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PS 5010 PROGRAMMABLE POWER SUPPLY

INSTRUCTION MANUAL

Tektronix, Inc.
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Beaverton, Oregon 97077

Serial Number _____

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WARNING

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

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OPERATORS SAFETY SUMMARY

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

TERMS

In This Manual

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

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

As Marked on Equipment

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

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

SYMBOLS

In This Manual

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

As Marked on Equipment

DANGER — High voltage.

Protective ground (earth) terminal.

ATTENTION — refer to manual.

Power Source

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

Grounding the Product

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

Danger Arising From Loss of Ground

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

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type, voltage rating and current rating as specified in the parts list for your product.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

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

Do Not Operate Without Covers

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

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

Use Care When Servicing With Power On

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

Disconnect power before removing protective panels, soldering, or replacing components.

Power Source

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

PS 5010 Programmable Power Supply

SPECIFICATION

Introduction

This PS 5010 Programmable Power Supply provides a floating dual supply and a ground referenced logic supply. Each supply has independent constant voltage or constant current modes with automatic crossover.

The floating supply provides 0 to +32 Vdc and 0 to −32 Vdc, both with respect to a common front panel terminal. All floating supply terminals may be elevated above ground to a maximum 150 V peak. Voltages from 0 to 64 V are available across the dual supply terminals. When the PS 5010 is installed in a TM 5000 series power module with one high power compartment, currents to 750 mA (from 0 to 32 V) and 1.6 A (from 0 to 15 V) are available. When the PS 5010 is installed in two low power compartments of the TM 5000 series power module, currents to 400 mA (from 0 to 32 V) and 750 mA (from 0 to 15 V) are available. The floating supplies are programmable in increments of 10 mV from 0 to 10.0 V and in increments of 100 mV from 10.1 V to 32.0 V. The current is programmed in 50 mA increments from 50 mA to 1.6 A.

The logic supply provides 4.5 Vdc to 5.5 Vdc at currents to 3 A. The logic supply is programmable in increments of 10 mV from 4.50 V to 5.50 V and in current increments of 100 mA over a range of 100 mA to 3.0 A.

The front panel LED display is divided into three sections. Each section indicates the programmed currrent or voltage for one supply. Each display contains a three digit segmented numeric LED display and two separate LEDs. These LEDs are located at the bottom of the numeric displays. They indicate whether voltage or current is being displayed.

In the operating mode, the displays show the true output voltage in constant voltage mode or current in the constant current mode. Since the display parameter changes with the automatic crossover the displays always indicate the true output values.

Complete information for programming the PS 5010 via the GPIB is found in the Programming section of this manual. A sample program is provided in the Programming section to verify the operation of the instrument on the GPIB.

NOTE

The PS 5010 operates only in a TM 5000 series power module.

IEEE 488 (GPIB) Function Capability

The PS 5010 is programmable via the digital interface specified in IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation". In this manual, the interface is commonly called the General Purpose Interface Bus (GPIB).

The IEEE Standard indentifies the interface function repertoire of an instrument on the GPIB in terms of interface function subsets. The subsets are defined in the standard. The subsets that apply to the PS 5010 are listed in Table 1-1.

Table 1-1
IEEE 488-1978
INTERFACE FUNCTION SUBSETS

Function	Subset	Capability
Source Handshake	SH1	Complete.
Acceptor Handshake	AH1	Complete.
Basic Talker	T6	Responds to Serial Poll.
Basic Listener	L4	Unlisten if My Talk Address (MTA) is received.
Service Request	SR1	Complete.
Remote-Local	RL1	Complete.
Parallel Poll	PP0	Does not respond to Parallel Poll.
Device Clear	DC1	Complete
Device Trigger	DT1	Complete.
Controller	C0	No controller function.

Performance Conditions

The electrical characteristics in this specification are valid only if the PS 5010 has been adjusted at an ambient temperature between +20°C and +30°C. The instrument must be in a noncondensing environment whose limits are described under the environmental part. Allow twenty minutes warm-up time for operation to specified accuracy; sixty minutes after exposure to or storage in a high humidity (condensing) environment. Any conditions that are unique to a particular characteristic are expressly stated as part of that characteristic.

The electrical and environmental performance limits, together with their related validation procedures, comprise a complete statement of the electrical and environmental performance of a calibrated instrument.

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in the Calibration section of this manual. Items listed in the Supplemental Information column are not verified in this manual.

Table 1-2
ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
POSITIVE and NEGATIVE FLOATING SUPPLIES		
Configuration		Dual floating supplies with shared common terminal. Independent constant voltage or constant current modes with automatic crossover.
Constant voltage mode		
Range		
Positive supply	0 to +32.0 V	
Negative supply	0 to −32.0 V	
Step size (resolution)	10 mV ±10 mV to 10.0 V	Typically 10 mV ±2 mV at 20°C to 30°C.
	100 mV ±40 mV above 10.1 V	Typically 100 mV ±10 mV at 20°C to 30°C.
Overall accuracy (total effect)	±(0.5% +20 mV)	Measured at front panel output terminals.
Source effect (line regulation)	(0.01% +2 mV)	
Load effect (load regulation)	10 mV for a 1 A change in load current	
	1 mV when using rear interface output connections with remote sensing.	Maximum allowable combined voltage drop in output leads is 500 mV. This may be less when output conditions exceed 14.5 V and 1.3 A at low line. Maximum allowable combined sense line resistance is 400 mΩ.
Drift		Typically <(0.1% +2 mV) for 8 hours.
Temperature coefficient		Typically <(0.01% + 0.1 mV)/°C
PARD (ripple and noise)	10 mV peak-to-peak, 1 mV rms	20 Hz to 20 MHz measured at front panel.
Load transient recovery	500 μs to recover within 20 mV of nominal value	For a 1A change measured at the front panel.

Table 1-2 (cont)

Characteristics	Performance Requirements		Supplemental Information
POSITIVE and NEGATIVE FLOATING SUPPLIES (cont)			
Voltage change response time	**No load**	**Max load**	
Up	1 ms	1 ms	
Down	20 ms	1 ms	
Constant current mode			
Range			
High power compartment	50 mA to 0.750 A (1.60 A at 15 V and below)		
Standard compartment	50 mA to 400 mA (0.750 A at 15 V and below)		
Step size (resolution)	50 mA ±15 mA		
Overall accuracy	±(5% + 20 mA)		
Source effect (line regulation)	1 mA		
Load effect (load regulation)	10 mA		Output impedance is typically 5 kΩ shunted by 10 μF.
Drift			Typically <(0.5% + 5 mA) for 8 hours.
Temperature coefficient			Typically <(0.1% + 1 mA)/°C
PARD (ripple and noise)	10 mA peak-to-peak, 5 mA rms		20 Hz to 20 MHz measured at front panel output terminals.
Current change response time			
Up	20 ms		
Down	20 ms		
Isolation voltage (maximum allowable voltage on any terminal with respect to ground)			
Front panel operation			150 V peak
Rear interface operation			42 V peak
Typical shunting capacitance between floating supplies and ground			0.015 μF
Output on-off response time			Typically 12 ms
Programming Time			
GET time			
Without output on-off change			10 ms typical
With output on-off change			30 ms typical

Table 1-2 (cont)

Characteristics	Performance Requirements	Supplemental Information
LOGIC SUPPLY		
Configuration		Single supply with negative terminal internally connected to chassis ground. Constant voltage mode with current limit and automatic crossover. Foldback current limiting starts below 4.5 V.
Constant voltage mode		
Voltage range	4.50 to 5.50 V	Ground referenced
Voltage step size	10 mV ±10 mV	
Overall accuracy	±50 mV	
Source effect (line regulation)	1 mV	
Load effect (load regulation)	10 mV for a 1 A change in load current	
	1 mV when using rear interface output with remote sensing	Maximum allowable combined voltage drop in output leads is 500 mV. Maximum allowable combined sense line resistance is 400 mΩ.
Drift		Typically <5 mV/hour
Temperature coefficient		Typically 500 μV/°C
PARD (ripple and noise)	10 mV peak to peak, 2 mV rms	20 Hz to 20 MHz measured at front panel output terminals.
Transient recovery	500 μs to within 20 mV of nominal value.	
Current limit		
Range	100 mA to 3.0 A	Foldback characteristic below 4.5 V. Maximum short circuit output current is <1.5 A.
Step size	100 mA ±30 mA	
Accuracy	±(5% + 20 mA)	
Scaled current out (rear interface only)		
Scale factor	10 mA = 1 mV ±(2% + 1 mV)	Not ground referenced. Requires two terminal measurement.
Output impedance		1kΩ
Programming time		
GET time		
Without output on-off change		3 ms typical
With output on-off change		35 ms typical
Overvoltage protection		SCR crowbar. Typically trips at 6 V to 7 V.

Table 1-2 (cont)

Characteristics	Description
MISCELLANEOUS	
Fuse Data	
25 Vac input from power module	2 ea 2.5 A medium blow, 3 AG, 125 V 2 ea 1.6 A, slow blow, 3 AG, 250 V
+26 Vdc from power module	1 A, fast blow, 3 AG, 250 V
−26 Vdc from power module	1 A, fast blow, 3 AG, 250 V
+8 Vdc from power module	6 A, fast blow, 3 AG, 250 V
Logic supply output	6 A, fast blow, 3 Ag, 250 V
Power consumption	250 VA maximum in high power compartment, 200 VA in standard compartment
Calibration interval	1000 hours or 6 months whichever occurs first
Warm-up time	20 minutes

Table 1-3
ENVIRONMENTAL CHARACTERISTICS[a]

Characteristics	Description	
Temperature		Meets MIL-T-28800B, class 5.
Operating	0°C to +50°C	
Nonoperating	−55°C to +75°C	
Humidity	95% RH, 0°C to 30°C 75% RH, to 40°C 45% RH, to 50°C	Exceeds MIL-T-28800B, class 5.
Altitude		Exceeds MIL-T-28800B, class 5.
Operating	4.6 Km (15,000 ft)	
Nonoperating	15 Km (50,000 ft)	
Vibration	0.38 mm (0.015 in) peak to peak, 5 Hz to 55 Hz, 75 minutes.	Meets MIL-T-28800B, class 5, when installed in qualified power modules.[b]
Shock	30 g's (1/2 sine) 11 ms duration, 3 shocks in each direction[d] along 3 major axes, 18 total shocks.	Meets MIL-T-28800B, class 5, when installed in qualified power modules.[b]
Bench handling[c]	12 drops from 45°, 4 inches or equilibrium, whichever occurs first.	Meets MIL-T-28800B, class 5, when installed in qualified power modules.[b]
Transportation[c]	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1 and 1A-B-2.	
EMC[e]	Within limits of F.C.C. Regulations, Part 15, Subpart J, Class A; VDE 0871; and MIL-461A tests RE01, RE02, CE01, CE03, RS01, RS03, CS01, and CS02.	
Electrical discharge	15 kV maximum charge applied to instrument case.	

