	R89	M-2	R108	---	R127	J-3	U2	A-5	U21	E-1	U40	K-5	U59	P-2
C6	H-4	C25	E-4	C44	G-1	C63	F-4	C82	---	CR2	G-2	J6	E-6	R14	K-3	R33	O-2	R52	---	R71	M-6	R90	M-3	R109	N-4	R128	L-4	U3	A-2	U22	G-6	U41	K-4	U60	J-1
C7	G-4	C26	A-1	C45	M-2	C64	---	C83	K-6	CR3	N-2			R15	K-2	R34	O-1	R53	---	R72	M-6	R91	L-5	R110	H-1	S1	L-2	U4	B-6	U23	G-5	U42	K-3		
C8	---	C27	P-2	C46	M-2	C65	---	C84	M-5	CR4	M-3	K1	P-6	R16	P-4	R35	---	R54	M-3	R73	M-5	R92	O-3	R111	I-2	S2	M-4	U5	B-5	U24	G-4	U43	K-2		
C9	---	C28	L-3	C47	O-2	C66	K-1	C85	H-2	CR5	M-3			R17	P-5	R36	P-1	R55	M-5	R74	P-6	R93	N-5	R112	G-4			U6	C-4	U25	G-3	U44	K-1		
C10	H-3	C29	P-1	C48	O-2	C67	N-3	C86	H-2	CR6	M-3	Q1	P-6	R18	---	R37	P-1	R56	N-4	R75	N-2	R94	P-5	R113	K-2	TP1	G-6	U7	C-3	U26	G-2	U45	L-6		
C11	---	C30	P-4	C49	O-3	C68	H-2	C87	H-2	CR7	M-2			R19	P-4	R38	P-1	R57	N-4	R76	N-1	R95	P-5	R114	Q-2	TP2	P-3	U8	C-2	U27	G-1	U46	L-5		
C12	---	C31	P-2	C50	P-2	C69	---	C88	O-2	CR8	M-5	R1	L-4	R20	---	R39	---	R58	M-5	R77	O-3	R96	Q-5	R115	P-1	TP3	P-3	U9	C-1	U28	H-6	U47	L-4		
C13	B-4	C32	P-3	C51	---	C70	---	C89	O-1	CR9	N-5	R2	N-2	R21	A-4	R40	O-5	R59	J-2	R78	O-3	R97	Q-5	R116	O-5	TP4	Q-2	U10	D-6	U29	H-5	U48	L-3		
C14	B-3	C33	P-3	C52	---	C71	M-3	C90	D-3	CR10	M-5	R3	P-5	R22	G-2	R41	O-6	R60	J-3	R79	P-3	R98	H-1	R117	K-4	TP5	Q-2	U11	D-5	U30	H-4	U49	L-1		
C15	D-4	C34	E-1	C53	B-1	C72	L-2	C91	H-1	CR11	P-6	R4	P-4	R23	I-1	R42	---	R61	J-2	R80	H-1	R99	N-5	R118	F-4	TP6	Q-2	U12	D-4	U31	H-5	U50	N-5		
C16	---	C35	D-1	C54	O-5	C73	L-1	C92	G-2			R5	O-5	R24	I-1	R43	---	R62	J-3	R81	M-4	R100	---	R119	P-5	TP7	O-5	U13	D-3	U32	H-2	U51	N-4		
C17	M-1	C36	L-4	C55	O-5	C74	O-6	C93	N-4			R6	O-1	R25	M-1	R44	O-4	R63	L-2	R82	P-6	R101	P-2	R120	N-4	TP8	O-5	U14	D-2	U33	H-1	U52	N-5		
C18	---	C37	N-3	C56	O-6	C75	---	C94	A-4			R7	N-2	R26	M-2	R45	O-5	R64	J-4	R83	M-4	R102	P-5	R121	A-4	TP9	O-5	U15	D-1	U34	I-6	U53	N-2		
C19	A-4	C38	J-4	C57	---	C76	I-1	C95	A-4			R8	G-4	R27	M-2	R46	K-1	R65	N-6	R84	L-2	R103	H-2	R122	A-4	TP10	O-4	U16	E-6	U35	I-5	U54	O-5		

REF DESIG	TYPE	REF DESIG	TYPE
U9, U6, U11, U14, U20	SN74LS367N		
U13, U36, U41, U46	SN74LS04N	U4, U17, U18, U29	SN74LS86N
U47	SN74LS27N	U16, U35, U37	SN74LS74N
U42	SN74LS51N	U24, U26, U27	AD561JD
U33	LM558N	U39	HA-4741-5
U21, U15	SN74LS174N	U32, U57	TL074CN
U30	SN74LS42N	U25	DM2504N
U23	K1108A	U38	LM339N
U10	SN74LS86N	U31	SN74LS11N
U1, U40	SN74LS10N	U7, U8, U9	2114L-4
U18, U46	SN74LS00N	U55	DG181AB
U12	SN74LS08N	U34	SN74LS02N
U57	8259A	U22, U43	SN74LS27N

NOTE: 1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/4 W ± 5% AND CAPACITOR VALUES ARE IN MICROFARADS
2. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE IN4148
3. POTENTIOMETER ARROW INDICATES CW ROTATION

PACIFIC MEASUREMENTS INCORPORATED

MEMORY BOARD

15528 J

SHEET 1 OF 1

REF DESIG	TYPE
U51	LM339N
U49	54765155N
U45	54765221N
U38, U39, U64	54765138N
U16, U60	54765106N
U41, U13	54765004N
U34, U35, U36	DG529CJ
U37, U50, U52	TL074CN
U32	LM319N

NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/4 W 5% AND CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE 1N4148.
3. POTENTIOMETER ARROW INDICATES CW ROTATION.

ASSEMBLY 15527
REF DESIG ARE ABBREVIATED WITH A6

PACIFIC MEASUREMENTS INCORPORATED

MEMORY BOARD

15528 J

SHEET 2 OF 2

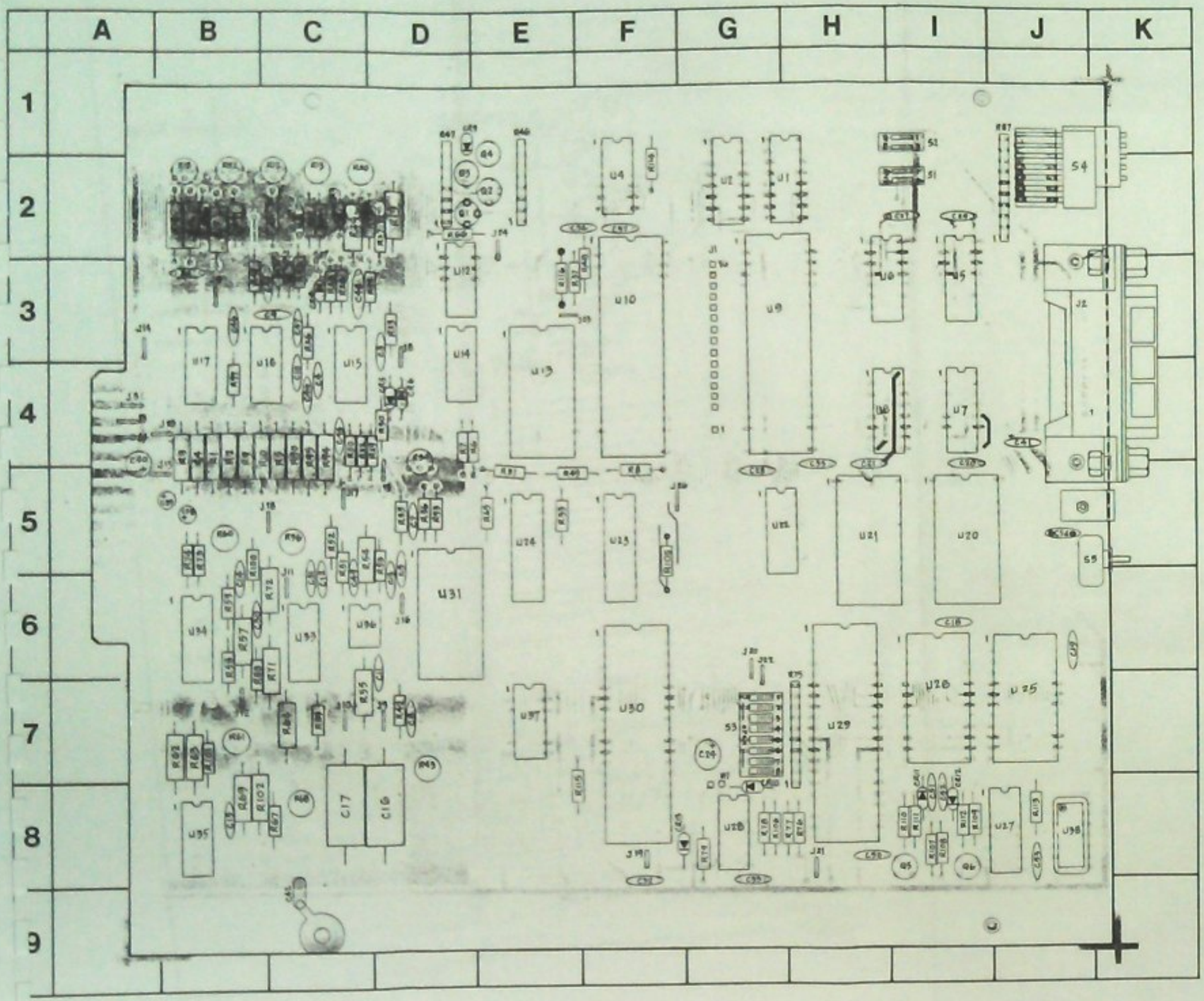


FIGURE 8-11 IEEE INTERFACE BUS PCB ASSEMBLY

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	B-3	CR1	C-3	R1	B-4	R57	B-6	R113	J-8
C2	C-2	CR2	C-3	R2	B-4	R58	B-6	R114	F-2
C3	D-3	CR3	C-2	R3	B-4	R59	B-6	R115	E-7
C4	C-4	CR4	C-3	R4	B-4	R60	B-5	R116	E-3
C5	D-5	CR5	D-4	R5	C-4	R61	B-7	S1	I-2
C6	---	CR6	D-4	R6	D-4	R62	B-7	S2	I-2
C7	D-5	CR7	---	R7	D-4	R63	B-7	S3	G-7
C8	D-7	CR8	---	R8	F-5	R64	C-7	S4	J-2
C9	C-3	CR9	D-1	R9	B-4	R65	E-5	S5	J-5
C10	C-4	CR10	G-8	R10	B-4	R66	D-2		
C11	D-6	CR11	I-8	R11	C-2	R67	C-8		
C12	C-6	CR12	I-8	R12	C-2	R68	C-8	U1	G-2
C13	D-6	CR13	G-8	R13	C-2	R69	B-8	U2	G-2
C14	B-6	J1	G-3	R14	C-2	R70	---	U3	---
C15	B-8	J2	J-3	R15	B-2	R71	C-6	U4	F-2
C16	D-8	J3	A-4	R16	B-2	R72	C-6	U5	I-3
C17	C-8	J4	A-4	R17	B-2	R73	B-5	U6	H-3
C18	I-6	J5	A-4	R18	B-2	R74	B-5	U7	I-4
C19	J-6	J6	B-3	R19	D-2	R75	G-7	U8	H-4
C20	I-5	J7	C-3	R20	C-2	R76	G-8	U9	G-3
C21	H-5	J8	D-3	R21	C-2	R77	G-8	U10	F-3
C22	---	J9	D-7	R22	C-3	R78	G-8	U11	---
C23	---	J10	C-7	R23	D-3	R79	G-8	U12	D-3
C24	G-8	J11	C-6	R24	C-2	R80	---	U13	E-4
C25	---	J12	B-7	R25	C-3	R81	---	U14	D-4
C26	---	J13	D-5	R26	C-3	R82	---	U15	C-4
C27	I-2	J14	A-3	R27	D-2	R83	---	U16	C-4
C28	G-5	J15	B-5	R28	C-3	R84	---	U17	B-4
C29	I-2	J16	D-6	R29	D-4	R85	---	U18	J-5
C30	B-6	J17	C-5	R30	D-4	R86	---	U19	I-5
C31	C-6	J18	C-5	R31	E-5	R87	J-2	U20	I-5
C32	F-8	J19	F-8	R32	C-4	R88	B-6	U21	H-5
C33	G-8	J20	G-6	R33	E-5	R89	C-7	U22	G-5
C34	E-2	J21	---	R34	D-4	R90	C-4	U23	F-5
C35	H-5	J22	G-7	R35	D-5	R91	B-2	U24	E-5
C36	J-2	J23	E-3	R36	D-5	R92	B-2	U25	J-7
C37	F-2	J24	E-3	R37	E-3	R93	D-5	U26	I-7
C38	B-5	J25	B-4	R38	---	R94	C-4	U27	I-8
C39	B-5	J26	F-5	R39	---	R95	C-4	U28	G-8
C40	A-4			R40	---	R96	B-2	U29	H-7
C41	J-4	Q1	D-2	R41	---	R97	B-4	U30	F-7
C42	B-9	Q2	E-2	R42	D-7	R98	C-2	U31	D-6
C43	C-4	Q3	D-2	R43	D-7	R99	D-3	U32	---
C44	C-4	Q4	E-1	R44	---	R100	B-5	U33	C-6
C45	C-3	Q5	I-8	R45	E-5	R101	B-7	U34	B-6
C46	B-3	Q6	I-8	R46	E-2	R102	B-8	U35	B-8
C47	C-3			R47	D-2	R103	---	U36	C-6
C48	C-3			R48	F-3	R104	---	U37	E-7
C49	C-5			R49	B-3	R105	---	U38	J-8
C50	H-8			R50	C-4	R106	G-8		
C51	I-8			R51	C-5	R107	I-8		
C52	I-8			R52	C-5	R108	I-8		
C53	J-8			R53	D-5	R109	I-8		
				R54	C-5	R110	H-8		
				R55	C-7	R111	I-8		
				R56	C-5	R112	I-8		

REF DESIG	TYPE
U13	[illegible]
U30	[illegible]
U31	[illegible]
U33, U34	[illegible]
U37, U35	[illegible]
U39, U33	[illegible]
U15	[illegible]
U16	[illegible]
U17	[illegible]
U18	[illegible]
U10, U30	[illegible]

A446MBV 15765

NOTE: [illegible]

U13 15 BIT DAC

U31 DIGITAL ANALOG CONVERTER

U30 PROGRAMMABLE PERIPHERAL INTERFACE

U10 PROGRAMMABLE PERIPHERAL INTERFACE

ANALOG COMMON

IEEE INTERFACE BUS

15766

ASSEMBLY 15765

REFERENCE DESIGNATORS ARE ASSOCIATED WITH PREFIX A10

NOTE: UNLESS OTHERWISE SPECIFIED,
1. RESISTOR VALUES ARE IN OHMS, ±5%, 1/4W;
CAPACITORS ARE IN MICROFARADS AND
DIODES ARE 1N4148
2. ⏚ IS 5V COM

REF DESIG	TYPE
U10	IC 1149A
U17	74LS175N

REF DESIG.	TYPE
U10	Z80
U14	74LS04
U15	74LS138
U16, U18	2732
U17	74LS175
U20, U21	2114
U9	8641A
U1, U2, U7, U8	MD 5260 HP
U4	74LS74N
U3, U5	MD 8641P

IEEE INTERFACE BUS

15766 1M

SUPPLEMENTARY DATA
MODEL 1038 SPEC 5294

Model 1038 Spec 5294 is a Model 1038 system which consists of the following items:

1 each	1038-D14A	Mainframe
1 each	1038-H13	Horizontal Plug-in
2 each	1038-V12	Vertical Log Plug-in
3 each	13782	Power Detector
1 each	12839-1	Extension Cable, 25 feet
1 each	12839-4	Extension Cable, 200 feet

REV	–	A
ECO	Released	DWG To D/MA
DATE	8/24/81	11/5/84

ORIG	DATE	WAVETEK PACIFIC MEASUREMENTS, INC. SUNNYVALE, CALIFORNIA
ENG Y. Ashizawa	11/5/84	MODEL 1038 SPEC 5294
PROD/TEST W. Lemmon	11/9/84	
MARKETING L. Nill	11/9/84	DOCUMENT NO. SPEC 5294
QA A. Ortega	11-9-84	SHEET 1 OF 1

SECTION 9

REPLACEABLE PARTS LISTINGS

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
		MAINFRAME/DISPLAY CHASSIS ASSEMBLY #15597			
A1	14101	Interface PC Board Assembly			
A2	15778	Interconnect PC Board Assembly			
A3	14126	Power Supply PC Board Assembly			
A4	14087	Deflection PC Board Assembly			
A5	14095	High Voltage PC Board Assembly			
A6	15527	Memory PC Board Assembly			
A7	14413	Front Panel PC Board Assembly			
A8	14493	IEEE Interconnect PC Board Assembly			
A9	15709	IEEE Interface PC Board Assembly			
A10	15765	IEEE Bus Interface PC Board Assembly (Option #04)			
CR1	15775	Diode, EDI PK10F or PA10			
CR2	14945	Diode, LED, Red			
CR3	15775	Diode, EDI PK10F or PA10			
F1	15058-1	Fuse, 2.0A 250V			
J1	16364	AC Receptacle			
J2 through J5	10048	Connector, BNC, UG-1094/U			
J6		Not Used			
J7	10048	Connector, BNC, UG-1094/U			
J8	11689	Connector, BNC, Insulated			
J9	11689	Connector, BNC, Insulated			
J10	11689	Connector, BNC, Insulated			
J11	14931-1	Connector Housing, 2 contacts			
J12 through J15	11689	Connector, BNC, Insulated			
J16	10048	Connector, BNC, UG-1094/U			
L1	14547	Twist Coil			
R1	15731-1	Resistor, Variable	25K Ω	±20%	1/2W
R2	11676-1	Resistor, Variable	100KΩ	±20%	1/2W
R3	14601-2	Resistor, Variable	5MΩ	±20%	1/2W
R4	15731-2	Resistor, Variable	100KΩ	±20%	1/2W
R5	11845-5	Resistor, Metal Glaze	36K Ω	±10%	2W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
R6	11845-5	Resistor, Metal Glaze	36K Ω	±10%	2W
R7	11845-5	Resistor, Metal Glaze	36K Ω	±10%	2W
R8	11845-5	Resistor, Metal Glaze	36K Ω	±10%	2W
R9	14877-1	Resistor, Metal Glaze	22K Ω	±10%	3W
T1	14093	Transformer			
V1	14548	CRT Tube			
W1	14567	Cable Assembly			
W2	15686	Cable Assembly, Main			
W3	14569	Cable Assembly			
W4	14570	Cable Assembly, CRT			
W5	15685	Cable Assembly			
S1	12483	Switch, Single Pole, Momentary			
S2	12483	Switch, Single Pole, Momentary			
		INTERFACE PC BOARD (A1) ASSEMBLY #14101			
A1C1	10000-11	Capacitor, Ceramic	.01 μF	±20%	100V
A1C2	10000-11	Capacitor, Ceramic	0.1 μF	±20#	100V
A1J1	12440-5	Connector, 44 contacts			
A1J2	12440-5	Connector, 44 contacts			
A1J3	12440-5	Connector, 44 contacts			
A1J4	12440-1	Connector, 36 contacts			
A1J5	14514-1	Post, .025 square			
A1J6	14514-1	Post, .025 square			
A1R1	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A1R2	12449-22	Resistor, Metal Film	2.500K Ω	±0.1%	1/8W
A1R3	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A1R4	12449-22	Resistor, Metal Film	2.500K Ω	±0.1%	1/8W
A1R5	10013-29	Resistor, Carbon Film	2.2K Ω	±5%	1/4W
A1R6	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A1U1	14521	Integrated Circuit	LM358N		
		INTERCONNECT PC BOARD (A2) ASSEMBLY #15778			
A2C1	10238-3	Capacitor, Elect.	2500 µF	+100% -10%	10V
A2C2	10238-4	Capacitor, Elect.	7500 µF	+100% -10%	25V
A2C3	10238-4	Capacitor, Elect.	7500 µF	+100% -10%	25V
A2C4	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A2J1		Not Used			
A2J2	14654	Tabs			
A2J3		Not Used			
A2J4	12440-4	Connector, 30 contacts			
A2J5	14654	Tabs			
A2J6	14514-1	Post, .025 square			
A2J7	14655	Connector, 36 contacts			
A2R1	10013-21	Resistor, Carbon Film	470Ω	±5%	1/4W
A2R2	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A2R3	10013-31	Resistor, Carbon Film	3.3KΩ	±5%	1/4W
A2R4	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
		POWER SUPPLY PC BOARD (A3) ASSEMBLY #14126			
A3C1	10787-4	Capacitor, Tantalum	68 µF	±20%	15V
A3C2	10000-11	Capacitor, Ceramic	0.1 µF	±20%	100V
A3C3	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A3C4	10000-4	Capacitor, Ceramic	.001 µF	±20%	1000V
A3C5	10787-4	Capacitor, Tantalum	68 µF	±20%	15V
A3C6		Not Used			
A3C7		Not Used			
A3C8		Not Used			
A3C9	10585-1	Capacitor, Ceramic	220pF	±5%	1000V
A3C10	10000-4	Capacitor, Ceramic	.001 µF	±20%	1000V
A3C11	10000-4	Capacitor, Ceramic	.001 µF	±20%	1000V
A3C12	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A3C13	10787-4	Capacitor, Tantalum	68 µF	±20%	15V
A3C14	10000-4	Capacitor, Ceramic	.001 µF	±20%	1000V
A3C15	10000-4	Capacitor, Ceramic	.001 µF	±20%	1000V
A3C16	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A3C17	10787-4	Capacitor, Tantalum	68 µF	±20%	15V
A3CR1	10043	Diode	1N4148		
A3CR2	11868	Diode	1N5229B	4.3V	±5%
A3CR3		Not Used			
A3CR4	10043	Diode	1N4148		
A3CR5	10043	Diode	1N4148		
A3CR6	10043	Diode	1N4148		
A3CR7	10043	Diode	1N4148		
A3CR8	10043	Diode	1N4148		
A3CR9	10043	Diode	1N4148		
A3CR10	10045	Diode	1N823		
A3CR11	10043	Diode	1N4148		
A3CR12	10043	Diode	1N4148		
A3CR13	10044-1	Diode	1N4383		
A3CR14	10043	Diode	1N4148		
A3CR15	10044-1	Diode	1N4383		
A3CR16	11345	Diode	HP2900		
A3F1	10064-13	Fuse, 10A 125V			
A3J1 through A3J9	14320-2	Test Jack			
A3Q1	11119	Transistor	2N4250		
A3Q2	10206	Transistor	2N2053		
A3Q3	14622	Transistor	2N6486		
A3Q4	14623	Transistor	2N6489		
A3Q5	10206	Transistor	2N3053		
A3Q6	10927	Transistor	2N4314		
A3Q7	14622	Transistor	2N6486		
A3R1	10015-133	Resistor, Metal Film	49.9KΩ	±1%	1/8W
A3R2	10015-211	Resistor, Metal Film	2.74KΩ	±1%	1/8W
A3R3	14935-1	Resistor, Wire Wound	0.1 Ω	±10%	4W
A3R4	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A3R5	10015-19	Resistor, Metal Film	1.00KΩ	±1%	1/8W
A3R6	10015-13	Resistor, Metal Film	100KΩ	±1%	1/8W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A3R7	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A3R8	11845-4	Resistor, Metal Glaze	15 Ω	±10%	2W
A3R9	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A3R10	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A3R11	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A3R12	10015-188	Resistor, Metal Film	33.2KΩ	±1%	1/8W
A3R13	10046-8	Resistor, Variable Comp	10KΩ	±20%	1/4W
A3R14	10013-11	Resistor, Carbon Film	68Ω	±5%	1/4W
A3R15	14935-1	Resistor, Wire Wound	0.1 Ω	±10%	4W
A3R16		Not Used			
A3R17	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A3R18	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A3R19	10665-3	Resistor, Carbon Comp	100Ω	±10%	1W
A3R20	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A3R21	10015-65	Resistor, Metal Film	4.99KΩ	±1%	1/8W
A3R22	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A3R23	10046-9	Resistor, Variable Comp	100Ω	±20%	1/4W
A3R24	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A3R25	12449-51	Resistor, Metal Film	2.000KΩ	±0.1%	1/8W
A3R26	14935-1	Resistor, Wire Wound	0.1 Ω	±10%	4W
A3R27	12449-75	Resistor, Metal Film	1.745KΩ	±0.1%	1/8W
A3R28	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A3R29	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A3R30	10665-3	Resistor, Carbon Comp	100 Ω	±10%	1W
A3R31	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A3R32	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A3R33	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A3R34	10015-20	Resistor, Metal Film	1.10KΩ	±1%	1/8W
A3R35	10015-84	Resistor, Metal Film	2.10KΩ	±1%	1/8W
A3R36	10015-65	Resistor, Metal Film	4.99KΩ	±1%	1/8W
A3R37	11711-1	Resistor, Variable	500Ω	±20%	1/2W
A3R38	10015-176	Resistor, Metal Film	3.48KΩ	±1%	1/8W
A3R39	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A3R40	12449-74	Resistor, Metal Film	1.182KΩ	±0.1%	1/8W
A3R41	14935-1	Resistor, Wire Wound	0.1 Ω	±10%	4W
A3R42	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A3R43	12449-19	Resistor, Metal Film	1.000KΩ	±0.1%	1/8W
A3R44	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A3U1	14621	Integrated Circuit	LM358N		
A3U2	13471	Integrated Circuit	LM324N		