[a] With power module.
[b] Refer to TM 5000 power module specifications.
[c] Without power module.
[d] Requires retainer clip in plug-in exit direction.
[e] System performance subject to exceptions of power module or other individual plug-ins.

Table 1-4
PHYSICAL CHARACTERISTICS

Characteristics	Description
Maximum overall dimensions	
Height	126.0 mm (4.96 in)
Width	134.47 mm (5.29 in)
Length	285.37 mm (11.24 in)
Net weight	≈27 kg (6 lbs)
Finish	Laminated polycarbonate front panel with anodized aluminum chassis.
Enclosure type and style per MIL-T-28800B	
Type	III
Style	E (style F in rackmount power modules)

OPERATING INSTRUCTIONS

Preparation For Use

The PS 5010 is calibrated and ready to use when received. The PS 5010 operates in any two adjacent compartments of a TM 5000 series power module. The PS 5010 is preset to GPIB address 22 with an EOI message terminator. The address may be verified by pressing the INST ID button on the front panel. A decimal appears after the address in the display if the terminator is LF-EOI. If other values are required they may be set by qualified service personnel as described in the Maintenance section of this manual.

CAUTION

To prevent damage to the PS 5010, turn the power module off before installing or removing the plug-in from the power module. Do not use excessive force to install or remove.

Refer to Fig. 2-1 for the following instructions. Align the PS 5010 chassis with the upper and lower guides of the selected power module compartments. Push the PS 5010 into the mainframe and press firmly to seat the rear connectors in their respective jacks at the rear of the power module. Connect the power cord to the power source and turn on the power module POWER switch.

Repackaging Information

If this instrument is to be shipped to a Tektronix Service center for service or repair, attach a tag showing owner (with address) and the name of an individual to contact. Include the complete instrument serial number and a description of the service required.

Save and reuse the package in which the instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

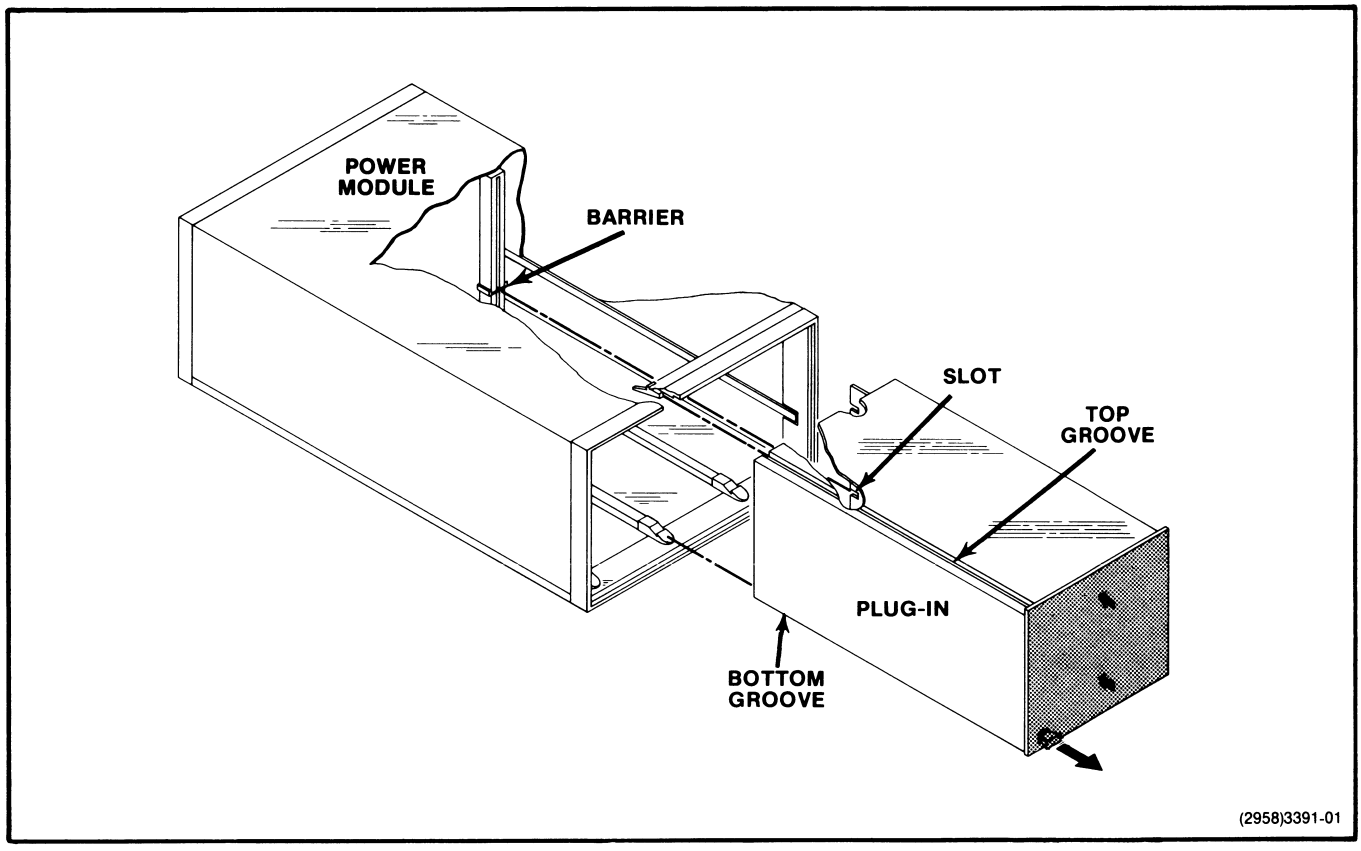

Fig. 2-1. Installation and removal.

1. Obtain a corrugated carton having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Use a carton having a test strength of at least 200 pounds.

2. Surround the instrument with protective polyethylene sheeting.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.

4. Seal carton with tape or industrial staples.

Power Up Conditions (Self Test)

At power up, the PS 5010 microprocessor performs a diagnostic routine to check the functionality of the ROM and RAM. If no internal error is found, the instrument enters the Local State (LOCS) with default settings as shown in Table 2-1. The SRQ line on the GPIB is also asserted.

Table 2-1
POWER ON SETTINGS

The instrument goes to the following settings at power on and when the INIT command is executed.

Function	Condition
Positive supply voltage	0.0 Volts
Positive supply current	0.4 Amps
Negative supply voltage	0.0 Volts
Negative supply current	0.4 Amps
Logic supply voltage	5.0 Volts
Logic supply current	1.0 Amps
Floating supply output	OFF
Logic supply output	OFF
Positive regulation interrupt	OFF
Negative regulation interrupt	OFF
Logic regulation interrupt	OFF
Request for service	ON
User request	OFF
Device trigger	OFF

If an internal error is found, an error code is displayed in the front-panel readout. See Table 2-2 for error codes.

Table 2-2
FRONT PANEL ERROR CODES

Error	Code
System error	302
Math pack error	303
System RAM error	340
System RAM error (low nibble)	341
C000 ROM placement error	372
D000 ROM placement error	373
E000 ROM placement error	374
F000 ROM placement error	375
C000 ROM checksum error	392
D000 ROM checksum error	393
E000 ROM checksum error	394
F000 ROM checksum error	395
Signature analysis mode	521
Calibration Mode	CAL

If one of these codes appears on the display during power up or operation, turn the power module off and on. If the error repeats, a qualified service person should refer to the procedure in the Troubleshooting part of the Maintenance section of this manual.

NOTE

IEEE Standard 488-1978 states that a complete system on the GPIB must be operated with power applied to at least one more than half the devices in the system. Powering up a device while the system is running may cause faulty operation.

To remove the PS 5010 from the power module, pull the release latch located on the lower left hand corner of the front panel.

Controls, Connectors and Indicators

All controls, connectors and indicators (except for the rear interface connector and the output selector switch) required for operation of the PS 5010 are located on the front panel. The following information along with Fig. 2-2 provides a description of front panel controls, connectors and indicators.

There are two modes of front panel operation for the PS 5010. These are the entry and operating modes. The voltage and current limits can be examined and changed in the entry mode. In the operating mode these values can be examined but not changed. The operating mode is the normal functional mode. All of the displays are bright in this mode. Supply parameter changes are made in the entry

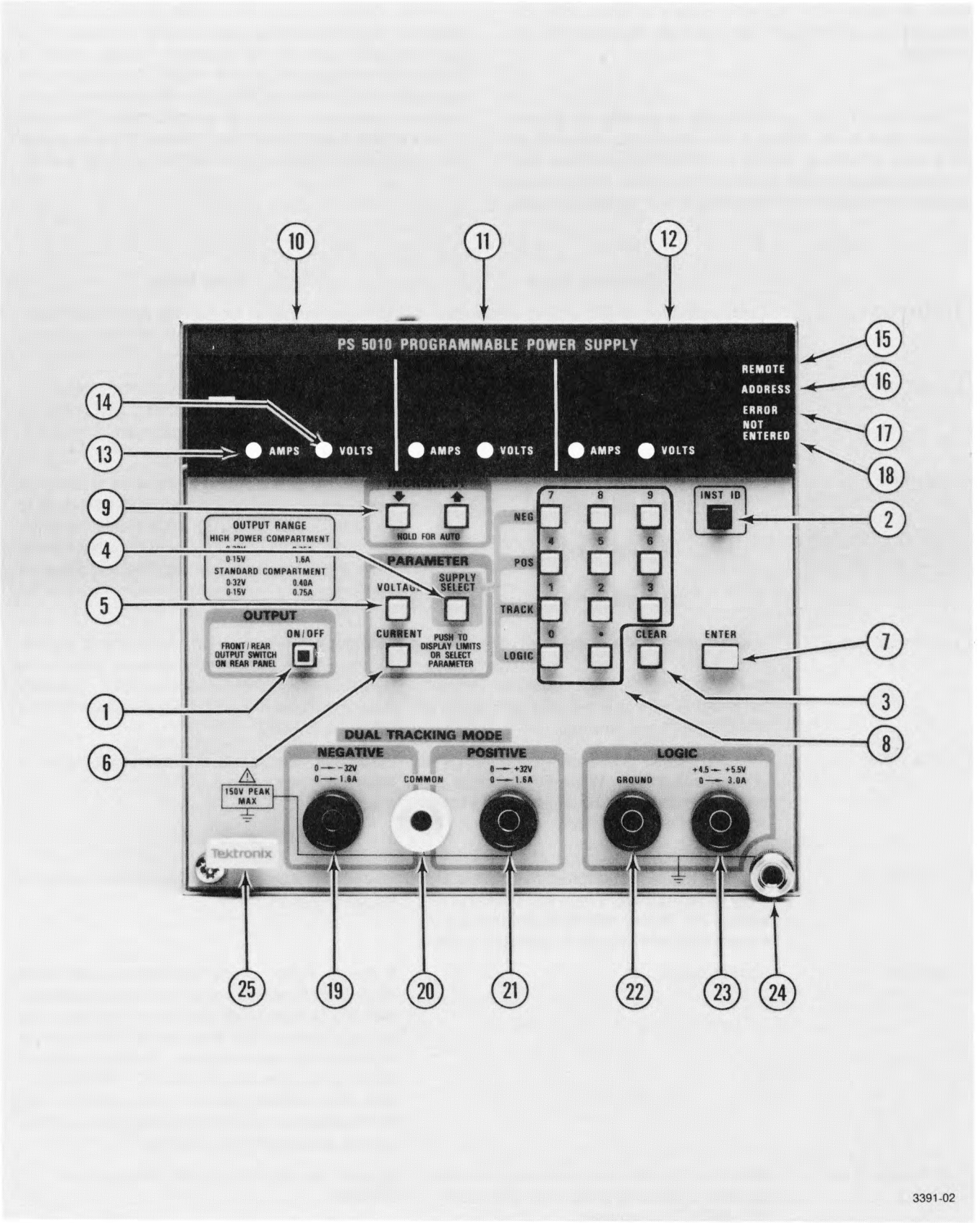

Fig. 2-2. Front panel controls and connectors.

mode. the display for the entry supply is bright with the other displays dim. Figure 2-3 graphically illustrates the entry mode.

When the VOLTS or AMPS LED is steadily on the parameter value in the display is the actual value outputed by the supply. A flashing VOLTS or AMPS LED indicates that the displayed parameter is not the true value of the output because the supply is not operating in this regulation mode.

In the operating mode, the displayed parameter automatically switches with regulation mode changes (the display indicates volts in the constant voltage mode and amperes in the constant current mode). The display blanks out (both VOLTS and AMPS LEDs off) when the supply is neither in constant voltage or current mode. This occurs when the logic supply folds back or when any supply is driven into an overvoltage situation from an external source.

	Operating Mode	Entry Mode
(1) OUTPUT	Turns output on or off. LED in pushbutton indicates output on. Functional in any keystroke sequence.	Turns output on or off. LED in pushbutton indicates output on. Functional in any keystroke sequence.
(2) INST ID	Displays instruments primary address while pressed. Asserts SRQ on GPIB if USER REQUEST is enabled. Functional in any keystroke sequence.	Displays instruments primary address while pressed. Asserts SRQ on GPIB if USER REQUEST is enabled. Functional in any keystroke sequence.
(3) CLEAR	Cancels SUPPLY SELECT keystroke.	The display of the supply in the entry mode returns to the previous entry if the ERROR light or NOT ENTERED light is flashing. This key is the only method to release the keyboard for other functions if the ERROR light is flashing. This key places the front panel into the operating mode if neither light is flashing.
(4) SUPPLY SELECT	Pressing this button places a supply in the entry mode. This must be followed with either NEG, POS, TRACK, or LOGIC. This button is nonfunctional if the NOT ENTERED or ERROR lights are flashing.	Changes entry mode from one supply to any other supply. This is also a two keystroke function, the supply selected is the other keystroke. This button is nonfunctional if the NOT ENTERED or ERROR lights are flashing.
(5) VOLTAGE	Pressing this button displays the voltage limit of all three supplies. When this button is released, the display is returned to the voltage or current limit each supply is operating under.	Places only the display of the selected supply into the voltage entry mode.
(6) CURRENT	Pressing this button displays the current limit of all three supplies. When this button is released, the display returns to the voltage or current limit each supply is operating under.	Places only the display of the selected supply into the current entry mode.
(7) ENTER	Nonfunctional.	A change in the voltage or current (except via the INCREMENT pushbuttons) must be completed with this button. Press the desired voltage or current pushbuttons and then the ENTER button to implement the value selected. The display indicates failure to enter by flashing the NOT ENTERED light. When entering current in the positive or negative supplies an automatic roundoff occurs if the current is not in 50 mA increments.
(8) 0 through 9 and period	Button 0, 1, 4, and 7 are functional to select supplies or tracking mode only after SUPPLY SELECT is pushed.	Numeric key pad for entering voltages and currents.

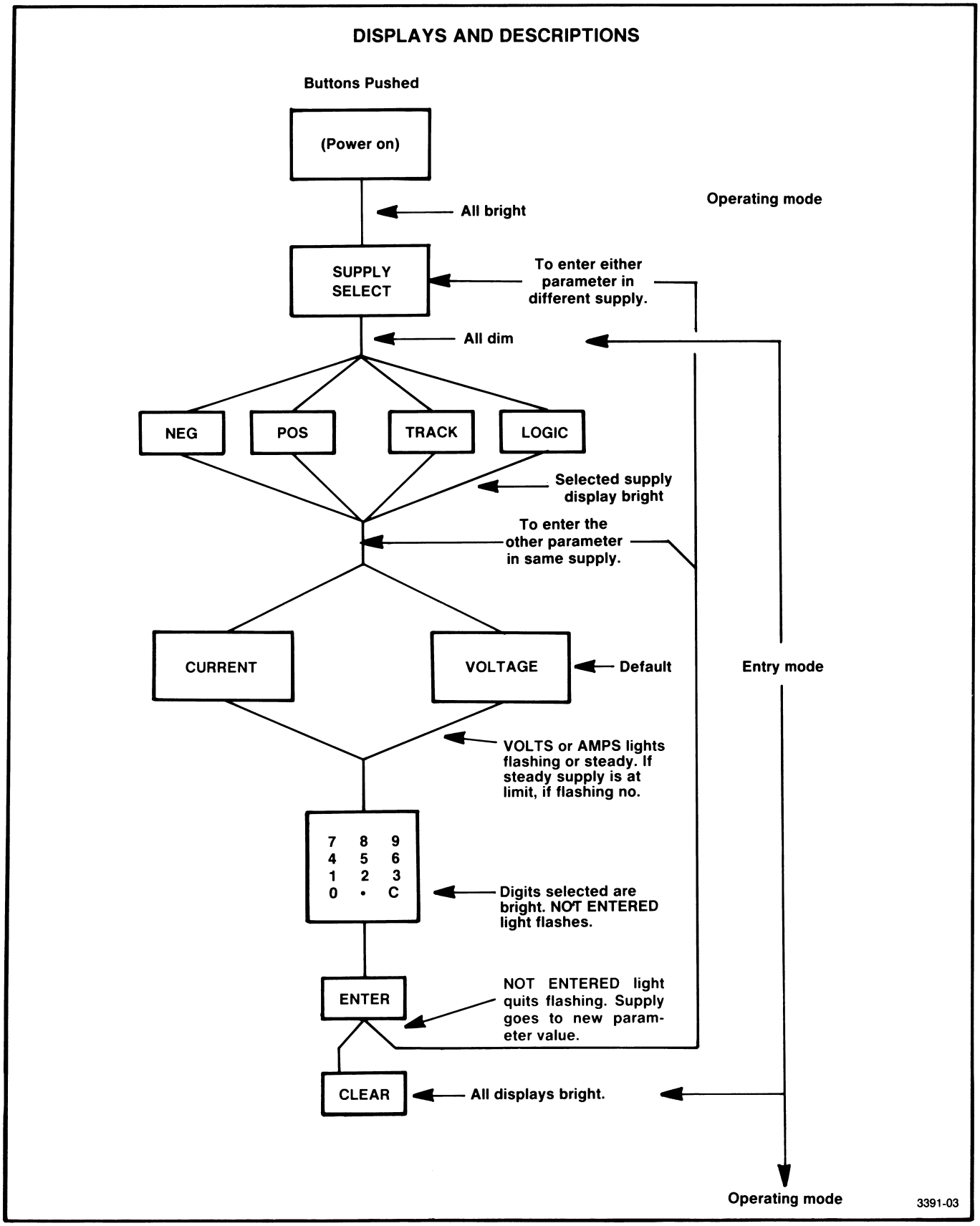

Fig. 2-3. Sequence of events used to enter a parameter into a supply.

	Operating Mode (cont)	Entry Mode (cont)
(9) INCREMENT	Nonfunctional.	Increases or decreases the voltage or current (whichever is programmed) by the smallest step possible. Holding these buttons in increases or decreases the voltage automatically at an increasing rate up to the supply limits. This is an automatic enter function. This pushbutton is nonfunctional if the NOT ENTERED or ERROR lights are flashing. In the track mode both supplies increment by the least significant digit of the highest display. Incrementing occurs until either supply reaches its maximum or minimum allowable value.
(10) Negative supply display	Normally indicates output parameter value. A blank display occurs when the supply is neither in the constant current or constant voltage mode. This may be caused by driving the supply into an overvoltage situation from an external source.	A bright display indicates the parameter value being entered. The remaining dim displays function the same as in the operating mode.
(11) Postive supply display	Normally indicates output parameter value. A blank display occurs when the supply is neither in the constant current or constant voltage mode. This may be caused by driving the supply into an overvoltage situation from an external source.	A bright display indicates the parameter value being entered. The remaining dim displays function the same as in the operating mode.
(12) Logic supply display	Normally indicates output parameter value. A blank display occurs when the supply is neither in the constant current or constant voltage mode. This happens when the output is foldback current limited or driven into overvoltage by an external source.	A bright display indicates the parameter value being entered. The remaining dim displays function the same as in the operating mode.
(13) AMPS	When illuminated, indicates the displayed paramter is amperes. A flashing AMPs LED occurs when the supply is not in constant current mode while the current button is pressed.	When illuminated, indicates the displayed parameter is amperes. A flashing LED indicates the value displayed is not the present value of the output. For example, this LED will flash while entering the amperage of a supply which is in voltage limit.
(14) VOLTS	When illuminated, indicates the displayed parameter is voltage. A flashing VOLTS LED occurs when the supply is not in constant current mode while the current button is pressed.	When illuminated, indicates the displayed parameter is voltage. A flashing LED indicates the value displayed is not the present value of the output. For example, this LED will flash while entering the voltage of a supply which is in current limit. This button is nonfunctional if the NOT ENTERED or ERROR lights are flashing.

(15) REMOTE — Illuminated when instrument is in remote state (controller programmable) via GPIB.

This does not apply to either entry or operating mode.

(16) ADDRESS — Indicates the instrument is addressed by a controller as a talker or listener via GPIB.

(17) ERROR — Illuminated when an attempt is made to enter an out-of-range value from the numerical keyboard.

(18) NOT ENTERED — Indicates value in intensified display(s) is not entered.