CIRCUIT REFERENCE	PART NO.	DESCRIPTION				
		DEFLECTION PC BOARD (A4) ASSEMBLY #14087				
A4C1	10003-16	Capacitor, Electrolytic	40 µF			
A4C2	10000-11	Capacitor, Ceramic	.01µ F	±20%	100V	
A4C3	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V	
A4C4	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V	
A4C5	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V	
A4C6	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V	
A4C7	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V	
A4C8	10001-2	Capacitor, Ceramic	4.7pF	±5%	1000V	
A4C9	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C10	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C11	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C12	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C13	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C14	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C15	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C16	10585-4	Capacitor, Ceramic	680pF	±5%	1000V	
A4C17	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C18	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C19	10000-4	Capacitor, Ceramic	.001 µF	±20%	1000V	
A4C20		Not Used				
A4C21	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C22	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C23	10787-3	Capacitor, Tantalum	27µF	±20%	20VDC	
A4C24	10000-3	Capacitor, Ceramic	470pF	±20%	1000V	
A4C25	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C26	10000-11	Capacitor, Ceramic	.01µF	±20%	100V	
A4C27	10001-2	Capacitor, Ceramic	4.7pF	±5%	1000V	
A4C28	10001-6	Capacitor, Ceramic	47pF	±5%	1000V	
A4C29	10000-3	Capacitor, Ceramic	470pF	±20%	100V	
A4C30	10000-4	Capacitor, Ceramic	.001 µF	±20%	100V	
A4C31	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C32	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C33	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C34	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C35	10000-1	Capacitor, Ceramic	100pF	±20%	1000V	
A4C36		Factory Selected				
A4C37	10003-5	Capacitor, Elect.	100µF	+50%	-10%	35V
A4CR1	16420	Diode	MDA106A			
A4CR2	10043	Diode	1N4148			
A4CR3	10885	Diode	1N957B (Standard)			
A4CR4	10043	Diode	1N4148			
A4CR5	10885	Diode	1N957B (Standard)			

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A4CR6	10043	Diode	1N4148		
A4CR7	10043	Diode	1N4148		
A4CR8	10043	Diode	1N4148		
A4CR9	10043	Diode	1N4148		
A4CR10	10043	Diode	1N4148		
A4CR11	10043	Diode	1N4148		
A4CR12	10044-2	Diode	1N4385		
A4CR13	10043	Diode	1N4148		
A4CR14	10043	Diode	1N4148		
A4CR15	10043	Diode	1N4148		
A4CR16	10043	Diode	1N4148		
A4J1 through A4J9	14514-1	Post, .025 square			
A4J10 through A4J19	14320-2	Test Jack			
A4J20		Not Used			
A4J21	10600	Pin, .058 diameter			
A4Q1	10025	Transistor	PN3644		
A4Q2	13638	Transistor	SE7056		
A4Q3	13638	Transistor	SE7056		
A4Q4	13638	Transistor	SE7056		
A4Q5	13638	Transistor	SE7056		
A4Q6	13638	Transistor	SE7056		
A4Q7	13638	Transistor	SE7056		
A4RV1	16419	Varistor, Metal Oxide	710V		
A4R1	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A4R2	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A4R3	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A4R4	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A4R5	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A4R6	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A4R7	12449-16	Resistor, Metal Film	150.00KΩ	±0.1%	1/8W
A4R8	10013-28	Resistor, Carbon Film	1.8KΩ	±5%	1/4W
A4R9	12449-18	Resistor, Metal Film	7.500KΩ	±0.1%	1/8W
A4R10	10013-206	Resistor, Metal Film	7.50KΩ	±1%	1/8W
A4R11	10013-210	Resistor, Metal Film	150.0KΩ	±1%	1/8W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A4R12	12449-37	Resistor, Metal Film	20.00K Ω	±0.1%	1/8W
A4R13	12449-21	Resistor, Metal Film	10.00K Ω	±0.1%	1/8W
A4R14	10046-10	Resistor, Variable Comp	100K Ω	±20%	1/4W
A4R15	10013-69	Resistor, Carbon Film	4.7M Ω	±5%	1/4W
A4R16	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A4R17	12449-37	Resistor, Metal Film	20.00K Ω	±0.1%	1/8W
A4R18	10013-28	Resistor, Carbon Film	1.8K Ω	±5%	1/4W
A4R19	12449-16	Resistor, Metal Film	150.00KΩ	±0.1%	1/8W
A4R20	12449-18	Resistor, Metal Film	7.500KΩ	±0.1%	1/8W
A4R21	10015-206	Resistor, Metal Film	7.50KΩ	±1%	1/8W
A4R22	10015-210	Resistor, Metal Film	150.0KΩ	±1%	1/8W
A4R23	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A4R24	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A4R25	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A4R26	12449-37	Resistor, Metal Film	20.00KΩ	±0.1%	1/8W
A4R27	12449-16	Resistor, Metal Film	150.0KΩ	±0.1%	1/8W
A4R28	12448-18	Resistor, Metal Film	7.500KΩ	±0.1%	1/8W
A4R29	10015-206	Resistor, Metal Film	7.50KΩ	±1%	1/8W
A4R30	10015-210	Resistor, Metal Film	150.0KΩ	±1%	1/8W
A4R31	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A4R32	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A4R33	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A4R34	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A4R35	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A4R36	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A4R37	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A4R38	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A4R39	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A4R40	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A4R41	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A4R42	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A4R43	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R44	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A4R45	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A4R46		Not Used			
A4R47	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R48	10046-3	Resistor, Variable Comp	50KΩ	±20%	1/4W
A4R49	10013-39	Resistor, Carbon Film	15KΩ	±5%	1/4W
A4R50	10046-2	Resistor, Variable Comp	20KΩ	±20%	1/4W
A4R51	10013-38	Resistor, Carbon Film	12KΩ	±5%	1/4W
A4R52	10013-41	Resistor, Carbon Film	22KΩ	±5%	1/4W
A4R53	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A4R54	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A4R55	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A4R56	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A4R57	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A4R58	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R59	12449-33	Resistor, Metal Film	100.00KΩ	±0.1%	1/8W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A4R60	12449-33	Resistor, Metal Film	100.00K Ω	±0.1%	1/8W
A4R61	12449-21	Resistor, Metal Film	10.00K Ω	±0.1%	1/8W
A4R62	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R63	12449-21	Resistor, Metal Film	10.00K Ω	±0.1%	1/4W
A4R64	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R65	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R66	12449-33	Resistor, Metal Film	100.00K Ω	±0.1%	1/8W
A4R67	12449-33	Resistor, Metal Film	100.00K Ω	±0.1%	1/8W
A4R68	12449-21	Resistor, Metal Film	10.00K Ω	±0.1%	1/8W
A4R69	10015-7	Resistor, Metal Film	10.0KΩ	±1%	1/8W
A4R70	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R71	10013-17	Resistor, Carbon Film	220 Ω	±5%	1/4W
A4R72		Not Used			
A4R73		Not Used			
A4R74	10013-17	Resistor, Carbon Film	220 Ω	±5%	1/4W
A4R75	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A4R76	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R77	10046-8	Resistor, Variable Comp	10K Ω	±20%	1/4W
A4R78	10015-207	Resistor, Metal Film	20.0KΩ	±1%	1/8W
A4R79	10015-7	Resistor, Metal Film	10.00KΩ	±1%	1/8W
A4R80	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R81	10015-102	Resistor, Metal Film	249K Ω	±1%	1/8W
A4R82	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R83	10015-19	Resistor, Metal Film	1.0K Ω	±1%	1/8W
A4R84	10015-19	Resistor, Metal Film	1.0K Ω	±1%	1/8W
A4R85	10046-3	Resistor, Variable Comp	50K Ω	±20%	1/4W
A4R86		Not Used			
A4R87	10013-1	Resistor, Carbon Film	10 Ω	±5%	1/4W
A4R88	10046-8	Resistor, Variable Comp	10KΩ	±20%	1/4W
A4R89	10015-62	Resistor, Metal Film	200.0KΩ	±1%	1/8W
A4R90	10013-38	Resistor, Carbon Film	12K Ω	±5%	1/4W
A4R91	10015-62	Resistor, Metal Film	200.0K Ω	±1%	1/8W
A4R92	10015-30	Resistor, Metal Film	7.68K Ω	±1%	1/8W
A4R93	10015-133	Resistor, Metal Film	49.9K Ω	±1%	1/8W
A4R94	10015-7	Resistor, Metal Film	10.0K Ω	±1%	1/8W
A4R95	10015-13	Resistor, Metal Film	100.0K Ω	±1%	1/8W
A4R96	10046-3	Resistor, Variable Comp	50KΩ	±20%	1/4W
A4R97	10015-205	Resistor, Metal Film	768 Ω	±1%	1/8W
A4R98	10015-30	Resistor, Metal Film	7.68KΩ	±1%	1/8W
A4R99	10013-75	Resistor, Carbon Film	3KΩ	±5%	1/4W
A4R100		Not Used			
A4R101	10015-256	Resistor, Metal Film	1.50KΩ	±1%	1/8W
A4R102	10015-205	Resistor, Metal Film	768Ω	±1%	1/8W
A4R103	12449-30	Resistor, Metal Film	30.00KΩ	±0.1%	1/8W
A4R104	12449-30	Resistor, Metal Film	30.00KΩ	±0.1%	1/8W
A4R105		Not Used			
A4R106	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A4R107	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A4R108	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A4R109	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A4R110		Not Used			
A4R111		Not Used			
A4R112	10013-43	Resistor, Carbon Film	33K Ω	±5%	1/4W
A4R113	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A4R114	12449-45	Resistor, Metal Film	250.00KΩ	±0.1%	1/8W
A4R115	12449-30	Resistor, Carbon Film	30.00K Ω	±0.1%	1/8W
A4R116	10633-1	Resistor, Carbon Film	1.0 Ω	±5%	1W
A4R117	12449-66	Resistor, Metal Film	31.50KΩ	±0.1%	1/8W
A4R118		Not Used			
A4R119	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A4R120	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A4R121	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A4R122	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A4R123	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A4R124	10015-19	Resistor, Metal Film	1.00KΩ	±1%	1/8W
A4R125	10015-19	Resistor, Metal Film	1.00KΩ	±1%	1/8W
A4R126	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R127	10013-17	Resistor, Carbon Film	220Ω	±5%	1/4W
A4R128	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A4R129		Not Used			
A4R130		Not Used			
A4R131	10013-17	Resistor, Carbon Film	220Ω	±5%	1/4W
A4R132	10013-45	Resistor, Carbon Film	47KΩ	±5%	1/4W
A4R133	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A4R134	10013-45	Resistor, Carbon Film	47KΩ	±5%	1/4W
A4R135	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A4R136	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A4R137	10015-7	Resistor, Metal Film	10.0KΩ	±1%	1/8W
A4R138	10015-45	Resistor, Metal Film	499KΩ	±1%	1/8W
A4R139	10665-8	Resistor, Carbon Comp	100KΩ	±5%	1W
A4R140	10015-191	Resistor, Metal Film	66.5KΩ	±1%	1/8W
A4R141	10015-7	Resistor, Metal Film	10.0KΩ	±1%	1/8W
A4R142	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A4R143	10015-102	Resistor, Metal Film	249.0KΩ	±1%	1/8W
A4R144	10015-262	Resistor, Metal Film	232.0KΩ	±1%	1/8W
A4R145	10046-12	Resistor, Variable Comp	500KΩ	±20%	1/4W
A4R146	10013-57	Resistor, Carbon Film	470KΩ	±5%	1/4W
A4R147	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A4R148	10046-12	Resistor, Variable Comp	500KΩ	±20%	1/4W
A4R149	10013-28	Resistor, Carbon Film	1.8K Ω	±5%	1/4W
A4R150	10013-28	Resistor, Carbon Film	1.8KΩ	±5%	1/4W
A4U1	14624	Integrated Circuit	TL072CP		
A4U2	15119	Integrated Circuit	DG201CJ		