(19) NEGATIVE supply output terminal

(20) Floating supply common terminal

@

Operating Mode (cont) **Entry Mode (cont)**

(21) POSITIVE supply output terminal

(22) LOGIC supply ground (chassis ground) terminal

(23) LOGIC supply positive output terminal

(24) Ground binding post

(25) Plug-in release latch

OPERATING CONSIDERATIONS

Auto Crossover

The floating supplies are the automatic crossover type. Under normal conditions, the supply operates in one of two modes: constant voltage or constant current. In the constant voltage mode, decreasing the load impedance increases the output current until the programmed current limit is reached. Further reduction in load impedance puts the supply in constant current mode. As the load impedance continues to decrease, the output current remains constant and the output voltage decreases.

The opposite is true with increasing load impedance. The supply provides constant current until the voltage reaches the programmed voltage limit. Further increase in load impedance puts the supply in the constant voltage mode. See Fig. 2-4.

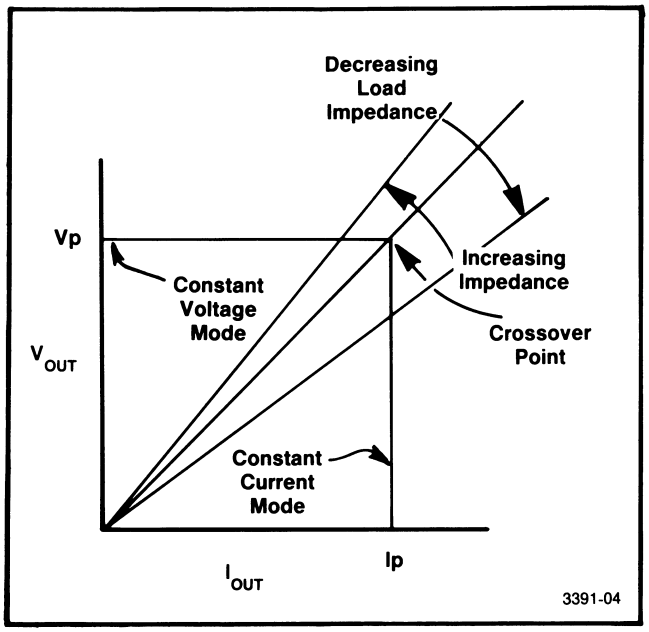

Fig. 2-4. Load lines for individual load impedances.

Logic Supply Foldback Current Limit

The logic supply regulator employs foldback current limiting. This term refers to current limit which is a function of the output voltage. The specified output voltage range of the logic supply is 4.5 V to 5.5 V. As long as the output voltage remains in the specified range, the supply operates in a constant voltage, constant current automatic crossover mode. For voltages under approximately 4 V, the maximum current limit becomes a linearly proportional function of output voltage. The current limit folds back to approximately 1 A with zero output voltage (short circuit). When the logic supply is in foldback mode, neither the current loop nor the voltage loop are balanced. The front panel will display this (blank in operating mode). See Fig. 2-5.

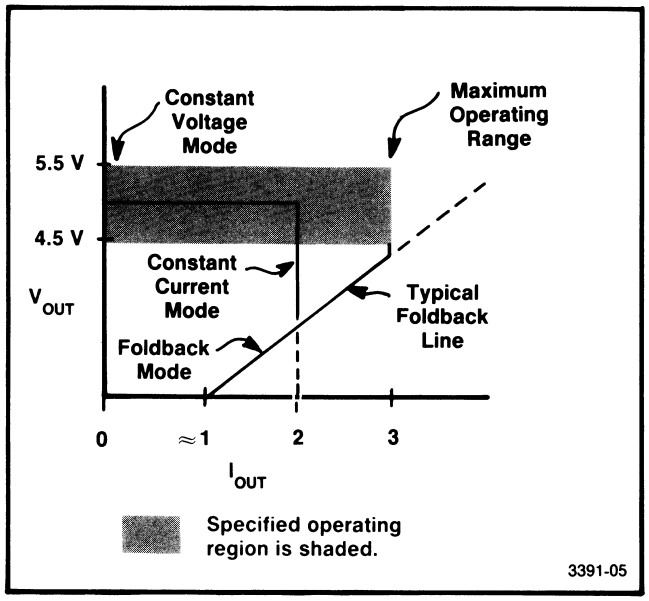

Fig. 2-5. Graph of output characteristics for logic supply.

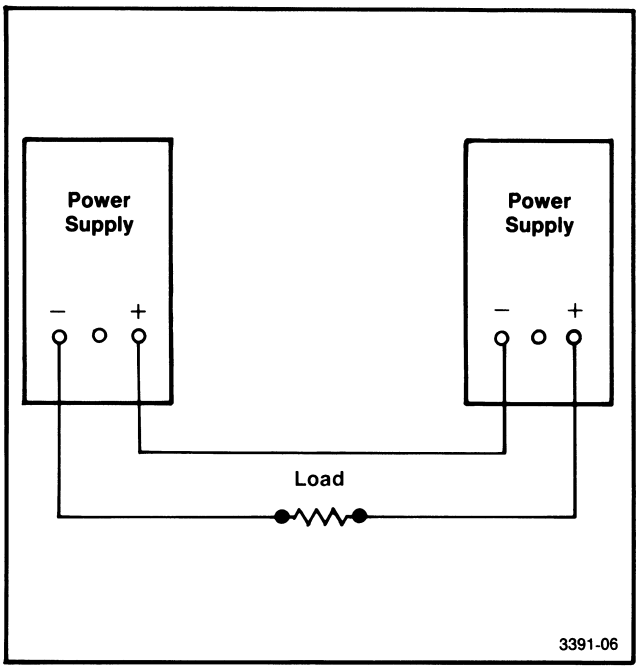

Fig. 2-6. Supplies series connected.

Series-Connected Supplies

The outputs of two or more PS 5010s can be connected in series as shown in Fig. 2-6 to obtain an output voltage equal to the sum of the output voltages from each supply. Each supply must be programmed individually to obtain the desired output voltage.

NOTE

The PS 5010 has internal diodes connected across the output to protect the series-connected supplies against reverse polarity if the load is shorted, or one of the supplies is not on.

Parallel-Connected Supplies

The output of two or more PS 5010s can be connected in parallel as shown in Fig. 2-7 to obtain an output current equal to the sum of the output currents from each supply. Each supply must be programmed individually to obtain the desired output current.

NOTE

The + and − supplies are internally connected in series. Therefore, the + and − supplies cannot be externally connected in parallel to obtain an output current equal to the sum of the currents from each supply.

Both supplies should be programmed to the same voltage. When operating, the display of one supply may blank out, indicating that it is out of regulation. This happens when the supply is driven into overvoltage by the other supply. If the load current increases enough, one supply will go into the constant current mode, and the other in constant voltage mode.

Reverse Voltage Loading

If the polarity across the output of a supply is reversed, a protection diode across the output forward biases, limiting this excursion to the forward voltage drop of the diode. This can occur when a supply is connected in series with another supply and one of two supplies current limit. The diode clamp protects the output transistors from over dissipation and the output capacitors from polarity reversal.

CAUTION

To prevent instrument damage current must be limited to 3 A or less when the polarity is reversed.

Reverse Current Loading

In some bias supply and digital circuitry applications the load may behave as a current source for part of the operating cycle. Since the output circuit of a series regulated sup-

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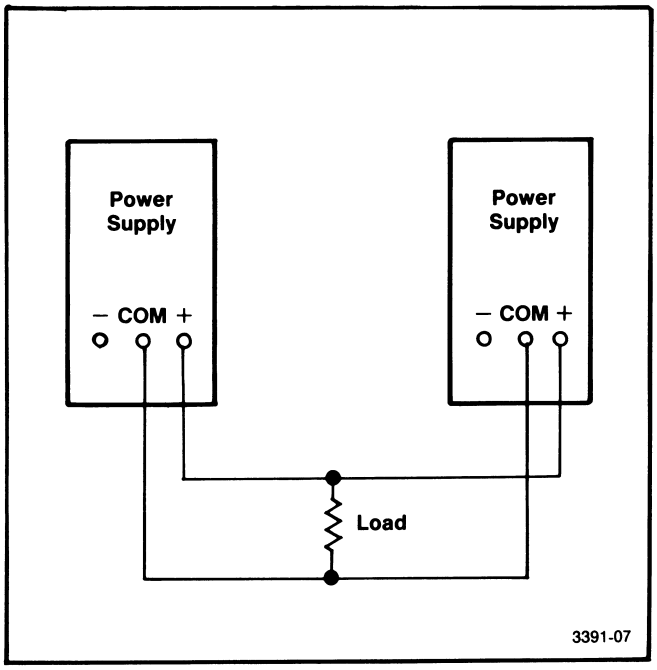

Fig. 2-7. Supplies parallel connected.

ply is unidirectional, current will not pass in the opposite direction except through undesirable paths. The internal reverse current diodes conduct only when the PS 5010 terminal voltage reverses. Connecting a shunt resistor (R_S) as shown in Fig. 2-8 provides an external reverse current path so the power supply always sources current.

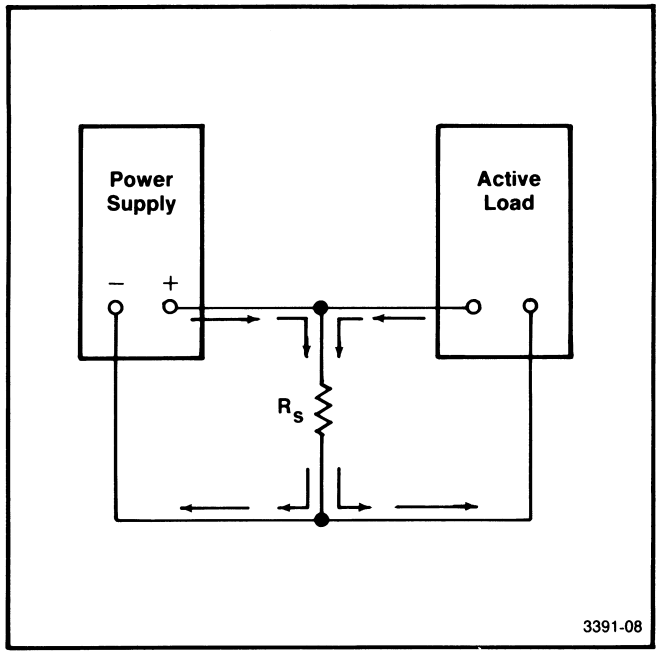

Fig. 2-8. Reverse-current shunt (R_S) with active load.

Overvoltage

CAUTION

Do not externally apply a voltage greater than the maximum rated output voltage of the supply across the output terminals.

Component failure in the PS 5010 can result in floating supply output voltages that exceed the normal range. This can cause load damage if external protection is not provided.