CIRCUIT REFERENCE	PART NO.	DESCRIPTION				
A4U3	15119	Integrated Circuit	DG201CJ			
A4U4	14631	Integrated Circuit	MM74C02			
A4U5	14637	Integrated Circuit	CD4002AE			
A4U6	14631	Integrated Circuit	MM74C02			
A4U7	14632	Integrated Circuit	MM74C04			
A4U8	14624	Integrated Circuit	TL072CP			
A4U9	14226	Integrated Circuit	TL074CN			
A4U10	15739	Integrated Circuit	HA-4741-5			
A4U11	14624	Integrated Circuit	TL072CP			
A4U12	14630	Integrated Circuit	MM74C00N			
A4U13	14633	Integrated Circuit	MM74C76N			
A4U14	14624	Integrated Circuit	TL072CP			
A4U15	14635	Integrated Circuit	LM3146N			
A4U16	14635	Integrated Circuit	LM3146N			
		HIGH VOLTAGE PC BOARD (A5) ASSEMBLY #14095				
A5C1	10007-14	Capacitor, Mylar	.33µF	±10%	200VDC	
A5C2	10000-9	Capacitor, Ceramic	.05µF	±20%	50V	
A5C3	10003-5	Capacitor, Elect.	100µF	+50%	-10%	35VDC
A5C4	10003-5	Capacitor, Elect.	100µF	+50%	-10%	35VDC
A5C5	14116-3	Capacitor, Ceramic	.005µF	+50%	-10%	3kV
A5C6	14116-3	Capacitor, Ceramic	.005µF	+50%	-10%	3kV
A5C7	14116-3	Capacitor, Ceramic	.005µF	+50%	-10%	3kV
A5C8	14116-3	Capacitor, Ceramic	.005µF	+50%	-10%	3kV
A5C9	14116-3	Capacitor, Ceramic	.005µF	+50%	-10%	3kV
A5C10		Not Used				
A5C11	14116-3	Capacitor, Ceramic	.005µF	+50%	-10%	3kV
A5C12	10000-3	Capacitor, Ceramic	470pF	±20%	1kVDC	
A5CR1	14648	Diode	FM50			
A5CR2	14648	Diode	FM50			
A5CR3	14648	Diode	FM50			
A5CR4	10043	Diode	1N4148			
A5CR5	15524	Diode	1N4250			
A5CR6	15524	Diode	1N4250			
A5DS1	10462	Lamp	NE-2H(C2A)			
A5DS2	10462	Lamp	NE-2H(C2A)			

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A5J1	14514-1	Post, .025 square			
A5J2	14514-1	Post, .025 square			
A5J3	10140-4	Test Point, Blue			
A5J4	10140-1	Test Point, Red			
A5P1	14587	Connector, CRT Anode			
A5Q1	14647	Transistor	2N6487		
A5R1	10241-5	Resistor, Carbon Comp	1.0 Ω	±5%	1/2W
A5R2	10241-9	Resistor, Carbon Comp	2.0 Ω	±5%	1/2W
A5R3	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A5R4	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A5R5	14941-3	Resistor, Carbon Comp	4.7MΩ	±5%	1W
A5R6	14941-3	Resistor, Carbon Comp	4.7MΩ	±5%	1W
A5R7	14941-3	Resistor, Carbon Comp	4.7MΩ	±5%	1W
A5R8	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A5R9	10013-41	Resistor, Carbon Film	22KΩ	±5%	1/4W
A5R10	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A5R11	10633-3	Resistor, Wire Wound	.36Ω	±5%	1W
A5R12	14662-1	Resistor, Metal Oxide	25.0MΩ	±1%	1W
A5R13	14941-1	Resistor, Carbon Comp	3.3MΩ	±5%	1W
A5R14	10046-14	Resistor, Variable Comp	2MΩ	±20%	1/4W
A5R15	14941-3	Resistor, Carbon Comp	4.7MΩ	±5%	1W
A5R16	14941-2	Resistor, Carbon Comp	3.9MΩ	±5%	1W
A5R17	10665-7	Resistor, Carbon Comp	10MΩ	±10%	1W
A5T1	13859	Coil, High Voltage			
A5T2	14525	Coil, Heater			
A5T3	14752	Spacer, Fiberglass			
A5T4	14627	U-Bolt			
A5T5	14626	U-Core			
		MEMORY PC BOARD (A6) ASSEMBLY #15527			
A6C1	15776-1	Capacitor, Ceramic	.01μF	±10%	50V
A6C2		Not Used			
A6C3		Not Used			

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6C4	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C5		Not Used			
A6C6	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C7	10001-6	Capacitor, Ceramic	47pF	±5%	1000V
A6C8		Not Used			
A6C9		Not Used			
A6C10	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C11		Not Used			
A6C12		Not Used			
A6C13	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C14	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C15	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C16		Not Used			
A6C17	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C18		Not Used			
A6C19	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C20		Not Used			
A6C21	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C22	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C23		Not Used			
A6C24	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C25	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C26	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C27	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C28	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C29	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C30	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C31	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C32	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C33	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C34	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C35	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C36	15776-2	Capacitor, Ceramic	.001µF	±10%	50V
A6C37	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C38	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C39		Not Used			
A6C40		Not Used			
A6C41	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C42	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C43	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C44	10001-6	Capacitor, Ceramic	47pF	±5%	1000V
A6C45	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C46	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C47	10001-3	Capacitor, Ceramic	10pF	±5%	1000V
A6C48	10909-2	Capacitor, Silver Mica	470pF	±1%	500V
A6C49	10000-3	Capacitor, Ceramic	470pF	±20%	1000V
A6C50	10000-4	Capacitor, Ceramic	.001µF	±20%	1000V
A6C51		Not Used			