The logic supply output is overvoltage protected by a SCR crowbar connected to the supply input. The trip voltage is approximately 6.2 V. If an internal supply failure or externally applied voltage exceeds this limit, the SCR fires, pulling down the mainframe supplies. This in turn opens the output relays to protect the load and supply from damage.

Load and Monitor Connections

A common source of voltage error is improper connection of loads and monitoring instruments to a power supply output. When using front panel terminals, the sense lines are internally connected. See Fig. 2-9. This maintains load regulation at the terminal. Any lead impedance results in voltage drop at the load. Monitoring of supply output or verification of specifications must be at the output terminal. If one supply output is used to power several loads, each

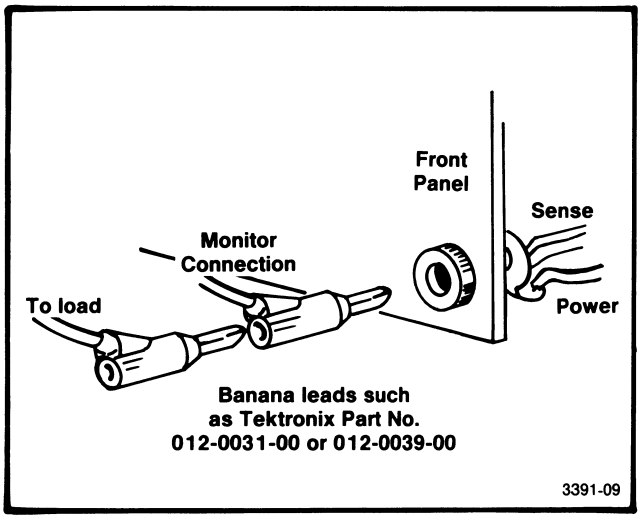

Fig. 2-9. Proper connection of load and monitor test leads to minimize voltage reading error.

load must have its own pair of leads connected as shown in Fig. 2-10. Usually, the load regulation degradation caused by voltage drop in the output leads is insignificant. If it is not, remote sense can be utilized via the rear interface.

Rear Interface Outputs

The logic supply and floating supply outputs and their associated remote sensing lines are available through the rear interface. The logic supply output is available simultaneously at the front panel and rear interface. The sense lines are clamped to the front panel terminals with 1 kΩ resistors. This impedance is large enough so that the lines can be easily pulled to the potential at the remote load. The three floating supply output terminals, and the three associated sense lines are switched to the front panel or rear interface by S1500 which is accessible from the rear panel of the instrument. When using rear interface outputs, remote sense must be used.

Increasing the length of the output leads adds series inductance to the output. This increases the ac impedance which degrades the load transient response. The effect can be minimized by placing a capacitor with good high frequency characteristics directly across the point of load. Larger capacitor values will improve transient resonse in the constant voltage mode, but greatly reduce the response characteristics in the constant current mode. Since this capacitor will temporarily supply large currents into a rapidly decreasing load impedance, delicate load components may be damaged from current supplied by this capacitor before the power supply has time to current limit.

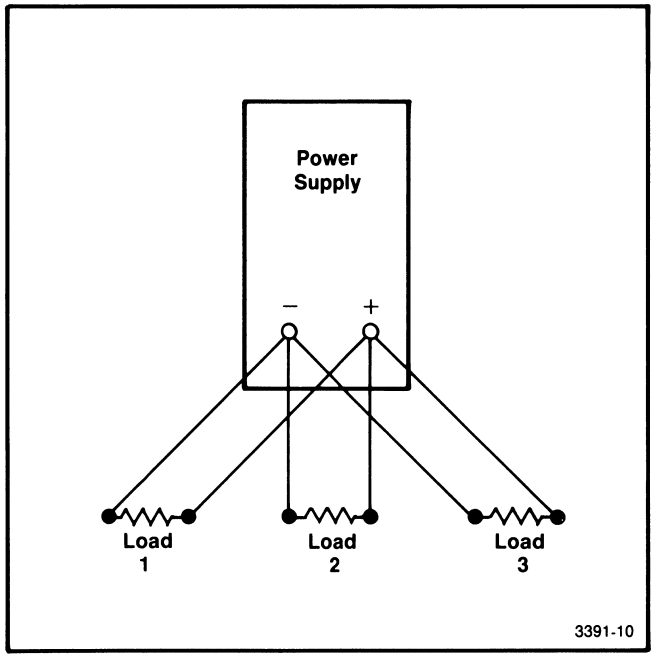

Fig. 2-10. Multiple load connections.

If the output of a supply with remote sensing utilized must be switched, the switch must interrupt both the output leads and the sense leads. It is desirable to open the sense leads first, and close them last. This is done internally when using the OUTPUT ON-OFF button.

Remote Sense

Remote sensing means acquiring voltage feedback from the point of load, rather than from the output terminals. This improves load regulation by allowing the supply to compensate for voltage drop in the power leads. Remote sensing involves only the voltage loop; it has no effect on constant current operation. Since utilization of remote sensing involves bringing the feedback path outside the power supply, precautions must be observed to avoid introducing voltage errors, noise or instability into the voltage loop. See Fig. 2-11.

The power leads to the load should be large enough to minimize the voltage drop. Each sense line is diode clamped to its respective output. This prevents uncontrolled regulator response should the sense lines be inadvertently left unconnected. These diodes limit the amount of load lead drop which the supply can correct for. The load regulation specification for the PS 5010 is valid for a 500 mV maximum combined voltage drop in both load leads. While the current drawn through the sense lines is small, it is not totally insignificant. This current produces a voltage drop in the sense line which may introduce error. Again, a condition for load regulation specification is a maximum combined sense line impedance of 400 mΩ.

The sense lines should be shielded to avoid noise and power line frequency pick up which might be amplified in the voltage loop and appear in the output. The shield should be connected to chassis ground at the power supply end only.

Logic Supply Ground Loops

The common output terminal of the logic supply is internally connected to chassis ground. If this terminal is also connected to earth ground at the point of load, a ground loop results. If this situation cannot be avoided, it is recommended that the logic supply ground lead be as large a conductor as practical. this insures that return currents will flow primarily through this lead rather than undesirable paths.

Floating Supply Elevation

The floating supply can be operated with any of the three output termiansl grounded or connect to an elevated potential. When operated at an elevated potential, the maximum voltage allowable on any front panel floating supply output terminal with respect to ground is 150 V peak. For example, if the supplies are operated at ±30 V, the common terminal

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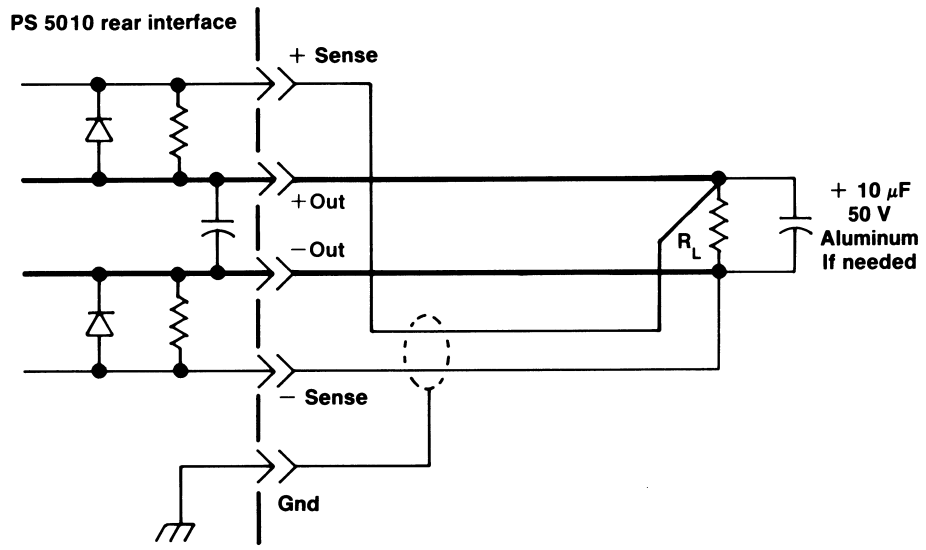

Observe sense lead polarity when connecting leads to load. Also see material under heading Floating Limitations in this section. Connection information can be found in Rear Interface part of Maintenance section (Section 6) and in the power module manual.

3391-11

Fig. 2-11. Typical application utilizing remote sensing.

could be floated to any potential between plus and minus 120 Vdc or peak ac with respect to chasis (earth) ground. The maximum allowable voltage on any rear interface output or sense terminal is 60 Vdc or 42 Vac peak with respect to ground.

CAUTION

When any of the floating supply output terminals are elevated with respect to ground, shorting a remaining terminal to ground will apply the elevating potential across the supply. If the elevating potential is of opposite polarity or exceeds the rated output of the supply severe damage to the PS 5010 may result.

When floating this supply with an ac potential, there is an inherent capacitance to chassis ground. This capacitance is distributed to all output terminals and has a value of approximately 0.015 μF.

PROGRAMMING

Introduction

This section of the manual provides information for programming the PS 5010 by remote control via the digital interface. In this manual the digital interface is called the IEEE-488 General Purpose Interface Bus (GPIB). The following information assumes the reader is knowledgeable in GPIB communications and has some exposure to programming controllers. Communication via the GPIB is specified and described in the IEEE Standard 488-1978, Standard Digital Interface for Programmable Instrumentation[1]. TM 5000 instruments are designed to communicate with any GPIB-compatible controller that sends and receives ASCII messages (commands) over the GPIB. These commands program the instrument or request information from the instrument.

Commands for TM 5000 programmable instruments are designed for compatabilty among instrument types. The same command is used in different instruments to control similar functions. In addition, commands are specified in mnemonics related to the functions they implement. For example, the command INIT initializes instrument settings to their power-up states. For further ease of programming, command mnemonics match those on the front panel.

Instrument commands are presented in three formats:

- A front panel illustration — showing command relationships to front panel operation. See Fig. 3-1.
- Functional Command List — A list divided into functional groups with brief descriptions.
- Detailed Command List — An alphabetical listing of commands with complete descriptions.

[1]**Published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY, 10017**

TM 5000 programmable instruments connect to the GPIB through a TM 5000 power module. Refer to the Operating Instructions section of this manual for information on installing the instrument in the power module. Also review this section to become familiar with front-panel and internally selectable instrument functions.