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6C52		Not Used			
A6C53	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C54	10007-4	Capacitor, Mylar	.01µF	±10%	200V
A6C55	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C56	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C57		Not Used			
A6C58		Not Used			
A6C59	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C60	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C61	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C62	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C63	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C64		Not Used			
A6C65		Not Used			
A6C66	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C67	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C68	10000-8	Capacitor, Ceramic	.022µF	±20%	500V
A6C69		Not Used			
A6C70		Not Used			
A6C71	10787-11	Capacitor, Tantalum	1.0µF	±20%	35V
A6C72	10787-2	Capacitor, Tantalum	12µF	±20%	20V
A6C73	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C74	10007-4	Capacitor, Mylar	.01µF	±10%	200V
A6C75		Not Used			
A6C76	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C77	10000-5	Capacitor, Ceramic	.0022µF	±20%	500V
A6C78	10585-3	Capacitor, Ceramic	470pF	±5%	1000V
A6C79	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C80	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C81	14119-2	Capacitor, Polystyrene	470pF	±2.5%	100VDC
A6C82		Not Used			
A6C83	10787-2	Capacitor, Tantalum	12µF	±20%	20V
A6C84	15776-6	Capacitor, Ceramic	.47µF	±10%	200V
A6C85	10000-5	Capacitor, Ceramic	.0022µF	±20%	500V
A6C86	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C87	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C88	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C89	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C90	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C91	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A6C92	10001-6	Capacitor, Ceramic	47pF	±5%	1000V
A6C93	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A6C94	11501-5	Capacitor, Ceramic	.47pF	±20%	50V
A6C95	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C96	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A6C97	10585-1	Capacitor, Ceramic	220pF	±5%	1000V
A6C98	11501-7	Capacitor, Ceramic	.01µF	±20%	100V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6CR1	11345	Diode	HP2900		
A6CR2	11345	Diode	HP2900		
A6CR3	10043	Diode	1N4148		
A6CR4	10043	Diode	1N4148		
A6CR5	10043	Diode	1N4148		
A6CR6	10043	Diode	1N4148		
A6CR7	10043	Diode	1N4148		
A6CR8	10043	Diode	1N4148		
A6CR9	10043	Diode	1N4148		
A6CR10	10043	Diode	1N4148		
A6CR11	10043	Diode	1N4148		
A6J1 through A6J6	14514-1	Posts, .025 square			
A6K1	16073	Relay, DIP			
A6R1	10013-39	Resistor, Carbon Film	15K Ω	±5%	1/4W
A6R2	10013-69	Resistor, Carbon Film	4.7M Ω	±5%	1/4W
A6R3	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R4	10013-33	Resistor, Carbon Film	4.7 Ω	±5%	1/4W
A6R5	10015-13	Resistor, Metal Film	100 Ω	±1%	1/4W
A6R6	12449-85	Resistor, Metal Film	1.37 Ω	±0.1%	1/8W
A6R7	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A6R8	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A6R9	10015-133	Resistor, Metal Film	49.9KΩ	±1%	1/4W
A6R10	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A6R11	10015-7	Resistor, Metal Film	10.0KΩ	±1%	1/4W
A6R12	10015-191	Resistor, Metal Film	66.5KΩ	±1%	1/4W
A6R13	10013-45	Resistor, Carbon Film	47KΩ	±5%	1/4W
A6R14	10013-23	Resistor, Carbon Film	680 Ω	±5%	1/4W
A6R15	10013-45	Resistor, Carbon Film	47KΩ	±5%	1/4W
A6R16	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A6R17	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A6R18		Not Used			
A6R19	15098-2	Resistor, SIP Network	10KΩ	±2%	1/8W
A6R20		Not Used			
A6R21	15098-2	Resistor, SIP Network	10KΩ	±2%	1/8W
A6R22	10015-175	Resistor, Metal Film	1.74Ω	±1%	1/8W
A6R23	10013-33	Resistor, Carbon Film	4.7 Ω	±5%	1/4W
A6R24	10013-33	Resistor, Carbon Film	4.7 Ω	±5%	1/4W
A6R25	13584-7	Resistor, Variable Comp	100KΩ	±20%	1/2W
A6R27	10015-7	Resistor, Metal Film	10.0K Ω	±1%	1/4W
A6R28	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6R29	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R30	10015-7	Resistor, Metal Film	10.0K Ω	±1%	1/4W
A6R31	10015-119	Resistor, Metal Film	34.8 Ω	±1%	1/4W
A6R32	10015-36	Resistor, Metal Film	5.11K Ω	±1%	1/4W
A6R33	10015-188	Resistor, Metal Film	33.2K Ω	±1%	1/4W
A6R34	13584-7	Resistor, Variable Comp	100K Ω	±20%	1/2W
A6R35		Not Used			
A6R36	10015-210	Resistor, Metal Film	150K Ω	±1%	1/4W
A6R37	10015-24	Resistor, Metal Film	46.4K Ω	±1%	1/4W
A6R38	13584-9	Resistor, Variable Comp	5K Ω	±20%	1/2W
A6R39		Not Used			
A6R40	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R41	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R42		Not Used			
A6R43		Not Used			
A6R44	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R45	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R46	10015-105	Resistor, Metal Film	6.19 Ω	±1%	1/4W
A6R47	10015-226	Resistor, Metal Film	2.21K Ω	±1%	1/4W
A6R48	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A6R49	10013-21	Resistor, Carbon Film	470 Ω	±5%	1/4W
A6R50	10013-73	Resistor, Carbon Film	10M Ω	±5%	1/4W
A6R51	10013-18	Resistor, Carbon Film	270 Ω	±5%	1/4W
A6R52		Not Used			
A6R53		Not Used			
A6R54	10013-65	Resistor, Carbon Film	2.2M Ω	±5%	1/4W
A6R55	10013-17	Resistor, Carbon Film	220 Ω	±5%	1/4W
A6R56	10015-248	Resistor, Metal Film	44.2K Ω	±1%	1/4W
A6R57	10015-210	Resistor, Metal Film	150K Ω	±1%	1/4W
A6R58	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A6R59	10015-226	Resistor, Metal Film	2.21K Ω	±1%	1/4W
A6R60	10015-105	Resistor, Metal Film	6.19K Ω	±1%	1/4W
A6R61	10015-226	Resistor, Metal Film	2.21K Ω	±1%	1/4W
A6R62	10015-104	Resistor, Metal Film	5.62K Ω	±1%	1/4W
A6R63	10015-260	Resistor, Metal Film	221K Ω	±1%	1/4W
A6R64	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A6R65	12449-21	Resistor, Metal Film	10.00K Ω	±0.1%	1/8W
A6R66	12449-109	Resistor, Metal Film	1.136K Ω	±0.1%	1/8W
A6R67	10015-114	Resistor, Metal Film	75.0K Ω	±1%	1/4W
A6R68	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A6R69	10013-33	Resistor, Carbon Film	4.7K Ω	±5%	1/4W
A6R70	10015-28	Resistor, Metal Film	23.7K Ω	±1%	1/4W
A6R71	10015-7	Resistor, Metal Film	10.0K Ω	±1%	1/4W
A6R72	10015-218	Resistor, Metal Film	40.2K Ω	±1%	1/4W
A6R73	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A6R74	10013-33	Resistor, Carbon Film	4.7K Ω	±5%	1/4W
A6R75	10015-65	Resistor, Metal Film	4.99K Ω	±1%	1/4W
A6R76	13584-3	Resistor, Variable Comp	500 Ω	±20%	1/2W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6R77	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R78	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A6R79	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A6R80	12449-30	Resistor, Metal Film	30.00KΩ	±0.1%	1/8W
A6R81	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A6R82	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A6R83	10015-105	Resistor, Metal Film	6.19KΩ	±1%	1/4W
A6R84	10015-226	Resistor, Metal Film	2.21KΩ	±1%	1/4W
A6R85	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A6R86	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A6R87	10015-65	Resistor, Metal Film	4.99KΩ	±1%	1/4W
A6R88	13584-4	Resistor, Variable Comp	1KΩ	±20%	1/2W
A6R89	10015-273	Resistor, Metal Film	3.65K Ω	±1%	1/4W
A6R90	15144-1	Resistor, Metal Film	10.0M Ω	±1%	1/4W
A6R91	10015-13	Resistor, Metal Film	100K Ω	±1%	1/4W
A6R92	10013-73	Resistor, Carbon Film	10M Ω	±5%	1/4W
A6R93	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A6R94	10015-87	Resistor, Metal Film	15.0KΩ	±1%	1/4W
A6R95	10015-43	Resistor, Metal Film	121.0KΩ	±1%	1/4W
A6R96	12449-26	Resistor, Metal Film	5.000KΩ	±0.1%	1/8W
A6R97	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A6R98	12449-48	Resistor, Metal Film	15.00KΩ	±0.1%	1/8W
A6R99	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A6R100		Not Used			
A6R101	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A6R102	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A6R103	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R104	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R105	12449-21	Resistor, Carbon Film	10.00KΩ	±0.1%	1/8W
A6R106	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R107	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R108		Not Used			
A6R109	10015-224	Resistor, Metal Film	150Ω	±1%	1/4W
A6R110	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R111	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A6R112	10013-21	Resistor, Carbon Film	470Ω	±5%	1/4W
A6R113	10013-43	Resistor, Carbon Film	33KΩ	±5%	1/4W
A6R114	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R115	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A6R116	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A6R117	10015-7	Resistor, Metal Film	10.0KΩ	±1%	1/4W
A6R118	10015-111	Resistor, Metal Film	24.9Ω	±1%	1/4W
A6R119	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A6R120	12449-108	Resistor, Metal Film	1.200KΩ	±0.1%	1/8W
A6R121	10013-51	Resistor, Carbon Film	150KΩ	±5%	1/4W
A6R122	10013-21	Resistor, Carbon Film	470KΩ	±5%	1/4W
A6R123	10013-53	Resistor, Carbon Film	220KΩ	±5%	1/4W
A6R124	10013-45	Resistor, Carbon Film	47K Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6R125	10013-45	Resistor, Carbon Film	47K Ω	±5%	1/4W
A6R126	10013-21	Resistor, Carbon Film	470 Ω	±5%	1/4W
A6R127	10013-21	Resistor, Carbon Film	470 Ω	±5%	1/4W
A6R128	10013-21	Resistor, Carbon Film	470 Ω	±5%	1/4W
A6S1	14663	Switch, DIP, SPST			
A6S2	15094	Switch, DIP, SPDT			
A6TP1 through A6TP10	14320-2	Test Jack			
A6Q1	10017	Transistor	2N3569		
A6U1	13470-6	Integrated Circuit	SN74LS10N		
A6U2	13470-5	Integrated Circuit	SN74LS08N		
A6U3	14641	Integrated Circuit	8255A		
A6U4	13470-56	Integrated Circuit	SN74LS393N		
A6U5	13470-38	Integrated Circuit	SN74LS367N		
A6U6	13470-38	Integrated Circuit	SN74LS367N		
A6U7	14640	Integrated Circuit	2114AL-4		
A6U8	14640	Integrated Circuit	2114AL-4		
A6U9	14640	Integrated Circuit	2114AL-4		
A6U10	13470-51	Integrated Circuit	SN74LS86N		
A6U11	13470-38	Integrated Circuit	SN74LS367N		
A6U12	13470-38	Integrated Circuit	SN74LS367N		
A6U13	13470-4	Integrated Circuit	SN74LS04N		
A6U14	13470-38	Integrated Circuit	SN74LS367N		
A6U15	13470-33	Integrated Circuit	SN74LS174N		
A6U16	13470-5	Integrated Circuit	SN74LS08N		
A6U17	13470-56	Integrated Circuit	SN74LS393N		
A6U18	13470-56	Integrated Circuit	SN74LS393N		
A6U19	13470-13	Integrated Circuit	SN74LS74N		
A6U20	13470-38	Integrated Circuit	SN74LS367N		
A6U21	13470-33	Integrated Circuit	SN74LS174N		
A6U22	13470-58	Integrated Circuit	SN74LS279N		
A6U23	15039	Integrated Circuit	K1148A		
A6U24	14645	Integrated Circuit	AD561JD		
A6U25	14670	Integrated Circuit	DM2504N		
A6U26	14645	Integrated Circuit	AD561JD		
A6U27	14645	Integrated Circuit	AD561JD		
A6U28	13470-1	Integrated Circuit	SN74LS00N		
A6U29	13470-56	Integrated Circuit	SN74LS393N		

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A6U30	13470-12	Integrated Circuit	SN74LS42N		
A6U31	13470-39	Integrated Circuit	SN74LS11N		
A6U32	14668	Integrated Circuit	LM319N		
A6U33	14621	Integrated Circuit	LM358N		
A6U34	13470-3	Integrated Circuit	SN74LS02N		
A6U35	13470-13	Integrated Circuit	SN74LS74N		
A6U36	13470-4	Integrated Circuit	SN74LS04N		
A6U37	13470-13	Integrated Circuit	SN74LS74N		
A6U38	13470-13	Integrated Circuit	SN74LS74N		
A6U39	13470-13	Integrated Circuit	SN74LS74N		
A6U40	13470-6	Integrated Circuit	SN74LS10N		
A6U41	13470-4	Integrated Circuit	SN74LS04N		
A6U42	13470-35	Integrated Circuit	SN74LS51N		
A6U43	13470-58	Integrated Circuit	SN74LS279N		
A6U44	13470-13	Integrated Circuit	SN74LS74N		
A6U45	13470-18	Integrated Circuit	SN74LS221N		
A6U46	13470-1	Integrated Circuit	SN74LS00N		
A6U47	13470-17	Integrated Circuit	SN74LS123N		
A6U48	13470-4	Integrated Circuit	SN74LS04N		
A6U49	13470-17	Integrated Circuit	SN74LS123N		
A6U50	14226	Integrated Circuit	TL074CN		
A6U51	15141	Integrated Circuit	LM339N		
A6U52	14226	Integrated Circuit	TL074CN		
A6U53	15738	Integrated Circuit	DG181BP		
A6U54	15119	Integrated Circuit	DG201CJ		
A6U55	15119	Integrated Circuit	DG201CJ		
A6U56	15119	Integrated Circuit	DG201CJ		
A6U57	14226	Integrated Circuit	TL074CN		
A6U58	15141	Integrated Circuit	LM339N		
A6U59	15739	Integrated Circuit	HA-4741-5		
A6U60	13470-5	Integrated Circuit	SN74LS08N		
		FRONT PANEL			
		PC BOARD (A7) ASSEMBLY #14413			
A7J1	14514-1	Post, .025 square			
A7J2	14514-1	Post, .025 square			
A7J3	14514-1	Post, .025 square			
A7Q1	10017	Transistor	2N3569		
A7Q2	10023	Transistor	2N3644		
A7R1	10013-16	Resistor, Carbon Film	180Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A7R2	12449-48	Resistor, Metal Film	15.00K Ω	±0.1%	1/8W
A7R3	12449-53	Resistor, Metal Film	50.00K Ω	±0.1%	1/8W
A7S1	14656	Switch, Pushbutton, 4 stations			
		IEEE INTERCONNECT PC (A8) BOARD ASSEMBLY #14493			
A8J1	12440-4	Connector, 30 contacts			
A8J2	14514-1	Post, .025 square			
		IEEE INDICATOR PC BOARD (A9) ASSEMBLY #15709			
A9CR1	14661-1	Diode, Light Emitting (Red)			
A9CR2	14661-3	Diode, Light Emitting (Yellow)			
A9CR3	14661-2	Diode, Light Emitting (Green)			
A9J1	14514-1	Post, .025 square			
		IEEE INTERFACE BUS PC BOARD (A10) ASSEMBLY #15765			
A10C1	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A10C2	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C3	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C4	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C5	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C6		Not Used			
A10C7	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C8	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C9	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C10	10000-11	Capacitor, Ceramic	.01 µF	±20%	100V
A10C11	10001-8	Capacitor, Ceramic	15pF	±5%	1000V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A10C12	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C13	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C14	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C15	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A10C16	13979-1	Capacitor, Polycarb.	1.0µF	±10%	100V
A10C17	13979-1	Capacitor, Polycarb.	1.0µF	±10%	100V
A10C18	11501-5	Capacitor, Ceramic	.47µF	±20%	100V
A10C19	11501-5	Capacitor, Ceramic	.47µF	±20%	100V
A10C20	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C21	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C22		Not Used			
A10C23		Not Used			
A10C24	10787-4	Capacitor, Tantalum	68µF	±20%	20V
A10C25		Not Used			
A10C26		Not Used			
A10C27	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C28	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C29	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C30	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C31	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C32	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C33	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C34	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C35	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C36	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C37	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C38	10787-5	Capacitor, Tantalum	1.0µF	±20%	15V
A10C39	10787-5	Capacitor, Tantalum	1.0µF	±20%	15V
A10C40	10787-5	Capacitor, Tantalum	1.0µF	±20%	15V
A10C41	10787-5	Capacitor, Tantalum	1.0µF	±20%	15V
A10C42	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A10C43	10000-4	Capacitor, Ceramic	.001µF	±20%	1000V
A10C44	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A10C45	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A10C46	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A10C47	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A10C48	10000-14	Capacitor, Ceramic	68pF	±20%	1000V
A10C49	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C50	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C51	10001-11	Capacitor, Ceramic	25pF	±5%	1000V
A10C52	10001-11	Capacitor, Ceramic	25pF	±5%	1000V
A10C53	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A10C54	11501-2	Capacitor, Ceramic	0.1µF	±20%	50V
A10CR1	10043	Diode	1N4148		
A10CR2	10043	Diode	1N4148		

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A10CR3	10043	Diode	1N4148		
A10CR4	10043	Diode	1N4148		
A10CR5	10043	Diode	1N4148		
A10CR6	10043	Diode	1N4148		
A10CR7		Not Used			
A10CR8		Not Used			
A10CR9	12389	Diode	MV5025		
A10CR10	10043	Diode	1N4148		
A10CR11	10043	Diode	1N4148		
A10CR12	10043	Diode	1N4148		
A10CR13	10043	Diode	1N4148		
A10J1	14514-1	Post, .025 square			
A10J2	14664	Connector, Right Angle, 24 pin			
A10J3 through A10J26	14320-2	Test Jack			
A10Q1	10017	Transistor	2N3569		
A10Q2	10017	Transistor	2N3569		
A10Q3	10017	Transistor	2N3569		
A10Q4	10017	Transistor	2N3569		
A10Q5	10398	Transistor	2N4121 or PN4917		
A10Q6	10018	Transistor	2N3646		
A10R1	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R2		Not Used			
A10R3	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R4		Not Used			
A10R5	12449-89	Resistor, Metal Film	6.200KΩ	±0.1%	1/8W
A10R6	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R7	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R8	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R9	12449-14	Resistor, Metal Film	37.50KΩ	±0.1%	1/8W
A10R10	10015-7	Resistor, Metal Film	10.0KΩ	±1%	1/4W
A10R11	10013-69	Resistor, Carbon Film	4.7MΩ	±5%	1/4W
A10R12	13300-4	Resistor, Variable Comp	100KΩ	±20%	1/4W
A10R13	13300-4	Resistor, Variable Comp	100KΩ	±20%	1/4W
A10R14	10013-69	Resistor, Carbon Film	4.7MΩ	±5%	1/4W
A10R15	12449-19	Resistor, Metal Film	1.000KΩ	±0.1%	1/8W
A10R16	12449-91	Resistor, Metal Film	9.150KΩ	±0.1%	1/8W
A10R17	12449-55	Resistor, Metal Film	4.000KΩ	±0.1%	1/8W
A10R18	13300-6	Resistor, Variable Comp	100Ω	±20%	1/4W
A10R19	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R20	13300-6	Resistor, Variable Comp	100Ω	±20%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A10R21	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A10R22	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R23	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R24	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R25	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R26	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R27	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R28	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A10R29	10013-29	Resistor, Carbon Film	2.2KΩ	±5%	1/4W
A10R30	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R31	10013-21	Resistor, Carbon Film	470Ω	±5%	1/4W
A10R32	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R33	10013-21	Resistor, Carbon Film	470Ω	±5%	1/4W
A10R34	13300-6	Resistor, Variable Comp	100Ω	±20%	1/4W
A10R35	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R36	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R37	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A10R38		Not Used			
A10R39		Not Used			
A10R40		Not Used			
A10R41		Not Used			
A10R42	10013-65	Resistor, Carbon Film	2.2MΩ	±5%	1/4W
A10R43	13300-5	Resistor, Variable Comp	50KΩ	±20%	1/4W
A10R44		Not Used			
A10R45	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A10R46	14881-2	Resistor, Network	1KΩ	±2%	250mW
A10R47	14881-1	Resistor, Network	220Ω	±2%	250mW
A10R48	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R49	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R50	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R51	10013-80	Resistor, Carbon Film	2.4KΩ	±5%	1/4W
A10R52	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R53	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R54	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R55	12449-19	Resistor, Metal Film	1.000KΩ	±0.1%	1/8W
A10R56	13300-6	Resistor, Variable Comp	100Ω	±20%	1/4W
A10R57	12449-91	Resistor, Metal Film	8.000KΩ	±0.1%	1/8W
A10R58	10013-35	Resistor, Carbon Film	6.8KΩ	±5%	1/4W
A10R59	10013-71	Resistor, Carbon Film	6.8MΩ	±5%	1/4W
A10R60	13300-4	Resistor, Variable Comp	100KΩ	±20%	1/4W
A10R61	13300-6	Resistor, Variable Comp	100Ω	±20%	1/4W
A10R62	12449-91	Resistor, Metal Film	9.150KΩ	±0.1%	1/8W
A10A63	12449-55	Resistor, Metal Film	4.00KΩ	±0.1%	1/8W
A10R64	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R65	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R66	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R67	10013-71	Resistor, Carbon Film	6.8MΩ	±5%	1/4W
A10R68	13300-4	Resistor, Variable Comp	100KΩ	±20%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A10R69	12449-21	Resistor, Metal Film	10.00K Ω	±0.1%	1/8W
A10R70		Not Used			
A10R71	10015-215	Resistor, Metal Film	12.4K Ω	±1%	1/4W
A10R72	10015-7	Resistor, Metal Film	10.0K Ω	±1%	1/4W
A10R73	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A10R74	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A10R75	14882-1	Resistor, Network	10KΩ	±2%	125mW
A10R76	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R77	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R78	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R79	10013-41	Resistor, Carbon Film	22KΩ	±5%	1/4W
A10R80		Not Used			
A10R81		Not Used			
A10R82		Not Used			
A10R83		Not Used			
A10R84		Not Used			
A10R85		Not Used			
A10R86		Not Used			
A10R87	14882-1	Resistor, Network	10K Ω	±2%	125mW
A10R88	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R89	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A10R90	10015-215	Resistor, Metal Film	12.4KΩ	±1%	1/4W
A10R91	10013-58	Resistor, Carbon Film	560KΩ	±5%	1/4W
A10R92	13300-4	Resistor, Variable Comp	100KΩ	±20%	1/4W
A10R93	10013-12	Resistor, Carbon Film	82 Ω	±5%	1/4W
A10R94	12449-21	Resistor, Metal Film	10.00KΩ	±0.1%	1/8W
A10R95	12449-31	Resistor, Metal Film	1.111KΩ	±0.1%	1/8W
A10R96	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A10R97	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R98	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A10R99	10013-31	Resistor, Carbon Film	3.3KΩ	±5%	1/4W
A10R100	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A10R101	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A10R102		Not Used			
A10R103		Not Used			
A10R104		Not Used			
A10R105	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R106	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A10R107	10013-5	Resistor, Carbon Film	22Ω	±5%	1/4W
A10R108	10013-5	Resistor, Carbon Film	22Ω	±5%	1/4W
A10R109	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A10R110	10013-17	Resistor, Carbon Film	220Ω	±5%	1/4W
A10R111	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A10R112	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A10R113	10013-78	Resistor, Carbon Film	2K Ω	±5%	1/4W
A10R114	10013-28	Resistor, Carbon Film	1.8KΩ	±5%	1/4W
A10R115	10013-33	Resistor, Carbon Film	4.7KΩ	±5%	1/4W
A10R116	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	
A10S1	14663	Switch, DIP, SPST (2 rocker arms)	
A10S2	14663	Switch, DIP, SPST (2 rocker arms)	
A10S3	14891	Switch, DIP, SPST (8 rocker arms)	
A10S4	14677	Switch, DIP, SPST (5 rocker arms)	
A10S5	15399	Switch, Pushbutton, Momentary	
A10U1	14672	Integrated Circuit	MC8T97P
A10U2	14672	Integrated Circuit	MC8T97P
A10U3		Not Used	
A10U4	13470-13	Integrated Circuit	SN74LS74N
A10U5	14673	Integrated Circuit	MC3448AP
A10U6	14673	Integrated Circuit	MC3448AP
A10U7	14673	Integrated Circuit	MC3448AP
A10U8	14673	Integrated Circuit	MC3448AP
A10U9	15796	Integrated Circuit	8291A
A10U10	14641	Integrated Circuit	8255
A10U11		Not Used	
A10U12	13470-4	Integrated Circuit	SN74LS04N
A10U13	14670	Integrated Circuit	DM2504N
A10U14	13470-2	Integrated Circuit	SN74LS01N
A10U15	14668	Integrated Circuit	LM319N
A10U16	14226	Integrated Circuit	TL074CN
A10U17	14667	Integrated Circuit	AH5014CN
A10U18		Not Used	
A10U19		Not Used	
A10U20	15770	Integrated Circuit	TMM2016P
A10U21	15770	Integrated Circuit	TMM2016P
A10U22	13470-44	Integrated Circuit	SN74LS138N
A10U23	13470-45	Integrated Circuit	SN74LS240N
A10U24	13470-45	Integrated Circuit	SN74LS240N
A10U25	15635-20	Integrated Circuit	2732
A10U26	15635-21	Integrated Circuit	2732
A10U27	13470-46	Integrated Circuit	SN74LS161N
A10U28	13470-7	Integrated Circuit	SN74LS14N
A10U29	14675	Integrated Circuit	Z80
A10U30	14641	Integrated Circuit	8255
A10U31	14671	Integrated Circuit	AD565JN
A10U32		Not Used	
A10U33	14226	Integrated Circuit	TL074CN
A10U34	15119	Integrated Circuit	DJ201CJ
A10U35	14667	Integrated Circuit	AH5014CN
A10U36	14669	Integrated Circuit	LF356N
A10U37	13470-47	Integrated Circuit	SN74LS32N
A10U38	15039	Integrated Circuit	K1148A