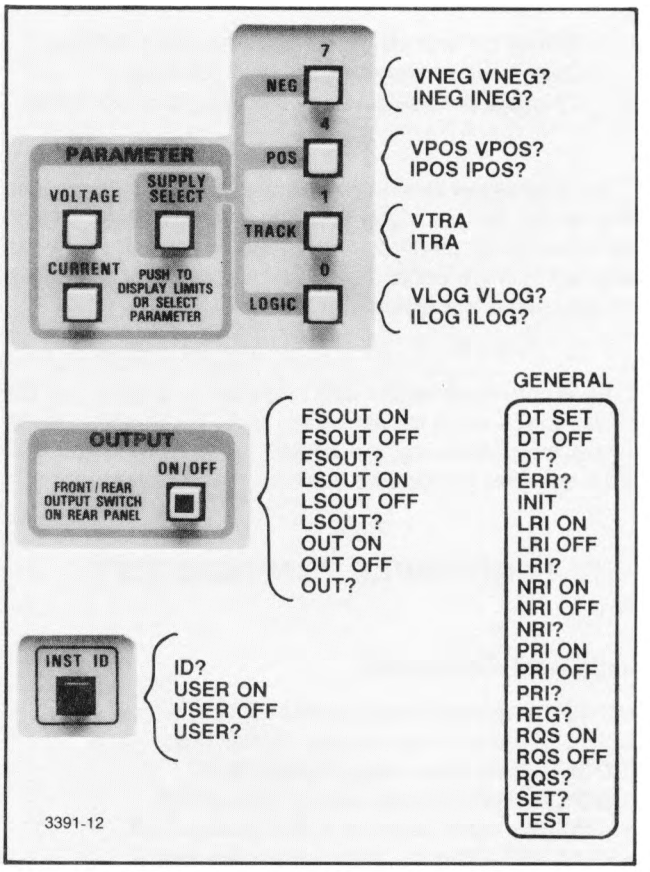

Fig. 3-1. Bus commands and relationships to the front panel.

The GPIB primary address for this instrument may be internally changed by qualified service personnel. The PS 5010 is shipped with the address set to decimal 22. The message terminator may also be internally selected by qualified service personnel. Message terminators are discussed in Messages and Communication Protocol (in this section). TM 5000 instruments are shipped with this terminator set to EOI ONLY. Refer qualified service personnel to the Maintenance section of this manual for locations and setting information. Pressing the INST ID button causes the instrument to display its selected GPIB primary address; the far right decimal point lights if the selected message terminator is LF/EOI.

COMMANDS

The instrument is controlled by the front panel or via commands received from the controller. These commands are of three types:

Setting commands — control instrument settings
Query-output commands — ask for data
Operational commands — cause a particular action

The instrument responds to and executes all commands when in the remote state. When in the local state, *setting* and *operational commands* generate errors since instrument function are under front panel control; only *query-output commands* are executed.

Each command begins with a header — a word that describes the function implemented. Many commands require an argument following the header — a word or number which specifies the desired state for the function.

FUNCTIONAL COMMAND LIST

Instrument Commands

ILOGIC—Sets logic supply current limit.
ILOGIC?—Returns logic supply current limit.
VLOGIC—Sets logic supply voltage limit.
VLOGIC?—Returns logic supply voltage limit.
INEGATIVE—Sets negative supply current limit.
INEGATIVE?—Returns negative current limit.
VNEGATIVE—Sets negative voltage limit.
VNEGATIVE?—Returns negative voltage limit.
IPOSITIVE—Sets positive current limit.
IPOSITIVE?—Returns positive current limit.
VPOSITIVE—Sets positive voltage limit.
VPOSITIVE?—Returns positive voltage limit.
ITRACK—Sets positive and negative current limits.
VTRACK—Sets positive and negative voltage limits.

Input/Output Commands

OUT ON—Connects supplies to output terminals.
OUT OFF—Disconnects supplies from output terminals.
OUTPUT?—Returns FSOUT and LSOUT ON or OFF.
FSOUTPUT ON—Connects the floating supplies to the output terminals.
FSOUTPUT OFF—Disconnects the floating supplies from the output terminals.
FSOUTPUT?—Returns FSOUT ON or OFF.
LSOUTPUT ON—Connects the logic supply to the output terminals.
LSOUTPUT OFF—Disconnects the logic supply from the output terminals.
LSOUTPUT?—Returns LSOUT ON or OFF.

Instrument Status Commands

REGULATION?—Returns regulation status of all supplies.
LRI ON—Enables logic supply regulation interrupt.
LRI OFF—Disables logic supply regulation interrupt.
LRI?—Returns LRI ON or LRI OFF.
NRI ON—Enables negative supply regulation interrupt.
NRI OFF—Disables negative supply regulation interrupt.
NRI?—Returns NRI ON or NRI OFF.
PRI ON—Enables positive supply regulation interrupt.
PRI OFF—Disables positive supply regulation interrupt.
PRI?—Returns PRI ON or PRI OFF.
RQS ON—Enables generation of service requests.
RQS OFF—Disables generation of service requests.
RQS?—Returns RQS ON or OFF.
USEREQ ON—Enables SRQ when ID button is pushed.
USEREQ OFF—Disables SRQ when ID button is pushed.
USEREQ?—Returns USER ON or OFF.

System Commands

DT SET—Updates hardware after <GET>.
DT OFF—Updates hardware without <GET> message.
DT?—Returns DT SET or OFF.
ERROR?—Returns error code.
ID?—Returns instrument identification and firmware version.
INIT—Initializes instrument settings.
SET?—Returns instrument settings.
TEST—Returns 0 or ROM error code.

DETAILED COMMAND LIST

DT (device trigger)

Type:

Setting or query

Setting syntax:

DT SET
DT OFF

Examples:

DT SET
DT OFF

Query syntax:

DT?

Query response:

DT SET;
DT OFF;

Discussion:

This command causes the instrument to wait for the <GET> (group execute trigger) interface message before updating the hardware to new settings. The OFF argument permits hardware updating without the <GET> message.

ERROR?

Type:

Query

Query syntax:

ERR:

Query ERROR? response:

ERR 103;
ERR 204;

Discussion:

This command returns an error code for the most recent error reported via serial poll. When the error status reporting is disabled (RQS OFF) this command returns the highest priority condition pending. The condition is cleared and not reported again.

FSOUTPUT

Type:

Setting or query

Setting syntax:

FSOUT ON
FSOUT OFF

Examples:

FSOUT ON
FSOUTPUT OFF

Query syntax:

FSOUT?

Query response:

FSOUT ON;
FSOUT OFF;

Discussion:

This command connects or disconnects both floating supplies to or from their respective output terminals. Some protective components remain connected to the output terminals. Refer to schematics 11 and 12 for components that remain connected.

ID?

Type:

Query

Query syntax:

ID?

Query response:

ID TEK/PS5010,V79.1,FXX;

Discussion:

XX indicates the firmware version number.

ILOGIC

Type:

Setting or query

Setting syntax:

ILOG <number>

Examples:

ILOG 2.8
ILOG .1
ILOGIC 2

Query syntax:

ILOG?

Query response examples:

ILOGIC 1.6;
ILOGIC 2;

Discussion:

This command sets the logic supply current limit to the value specified. The units are amperes for both the setting and query versions. The range is 0.10 A to 3.0 A and the resolution is 100 mA.

INEGATIVE

Type:

Setting or query

Setting syntax:

INEG <number>

Examples:

INEG 1.45
INEG 1
INEGATIVE .3

Query syntax:

INEG?

Query response examples:

INEG 1.1;
INEG .750;

Discussion:

This command sets the negative supply current limit to the absolute value specified. The units for the setting and query versions are amperes. The range is 0.050 A to 0.750 A (1.6 A at 15 V and below) in the high power compartment and 0.050 A to 0.40 A (0.75 A at 15 V and below) in the standard compartment. The resolution is 0.050 A.

INIT

Type:

Operational

Operational syntax:

INIT

Discussion:

This command changes instrument settings to the power-on state. These settings are shown in Table 3-3 in this section.

IPOSITIVE

Type:

Setting or query

Setting syntax:

IPOS <number>

Examples:

IPOS .45
IPOS 1
IPOSITIVE 0.3

Query syntax:

IPOS?

Query response examples:

IPOS 1.1;
IPOS .750;

Discussion:

This command sets the positive supply current limit to the value specified. Units for the setting and query versions are in amperes. The range is 0.05 A to 0.750 A (1.6 A at 15 V and below) in the high power compartment and 0.05 A to 0.40 A (0.75 A at 15 V and below) in the standard compartment. The resolution is 0.05 A.

ITRACK

Type:

Setting

Setting syntax:

ITRA <number>

Examples:

ITRA 0.45
ITRA 1.0
ITRACK .3

Discussion:

This command sets the magnitude of both floating supplies to the absolute value specified. Units are amperes. The range is 0.05 A to 0.750 A (1.6 A at 15 V and below) in the high power compartment and 0.05 A to 0.40 A (0.75 A at 15 V and below) in the standard compartment. The resolution is 0.05 A.

LLSET

Type:

Setting or query

Setting syntax:

LLSET <binary block>

Query syntax:

LLSET?

Query response:

LLSET <binary block>;

Discussion:

The setting command changes all instrument settings to the states as specified in the binary block argument. Use this command for rapid transfer of settings. The binary block is generated by the instrument and is not intended to be generated or modified by the user. The query returns all instrument settings in low level (binary) format.

The binary block format consists of the percent (%) sign (decimal 37) followed by a two byte binary count, the data bytes and finally the checksum. The two byte binary count (integer, most significant bit first) specifies the number of data bytes plus the checksum byte. The checksum is the 2's complement of the modulo 256 sum of the preceding binary data bytes and the binary count bytes. The checksum does not include the % sign.

LRI

Type:

Setting or query

Setting syntax:

LRI ON
LRI OFF

Examples:

LRI ON
LRI OFF

Query syntax:

LRI?

Query response:

LRI ON;
LRI OFF;

Discussion:

This command enables the logic supply regulation interrupt. SRQ is asserted when the logic supply changes between any two of the three regulated modes. These modes are constant voltage, constant current and unregulated. The device dependent serial poll status byte indicates which supply caused the SRQ and the mode changed to. See Table 3-1.

The status message returned (with RQS asserted), as a result of enabling the LRI interrupt, does not necessarily show the instruments present status. It shows the status which was latched at the time the interrupt occurred. Use the command REG? to determine present status.

LSOUTPUT

Type:

Setting or query

Setting syntax:

LSOUT ON
LSOUT OFF

Examples:

LSOUT ON
LSOUT OFF

Query syntax:

LSOUT?

Query response:

LSOUT ON;
LSOUT OFF;

Discussion:

This command connects or disconnects the logic supply to its positive output terminal. Some protective components remain connected to the output terminals. Refer to schematic 8 for components that remain connected.

NRI

Type:

Setting or query

Setting syntax:

NRI ON
NRI OFF

Examples:

NRI ON
NRI OFF

Query syntax:

NRI?

Query response:

NRI ON;
NRI OFF;

Discussion:

This command enables the negative supply regulation interrupt. SRQ is asserted when the negative supply changes between any two of the three modes. These modes are constant voltage, constant current and unregulated. The device dependent serial poll status byte indicates the supply causing the SRQ and the mode changed to. See Table 3-1.