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10000-1	56289	5GA-T10
10000-3	56289	5GA-T47
10000-4	56289	5GA-D10
10000-5	56289	5GA-D22
10000-6	56289	5GA-D47
10000-8	56289	5GAS-S20
10000-11	72989	805-000-X5VD-103Z
10000-14	56289	5GA-T68
10001-1	56289	10TCC-V22
10001-2	56289	10TCC-47
10001-3	56289	10TCC-Q10
10001-5	56289	10TCC-Q33
10001-6	56289	10TCC-Q47
10001-8	56289	10TCC-Q15
10001-11	56289	10TCC-Q25
10001-12	56289	10TCC-V33
10001-15	56289	10TCC-Q150
10001-17	56289	10TCC-Q82
10003-5	25088	B41283-100/40/8113
10003-16	56289	TVA-1659
10007-1	09214	75FIR2A 102
10007-4	09214	75FIR2A 103
10007-14	14655	WMF2P33
10013-1	80031	B803104NB 100
10013-5	80031	B803104NB 220
10013-9	80031	B803104NB 470
10013-11	80031	B803104NB 680
10013-12	80031	B803104NB 820
10013-13	80031	B803104NB 101
10013-16	80031	B803104NB 181
10013-17	80031	B803104NB 221
10013-18	80031	B803104NB 271
10013-21	80031	B803104NB 471

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10013-23	80031	B803104NB 681
10013-25	80031	B803104NB 102
10013-27	80031	B803104NB 152
10013-28	80031	B803104NB 182
10013-29	80031	B803104NB 222
10013-30	80031	B803104NB 272
10013-31	80031	B803104NB 332
10013-33	80031	B803104NB 472
10013-35	80031	B803104NB 682
10013-37	80031	B803104NB 103
10013-38	80031	B803104NB 123
10013-39	80031	B803104NB 153
10013-41	80031	B803104NB 223
10013-43	80031	B803104NB 333
10013-45	80031	B803104NB 473
10013-49	80031	B803104NB 104
10013-51	80031	B803104NB 154
10013-53	80031	B803104NB 224
10013-57	80031	B803104NB 474
10013-61	80031	B803104NB 105
10013-65	80031	B803104NB 225
10013-69	80031	B803104NB 475
10013-71	80031	B803104NB 685
10013-73	80031	B803104NB 106
10013-75	80031	B803104NB 302
10013-78	01121	RC07GF202J
10013-80	80031	B803104NB 242
10015-7	24546	RN55D 10.0KΩ 1%
10015-13	24546	RN55D 100KΩ 1%
10015-19	24546	RN55D 1.0KΩ 1%
10015-20	24546	RN55D 1.10KΩ 1%
10015-24	24546	RN55D 46.4KΩ 1%
10015-28	24546	RN55D 23.7KΩ 1%
10015-30	24546	RN55D 7.68KΩ 1%
10015-36	24546	RN55D 5.11KΩ 1%
10015-43	24546	RN55D 121KΩ 1%
10015-45	24546	RN55D 499KΩ 1%
10015-48	24546	RN55D 27.4KΩ 1%
10015-62	24546	RN55D 402KΩ 1%

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10015-65	24546	RN55D 4.99KΩ 1%
10015-68	24546	RN55D 100Ω 1%
10015-72	24546	RN55D 1.96KΩ 1%
10015-84	24546	RN55D 2.10KΩ 1%
10015-87	24546	RN55D 15.0KΩ 1%
10015-90	24546	RN55D 24.9KΩ 1%
10015-102	24546	RN55D 249KΩ 1%
10015-104	24546	RN55D 5.62KΩ 1%
10015-105	24546	RN55D 6.19KΩ 1%
10015-111	24546	RN55D 24.9Ω 1%
10015-119	24546	RN55D 75KΩ 1%
10015-119	24546	RN55D 34.8Ω 1%
10015-133	24546	RN55D 49.9KΩ 1%
10015-175	24546	RN55D 1.74Ω 1%
10015-176	24546	RN55D 3.48KΩ 1%
10015-188	24546	RN55D 33.2KΩ 1%
10015-191	24546	RN55D 66.5KΩ 1%
10015-205	24546	RN55D 768Ω 1%
10015-206	24546	RN55D 7.50KΩ 1%
10015-207	24546	RN55D 20.0KΩ 1%
10015-210	24546	RN55D 150KΩ 1%
10015-211	24546	RN55D 2.74KΩ 1%
10015-218	24546	RN55D 40.2KΩ 1%
10015-219	24546	RN55D 261KΩ 1%
10015-224	24546	RN55D 150Ω 1%
10015-226	24546	RN55D 2.21KΩ 1%
10015-248	24546	RN55D 44.2KΩ 1%
10015-256	24546	RN55D 1.50KΩ 1%
10015-260	24546	RN55D 221KΩ 1%
10015-262	24546	RN55D 232KΩ 1%
10017	07263	2N3569
10018	07263	2N3646
10023	07263	2N3644
10043	01002	1N4148
10044-1	28821	1N4383
10044-2	28821	1N4385

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10045	12954	1N823
10046-1	71450	X201R501B
10046-3	71450	X201R503B
10046-8	71450	X201R103B
10046-9	71450	X201R101B
10046-10	71450	X201R104B
10046-12	71450	X201R504B
10046-14	71450	X201R205B
10064-13	75915	312010
10140-1	74970	105-0852-001
10140-1	74970	105-0860-001
10142-8	01121	RCR07GF470J
10206	07263	2N3053
10238-3	14655	FAH-42500-15-B2
10238-4	14655	FAH-752-25-A3
10241-5	01121	RC20GF1R0J
10241-9	01121	RC20G2R0JS
10398	07263	PN4917
10462	28821	ME2H (C2A)
10581-1	72982	538-006,A,2-8pF
10585-1	56289	C028B102E221J
10585-4	56289	C028B102F681J
10631-7	99800	1025-64
10633-1	81483	BW-20 1 ohm 5%
10633-3	81483	BW-20 .36 ohm 5%
10634-3	91637	MMF 1/2T-1 1.0M ohm 1%
10665-3	75042	RCR 32G 100 ohm 10%
10665-7	75042	RCR 32G 10M ohm 10%
10665-8	01121	RC 32F 104J

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10787-2	56289	196D126X9020 JA1
10787-3	56289	196D276X9025 LA3
10787-4	56289	196D686X0025 MA3
10787-5	56289	196D105X0035 HA1
10787-11	56289	196D105X9035 HA1
10885	01295	1N957B
10909-2	84171	CM 06FD471F03
10909-3	84171	CM 06FD391F03
10927	02735	2N4314
11119	07263	2N4250
11345	28480	5082-2900
11501-2	72982	8131-050-651-104M
11501-5	72982	8131-050-651-474M
11507	01295	TIS 97
11711-1	73138	66WR 500 ohm
11845-4	24546	FP-2 15 ohm 1% 2W
11845-5	24546	FP-2 36K ohm 1% 2W
11868	04713	1N5229B
12389	76541	MV5025
12409	83701	PE10
12440-1	02660	225-21821-110
12440-4	75042	50-30EE-140
12440-5	75042	50-44S-30-1
12449-15	14298	EE1/8 C2 75.0KΩ 0.1%
12449-16	14298	EE1/8 C2 150.0KΩ 0.1%
12449-18	14298	EE1/8 C2 7.50KΩ 0.1%
12449-19	14298	EE1/8 C2 1.00KΩ 0.1%
12449-21	14298	EE1/8 C2 10.00KΩ 0.1%
12449-22	14298	EE1/8 C2 2.50KΩ 0.1%
12449-26	14298	EE1/8 C2 5.000KΩ 0.1%