The status message returned (with RQS asserted), as a result of enabling the NRI interrupt, does not necessarily show the instruments present status. Instead, it shows the status which was latched at the time the interrupt occurred. Use the command REG? to determine present status.

OUTPUT

Type:

Setting or query

Setting syntax:

OUT ON
OUT OFF

Examples:

OUT ON
OUTPUT OFF

Query syntax:

OUT?

Query response examples:

FSOUT ON; LSOUT OFF;
FSOUT OFF; LSOUT ON;

Discussion:

This command connects or disconnects all supplies to or from their respective output terminals. Some protective components remain connected to the output terminals. Refer to schematics 8, 11, and 12 for components that remain connected.

PRI

Type:

Setting or query

Setting syntax:

PRI ON
PRI OFF

Examples:

PRI ON
PRI OFF

Query syntax:

PRI?

Query response:

PRI ON;
PRI OFF;

Discussion:

This command enables the positive supply regulation interrupt. SRQ is asserted when the positive supply changes between any two of the three modes. These modes are constant voltage, constant current and unregulated. The device dependent serial poll status byte indicates the supply causing the SRQ and the mode changed to. See Table 3-1.

The status message returned (with RQS asserted), as a result of enabling the PRI interrupt, does not necessarily show the instruments present status. Instead, it shows the status which was latched at the time the interrupt occurred. Use the command REG? to determine present status.

REGULATION?

Type:

Query

Query syntax:

REG?
REGULATION?

Query response:

REG <number>,<number>,<number>

Discussion:

This command provides a means of determining the regulation status of the three supplies. The three numbers returned apply to the negative, positive, and logic supplies in that order. The numbers returned mean: (1) supply is in constant voltage mode, (2) supply is in constant current mode, (3) supply is unregulated.

RQS

Type:

Setting or query

Setting syntax:

RQS ON
RQS OFF

Examples:

RQS ON
RQS OFF

Query syntax:

RQS?

Query response:

RQS ON;
RQS OFF;

Discussion:

This command enables the instrument to generate service requests. The OFF version of the command disables all service requests.

SET?

Type:

Query

Query syntax:

SET?

Query response example:

VNEG 0.0;INEG 0.4;VPOS 0.0;IPOS 0.4;VLOG 5.0;
ILOG 1.0; FSOUT OFF;LS OUT OFF;NRI OFF;PRI OFF;
LRI OFF; DT OFF;USER OFF;RQS ON;

Discussion:

Returns values for all instrument states as shown in example.

TEST

Type:

Output

Output syntax:

TEST

Discussion:

This command returns 0 or the error code corresponding to the ROM in which the checksum error was found. See Table 3-2.

USEREQ

Type:

Setting or query

Setting syntax:

USER ON
USER OFF
USEREQ ON
USEREQ OFF

Query syntax:

USER?
USEREQ?

Query response:

USER ON;
USER OFF;

Discussion:

Enables SRQ when INST ID front panel button is pressed.

VLOGIC

Type:

Setting or query

Setting syntax:

VLOG <number>
VLOGIC <number>

Examples:

VLOG 5
VLOGIC 4.97

Query syntax:

VLOG?
VLOGIC?

Query response example:

VLOGIC 5.1;

Discussion:

This command sets the logic supply voltage limit to the value specified. The units are volts for both the setting and query versions. The range is 4.5 V to 5.5 V and the resolution is 0.010 V.

VNEGATIVE

Type:

Setting or query

Setting syntax:

VNEG 26.7
VNEGATIVE −3.5

Query syntax:

VNEG?
VNEGATIVE?

Query response example:

VNEG 23.2;
VNEG 1.0;

Discussion:

This command sets the negative floating supply voltage limit to the value specified. The units are volts for both the setting and query versions. The range is 0 to −32 V and the resolution is 0.010 V to 10 V and 0.10 V above 10.1 V.

VPOSITIVE

Type:

Setting or query

Setting syntax:

VPOS <number>
VPOSITIVE <number>

Query syntax:

VPOS?
VPOSITIVE?

Query response example:

VPOS 1.0;
VPOS 29.7;

Discussion:

This command sets the positive floating supply voltage limit to the value specified. The units are volts for both the setting and query versions. The range is 0 V to +32 V and the resolution is 0.01 V to 10 V and 0.10 V above 10.1 V.

VTRACK

Type:

Setting

Setting syntax:

VTRA <number>
VTRACK <number>

Examples:

VTRA 25.3
VTRA 5.02
VTRACK 2

Discussion:

This command sets the voltage magnitude of both floating supplies to the absolute value specified. Units are volts. The range is 0 V to 32 V and the resolution is 0.01 V to 10 V and 0.10 V above 10.0 V.

MESSAGES AND COMMUNICATION PROTOCOL

Command Separator

A message consists of one command or a series of commands, followed by a message terminator. Messages consisting of multiple commands must have the commands separated by semicolons. A semicolon at the end of a message is optional. For example, each line below is a message.

```
INIT
TEST;INIT;RQS ON;USER OFF;ID?;SET?
TEST;
```

Message Terminator

Messages may be terminated with EOI or the ASCII line feed (LF) character. Some controllers assert EOI concurrently with the last data byte; others use only the LF character as a terminator. The instrument can be internally set to accept either terminator. With EOI ONLY selected as the terminator, the instrument interprets a data byte received with EOI asserted as the end of the input message; it also asserts EOI concurrently with the last byte of the output message. With the LF/EOI setting, the instrument interprets the LF character without EOI asserted (or any data byte received with EOI asserted) as the end of an input message; it transmits carriage return (CR) followed by line feed (the LF with EOI asserted) to terminate output messages. Refer service personnel to the Maintenance section of the manual for information on setting the message terminator. TM 5000 instruments are shipped with EOI ONLY selected.

Formatting A Message

Commands sent to TM 5000 instruments must have the proper format (syntax) to be understood; however, this format is flexible in that many variations are acceptable. The following describes this format and the acceptable variations.

The instruments expect all commands to be encoded in ASCII; however, they accept both upper and lower case ASCII characters. All data output is in upper case. See Fig. 3-2.

As previously discussed, a command consists of a header followed, if necessary, by arguments. A command with arguments must have a header delimiter which is the space character SP between the header and the argument. The space character $_{SP}$, carriage return $_{CR}$, and line feed $_{LF}$ are shown as subscripts in the following examples.

RQS$_{SP}$ON

If extra formatting characters SP, CR, and LF (the LF cannot be used for format in the LF/EOI terminator mode) are added between the header delimiter and the argument, they are ignored by the instrument.

Example 1: RQS$_{SP}$ON;
Example 2: RQS$_{SP\ SP}$ ON;
Example 3: RQS$_{SP\ CR\ LF\ SP\ SP}$ON

In general, these formatting characters are ignored after any delimiter and the beginning and end of a message.

$_{SP}$RQS$_{SP}$ON;$_{CR\ LF}$

$_{SP}$USER$_{SP}$OFF

In the command list, some headers and arguments are listed in two forms, a full-length version and an abbreviated version. The instrument accepts any header or argument containing at least the characters listed in the short form; any characters added to the abbreviated version must be those given in the full-length version. For documentation of programs, the user may add alpha characters to the full-length version. Alpha characters may also be added to query header, provided the question mark is at the end.

```
USER?
USERE?
USEREQ?
USEREQUEST?
```

Multiple arguments are separated by a comma; however, the instrument will also accept a space or spaces as a delimiter.

2.3
2$_{SP}$3
2,$_{SP}$3

NOTE

In the last example, the space is treated as a format character because it follows the comma (the argument delimiter).

Number Formats

The instrument accepts the following kinds of numbers for any of the numeric arguments.

- Signed or unsigned integers (including +0 and −0). Unsigned integers are interpreted as positive. Examples: +1, 2, −1, −10.

ASCII & IEEE 488 (GPIB) CODE CHART

BITS B4 B3 B2 B1	B7 B6 B5 = Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER	
Ø Ø Ø Ø	0 NUL 0 (0)	20 DLE 10 (16)	40 SP 20 (32)	60 0 30 (48)	100 @ 40 (64)	120 P 50 (80)	140 ` 60 (96)	160 p 70 (112)
Ø Ø Ø 1	1 GTL SOH 1 (1)	21 LLO DC1 11 (17)	41 ! 21 (33)	61 1 31 (49)	101 A 41 (65)	121 Q 51 (81)	141 a 61 (97)	161 q 71 (113)
Ø Ø 1 Ø	2 STX 2 (2)	22 DC2 12 (18)	42 " 22 (34)	62 2 32 (50)	102 B 42 (66)	122 R 52 (82)	142 b 62 (98)	162 r 72 (114)
Ø Ø 1 1	3 ETX 3 (3)	23 DC3 13 (19)	43 # 23 (35)	63 3 33 (51)	103 C 43 (67)	123 S 53 (83)	143 c 63 (99)	163 s 73 (115)
Ø 1 Ø Ø	4 SDC EOT 4 (4)	24 DCL DC4 14 (20)	44 $ 24 (36)	64 4 34 (52)	104 D 44 (68)	124 T 54 (84)	144 d 64 (100)	164 t 74 (116)
Ø 1 Ø 1	5 PPC ENQ 5 (5)	25 PPU NAK 15 (21)	45 % 25 (37)	65 5 35 (53)	105 E 45 (69)	125 U 55 (85)	145 e 65 (101)	165 u 75 (117)
Ø 1 1 Ø	6 ACK 6 (6)	26 SYN 16 (22)	46 & 26 (38)	66 6 36 (54)	106 F 46 (70)	126 V 56 (86)	146 f 66 (102)	166 v 76 (118)
Ø 1 1 1	7 BEL 7 (7)	27 ETB 17 (23)	47 ' 27 (39)	67 7 37 (55)	107 G 47 (71)	127 W 57 (87)	147 g 67 (103)	167 w 77 (119)
1 Ø Ø Ø	10 GET BS 8 (8)	30 SPE CAN 18 (24)	50 (28 (40)	70 8 38 (56)	110 H 48 (72)	130 X 58 (88)	150 h 68 (104)	170 x 78 (120)
1 Ø Ø 1	11 TCT HT 9 (9)	31 SPD EM 19 (25)	51) 29 (41)	71 9 39 (57)	111 I 49 (73)	131 Y 59 (89)	151 i 69 (105)	171 y 79 (121)
1 Ø 1 Ø	12 LF A (10)	32 SUB 1A (26)	52 * 2A (42)	72 : 3A (58)	112 J 4A (74)	132 Z 5A (90)	152 j 6A (106)	172 z 7A (122)
1 Ø 1 1	13 VT B (11)	33 ESC 1B (27)	53 + 2B (43)	73 ; 3B (59)	113 K 4B (75)	133 [5B (91)	153 k 6B (107)	173 { 7B (123)
1 1 Ø Ø	14 FF C (12)	34 FS 1C (28)	54 , 2C (44)	74 < 3C (60)	114 L 4C (76)	134 \ 5C (92)	154 l 6C (108)	174 | 7C (124)
1 1 Ø 1	15 CR D (13)	35 GS 1D (29)	55 − 2D (45)	75 = 3D (61)	115 M 4D (77)	135] 5D (93)	155 m 6D (109)	175 } 7D (125)
1 1 1 Ø	16 SO E (14)	36 RS 1E (30)	56 . 2E (46)	76 > 3E (62)	116 N 4E (78)	136 ^ 5E (94)	156 n 6E (110)	176 ~ 7E (126)
1 1 1 1	17 SI F (15)	37 US 1F (31)	57 / 2F (47)	77 ? UNL 3F (63)	117 O 4F (79)	137 UNT _ 5F (95)	157 o 6F (111)	1 7 RUBOUT (DEL) 7F (127)

ADDRESSED COMMANDS

UNIVERSAL COMMANDS

LISTEN ADDRESSES

TALK ADDRESSES

SECONDARY ADDRESSES OR COMMANDS

KEY TO CHART

octal — 25 PPU — GPIB code

NAK — ASCII character

hex — 15 (21) — decimal

3391-13

Fig. 3-2. ASCII and IEEE 488 (GPIB) Code Chart.