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
12449-28	14298	EE1/8 C2 12.5KΩ 0.1%
12449-30	14298	EE1/8 C2 30.0KΩ 0.1%
12449-31	14298	EE1/8 C2 1.11KΩ 0.1%
12449-33	14298	EE1/8 C2 20KΩ 0.1%
12449-37	14298	EE1/8 C2 20KΩ 0.1%
12449-45	14298	EE1/8 C2 250KΩ 0.1%
12449-51	91637	MMF1/8T-2 2.000KΩ 0.1%
12449-54	91637	MMF1/8T-2 1.333KΩ 0.1%
12449-55	91637	MMF1/8T-2 4.000KΩ 0.1%
12449-65	14298	EE1/8 C2 2.20KΩ 0.1%
12449-66	14298	EE1/8 C2 31.50KΩ 0.1%
12449-73	14298	EE1/8 C2 10.20KΩ 0.1%
12449-74	91637	MMF1/8T-2 1.182KΩ 0.1%
12449-76	14298	EE1/8 C2 0.20KΩ 0.1%
12449-85	14298	EE1/8 C2 1.370Ω 0.1%
12591	17856	E112
13300-4	01121	D2C104
13300-5	01121	D2C503
13300-6	71450	375T101B
13470-1	01295	SN74LS00N
13470-2	01295	SN74LS01N
13470-3	01295	SN74LS02N
13470-4	01295	SN74LS04N
13470-5	01295	SN74LS08N
13470-6	01295	SN74LS10N
13470-7	01295	SN74LS14N
13470-12	01295	SN74LS42N
13470-13	01295	SN74LS74N
13470-14	01295	SN74LS75N
13470-17	01295	SN74LS123N
13470-18	01295	SN74LS221N
13470-24	01295	SN74LS132N
13470-33	01295	SN74LS174N
13470-35	01295	SN74LS51N
13470-39	01295	SN74LS367N
13470-39	01295	SN74LS11N
13470-40	01295	SN74LS125N

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
13470-41	01295	SN74LS163N
13470-42	01295	SN74LS365N
13470-43	01295	SN74LS374N
13470-44	01295	SN74LS138N
13470-45	01295	SN74LS240N
13470-46	01295	SN74LS161N
13470-47	01295	SN74LS32N
13470-51	01295	SN74LS86N
13470-56	01295	SN74LS393N
13470-58	01295	SN74LS279N
13471	27014	LM324N
13584-3	71450	375X501B
13584-4	71450	375X102B
13584-7	71450	375X104B
13584-9	71450	375X502B
13638	07263	SE7056
13859	28821	13859
13979-1	80031	C281CH/AIM
14116-3	71590	DD30-502
14119-2	90303	5XM347
14142	28821	AM2503DC
14226	01295	TL074CN
14320-2	28821	14320-2
14514-1	00779	87022-1 Reeled
14525	28821	14525
14621	27014	LM358N
14622	02735	2N6486
14623	02735	2N6489
14624	01295	TL072CP

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
14626	02114	1F 31-3C8
14627	02114	41 'U' Bolt
14629	27014	LF13331N
14630	27014	MM74C00N
14631	27014	MM74C02N
14632	27014	MM74C04N
14633	27014	MM74C76N
14634	27014	LM311N
14635	27014	LM3146N
14637	02735	CD4002AE
14639	34649	P2102A
14640	34649	P2114
14641	34649	8255A
14644	28821	DAC08EQ
14645	28821	AD56AJD
14647	02735	2N6487
14648	14099	FM50
14649	04713	MDA104A
14654	28821	#1287
14655	00779	#552742-1
14656	28821	14656
14661-1	28821	#LLL-7
14661-2	28821	#LLL-17
14661-3	28821	#LLL-27
14662-1	03888	#PVC70-25M
14663	81073	76B02
14664	00779	552791-2
14667	32293	IH5014CPD
14668	27014	LM319N
14669	27014	LF356N
14670	27014	DM2504CN
14671	28821	AD565JN
14673	04713	MC3448L
14675	28821	Z80 CPU
14677	81073	#76SB05
14687	04435	9684-1
14877-1	24546	FP3 22K ohm 10% 3W

PART NUMBER CROSS REFERENCE			PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.	PART NO.	MFGR. CODE	MFGR. PART NO.
14881-1	01121	108B221			
14881-2	01121	108B102			
14882-1	01121	110A103			
14891	81073	76SB08			
14920	28821	2MHz Crystal HC6			
14935-1	91637	CW-5-2 0.1 ohm 4W			
14941-3	01121	RCR32G475JF			
14977-1	50088	MK2716N			
14977-6	50088	2716			
14977-7	50088	2716			
15036	34649	8291			
15039	04713	K1148A			
15098-2	01121	108A103			
15119	17856	DG201CJ			
15141	27014	LM339N			
15144-1	80031	SPR5053YD			
15399	81073	39-251-RED			
15524	04713	1N4250			
15635-20	34649	2732			
15635-21	34649	2732			
15731-1	01121	WA1G056P253MA			
15731-2	01121	WA1G056P104MA			
15738	17856	DG181BP			
15739	34371	HA4741-5			
15770	Toshiba	TMM2016P			
15775	83701	EDI PK10F or PA10			
15776-1	71590	CW15C103K			
15776-2	71590	CW15C102K			
15776-6	71590	CW40C474K			
15796	34649	8219A			

The following five-digit code numbers are listed in numerical sequence along with the name and location of the manufacturer to which the code number has been assigned.

The Federal Supply Code has been taken from Cataloging Handbook H 4-1, Name to Code.

00303	Shelly Associates, Inc. El Segundo, California
00656	Aerovox Corp. New Bedford, Massachusetts
00779	Amp, Inc. Harrisburg, Pennsylvania
01002	General Electric Co. Capacitor Dep't. Hudson Falls, New York
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01961	Pulse Engineering, Inc. Santa Clara, California
02114	Ferroxcube Corp. of America Saugerties, New York
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02735	Radio Corp. of America Semiconductor and Materials Div. Somerville, New Jersey
03888	Pyrofilm Resistor Co., Inc. Whippany, New Jersey
04062	Elmenco Products Co. New York, New York
04435	Jettron Products, Inc. Hanover, New Jersey
04713	Motorola, Inc. Semiconductor Products Div. Phoenix, Arizona
05035	Ayer Manufacturing Co. Chicago Heights, Illinois
05245	Corcom, Inc. Chicago, Illinois
07126	Digitran Co. Pasadena, California
07263	Fairchild Camera and Inst. Co. Semiconductor Div. Mountain View, California
07910	Continental Device Corp. Hawthorne, California
09214	General Electric Co. Semiconductor Products Dep't. Auburn, New York
09353	C and K Components, Inc. Newton, Massachusetts
11323	General Microwave Corp. Farmingdale, New York
11711	General Instruments, Inc. Semiconductor Div. Newark, New Jersey
12674	Syncro Corp. Hicksville, Ohio
12954	Dickson Electronics Corp. Scottsdale, Arizona
14099	Semtech Corp. Newbury Park, California
14298	American Components Conshohocken, Pennsylvania
14655	Cornell Dubilier Corp. New York, New York
16733	Cablewave Systems North Haven, Connecticut
17540	Alpha Industries Woburn, Massachusetts

17856	Siliconix, Inc. Santa Clara, California
18235	KRL Electronics, Inc. Manchester, New Hampshire
18324	Signetics Corp. Sunnyvale, California
19447	Electro-Technique, Inc. Oceanside, California
21847	Aertech Industries Sunnyvale, California
22045	Jordan Electric Co. Van Nuys, California
22526	Berg Electronics Corp. New Cumberland, Pennsylvania
24546	Corning Glass Works Electronic Components Div. Raleigh, North Carolina
24931	Specialty Connector Co., Inc. Indianapolis, Indiana
25088	Siemens America Corp. Iselin, New Jersey
27014	National Semiconductor Corp. Santa Clara, California
27556	IMB Electronic Products Santa Fe Springs, California
28480	Hewlett-Packard Co. Palo Alto, California
28821	Wavetek Pacific Measurements Inc. Sunnyvale, California
31918	International Electro Exchange Eden Prairie, Minnesota
32284	Rotron Manufacturing Co., Inc. Woodstock, New York
32293	Intersil, Inc. Cupertino, California
33025	Omni Spectra Co. Tempe, Arizona
34078	Midwest Microwave, Inc. Ann Arbor, Michigan
34371	Harris Corp. Melbourne, Florida
34649	Intel Corp. Santa Clara, California
44655	Ohmite Manufacturing Co. Skokie, Illinois
50088	Mostek Corp. Carrolton, Texas
50625	Revere Corp. of America Wallingford, Connecticut
56289	Sprague Electric Co. North Adams, Massachusetts
70903	Belden Manufacturing Co. Chicago, Illinois
71034	Bliley Electric Co. Erie, Pennsylvania
71400	Bussman Manufacturing Div. of McGraw-Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71590	Centralab, Electronics Milwaukee, Wisconsin
72982	Erie Technical Products, Inc. Erie, Pennsylvania
73138	Beckman Instruments, Inc. Helipot Division Fullerton, California
73445	Amperex Electronic Corp. Hicksville, New York
74970	E. F. Johnson Co. Waseca, Minnesota
75042	TRW Electronic Components IRC Philadelphia, Pennsylvania

75915	Littlefuse, Inc. Des Plaines, Illinois
76493	J. W. Miller Co. Compton, California
76541	Monsanto Commercial Products Cupertino, California
76854	Oak Manufacturing Co. Crystal Lake, Illinois
79727	Continental-Wirt Elect. Corp. Philadelphia, Pennsylvania
80031	Mepco/Electra, Inc. A North American Phillips Co. Morristown, New Jersey
80294	Bournes, Inc. Trimpot Division Riverside, California
81073	Grayhill, Inc. La Grange, Illinois
81095	Traid Transformer Corp. Venice, California
81483	International Rectifier Corp. El Segundo, California
82389	Switchcraft, Inc. Chicago, Illinois
83330	H. H. Smith, Inc. Brooklyn, New York
83594	Burroughs Corp. Electronic Components Div. Plainfield, New Jersey
83701	Electronic Devices, Inc. Yonkers, New York
84171	Arco Electronics, Inc. Great Neck, New York
90303	Mallory Battery Co. Tarrytown, New York
90634	Saft America, Inc. Metuchen, New Jersey
91418	Radio Materials Co. Chicago, Illinois
91637	Dale Electronics, Inc. Columbus, Nebraska
91929	Honeywell, Inc. Microswitch Division Freeport, Illinois
94144	Raytheon Co. Components Division Quincy, Massachusetts
94222	Southco, Inc. Lester, Pennsylvania
95146	Alco Electronics Lawrence, Massachusetts
99392	STM Corp. Oakland, California
99800	Delevan Electronics Corp. East Aurora, New York

SECTION

MANUAL CORRECTIONS

This section lists the corrections that must be incorporated in this manual to make it correspond to a particular instrument. The serial number of each instrument is prefixed by a code number. This code number is used to identify the applicable manual corrections for a particular instrument. When correcting this manual start with the corrections corresponding to the Code No. on the instrument. If a particular component has been changed more than one time, make only the first change encountered.

CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
25	None		
ALL	On page 4-9, Section 4.6.1.1., Step 3, change A10TP1013 to read A10TP1012		
ALL	On page 9-13, change A5T1 through A5T5 as follows: A5T1 13859 Coil, High Voltage Delete Ref. Desig. A5T2 through A5T5 and, instead, indicate that these four items are part of A5T1.		