@

- Signed or unsigned decimal numbers. Unsigned decimal numbers are interpreted to be positive. Examples: −3.2, +5.0, .2.

- Floating point numbers expressed in scientific notation. Examples: +1.0E−2, 1.47E1, 1.E−2, 0.01E+0.

Rounding of Numeric Arguments

The instrument rounds numeric arguments to the nearest unit of resolution and then checks for out-of-range conditions.

Message Protocol

As the instrument receives a message it is stored in the Input Buffer, processed, and executed. Processing a message consists of decoding commands, detecting delimiters, and checking syntax. For *setting commands*, the instrument then stores the indicated changes in the Pending Settings Buffer. If an error is detected during processing the instrument asserts SRQ, ignores the remainder of the message, and resets the Pending Settings Buffer. Resetting the Pending Settings Buffer avoids undesirable states which could occur if some *setting commands* are executed while others in the same message are not.

Executing a message consists of performing the actions specified by its command(s). For *setting commands*, this involves updating the instrument settings and recording these updates in the Current Settings Buffer. The *setting commands* are executed in groups — that is, a series of *setting commands* is processed and recorded in the Pending Settings Buffer before execution takes place. This allows the user to specify a new instrument state without having to consider whether a particular sequence would be valid. Execution of the settings occurs when the instrument processes the message terminator, a *query-output command*, or an *operational command* in a message. The normal execution of settings is modified by the DT SETTINGS command.

When the instrument processes a *query-output command* in a message, it executes any preceding *setting commands* to update the state of the instrument. It then executes the *query-output command* by retrieving the appropriate data and putting it in the Output Buffer. Then, processing and execution continue for the remainder of the message. The data are sent to the controller when the instrument is made a talker.

When the instrument processes an *operational command* in a message, it executes any preceding *setting commands* before executing the *operational command*.

Multiple Messages

The Input Buffer has finite capacity and a single message may be long enough to fill it. In this case, a portion of the message is processed before the instrument accepts additional input. During command processing the instrument holds off additional data (by asserting NRFD) until space is available in the buffer.

When space is available, the instrument can accept a second message before the first has been processed. However, it holds off additional messages with NRFD until it completes processing the first.

After the instrument executes a *query-output command* in a message, it holds the response in its Output Buffer until the controller makes the instrument a talker. If the instrument receives a new message before all of the output from the previous message is read it clears the Output Buffer before executing the new message. This prevents the controller from getting unwanted data from old messages.

One other situation may cause the instrument to delete output. The execution of a long message might cause both the Input and Output Buffers to become full. When this occurs, the instrument cannot finish executing the message because it is waiting for the controller to read the data it has generated; but the controller cannot read the data because it is waiting to finish sending its message. Because the instruments Input Buffer is full and it is holding off the rest of the controllers message with NRFD, the system is hung up with the controller and instrument waiting for each other. When the instrument detects this condition, it generates an error, asserts SRQ and deletes the data in the Output Buffer. This action allows the controller to transmit the rest of the message and informs the controller that the message was executed and that the output was deleted.

A TM 5000 instrument can be made a talker without having received a message which specifies what it should output. In this case, acquisition instruments (counters and multimeters) return a measurement if one is ready. If no measurement is ready, they return a single byte message with all bits equal to 1 (with message terminator); other TM 5000 instruments will return only this message.

INSTRUMENT RESPONSE TO IEEE-488 INTERFACE MESSAGES

Interface messages and their effects on the instruments interface functions are defined in IEEE Standard 488-1978. Abbreviations from the standard are used in this discussion which describe the effects of interface messages on instrument operation.

Bus interface control messages are sent as low level commands through the use of WBYTE controller commands. For the following commands A = 32 plus the instrument address and B = 64 plus the instrument address.

Listen	WBYTE @ A:
Unlisten	WBYTE @ 63:
Talk	WBYTE @ B:
Untalk	WBYTE @ 95:
Untalk-unlisten	WBYTE @ 63, 95:
Device clear (DCL)	WBYTE @ 20
Selective device clear (SDC)	WBYTE @ A, 4:
Go to local (GTL)	WBYTE @ A, 1:
Remote with lockout	WBYTE @ A, 17, 63:
Local lockout of all instruments	WBYTE @ 17:
Group execute trigger (GET)	WBYTE @ A, 8:

These commands are for the TEKTRONIX 4050-Series controllers and representative for other controllers.

UNL—Unlisten
UNT—Untalk

When the UNL command is received, the instruments listener function goes to its idle state (unaddressed). In the idle state, the instrument will not accept instrument commands from the GPIB.

The talker function goes to its idle state when the instrument receives the UNT command. In this state, the instrument cannot output data via the GPIB.

The ADDRESSED light is off when both the talker and listener functions are idle. If the instrument is either talk addressed or listen addressed, the light is on.

IFC—Interface Clear

This uniline message has the same affect as both the UNT and UNL messages. The front panel ADDRESSED light is off.

DCL—Device Clear

The Device Clear message reinitializes communication between the instrument and controller. In response to DCL, the instrument clears any input and output messages and any unexecuted settings in the Pending Settings Buffer. Also cleared are any errors or events waiting to be reported, except the power-on event. If the SRQ line is asserted for any reason other than power-on when DCL is received, the SRQ is unasserted.

SDC—Selected Device Clear

This message performs the same function as DCL; however, only instruments that are listen addressed respond to SDC.

GET—Group Execute Trigger

The instrument responds to GET only if it is listen addressed and the instruments device trigger function has been enabled by the Device Trigger command (DT). The GET message is ignored and an SRQ generated if the DT function is disabled (DT OFF), the instrument is in the local state, or if a message is being processed when GET is received.

SPE—Serial Poll Enable
SPD—Serial Poll Disable

The SPE message enables the instrument to output serial poll status bytes when it is talk addressed. The SPD message switches the instrument back to its normal operation of sending the data from the Output Buffer.

MLA—My Listen Address
MTA—My Talk Address

The primary listen and talk addresses are established by the instruments GPIB address (internally set). The current setting of the GPIB address is displayed on the front panel when the ID button is pressed. When the instrument is addressed to talk or listen, the front panel ADDRESSED indicator is illuminated.

LLO—Local Lockout

In response to LLO, the instrument goes to a lockout state—from LOCS to LWLS or from REMS to RWLS.

REN—Remote Enable

If REN is true, the instrument goes to a remote state (from LOCS to REMS or from LWLS to RWLS) when its listen address is received. REN false causes a transition from any state to LOCS; the instrument stays in LOCS as long as REN is false.

A REN transition may occur after message processing has begun. In this case execution of the message being processed is not affected by a transition.

GTL—Go To Local

Only instruments that are listen addressed respond to GTL by going to a local state. Remote-to-local transitions caused by GTL do not affect the execution of the message being processed when GTL was received.

Remote-Local Operation

The preceding discussion of interface messages describes the state transitions caused by GTL and REN. Most front panel controls cause a transition from REMS to LOCS by asserting a message called return-to-local (*rtl*). This transition may occur during message execution; but in contrast to GTL and REN transitions, a transition initiated by *rtl* does affect message execution. In this case, the instrument generates an error if there are any unexecuted setting or operational commands. Front panel controls that only change the display (like ID) do not affect the remote-local states — only front panel controls that change settings assert *rtl*. The *rtl* message remains asserted while multiple keystroke settings are entered; and it is unasserted after the execution of the settings. Since *rtl* prevents transitions to REMS, the instrument unasserts *rtl* if a multiple button sequence is not completed in a reasonable length of time (approximately 5 to 10 seconds).

The instrument maintains a record of its settings in the Current Settings Buffer and new settings from the front panel or the controller update these recorded settings. In addition, the front panel is updated to reflect setting changes due to commands. Instrument settings are unaffected by transitions between the four remote-local states. The REMOTE indicator is illuminated when the instrument is in REMS or RWLS.

Local State (LOCS)

In LOCS, instrument settings are controlled by the operator via front panel pushbuttons. When in LOCS, only bus commands that do not change instrument settings are executed (*query-output commands*); all other bus commands (*setting* and *operational*) generate an error since their functions are under front panel control.

Local With Lockout State (LWLS)

The instrument operates the same as it does in LOCS, except that *rtl* will not inhibit a transition to remote.

Remote State (REMS)

In this state, the instrument executes all instrument commands. For commands having front panel indicators, the front panel is updated when the commands are executed.

Remote With Lockout State (RWLS)

Instrument operation is identical to REMS operation except that the *rtl* message is ignored.

STATUS AND ERROR REPORTING

Through the Service Request function (defined in the IEEE-488 Standard), the instrument may alert the controller that it needs service. This service request is also a means of indicating that an event (a change in status or an error) has occurred. To service a request the controller performs a Serial Poll; in response the instrument returns a Status Byte (STB) which indicates whether it was requesting service or not. The STB can also provide a limited amount of information about the request. The format of the information encoded in the STB is given in Fig. 3-3. When data bit 8 is set, the STB conveys Device Status information which is indicated by bits 1 through 4.

Because the STB conveys limited information about an event, the events are divided into classes; the Status Byte reports the class. The classes of events are defined as follows:

COMMAND ERROR Indicates the instrument has received a command which it cannot understand.

EXECUTION ERROR Indicates that the instrument has received a command that it cannot execute. This is caused by arguments out of range or settings that conflict.

INTERNAL ERROR Indicates that the instrument has detected a hardware condition or firmware problem that prevents operation.

SYSTEM EVENTS Events that are common to instruments in a system (e.g., Power on, User Request, etc.).

EXECUTION WARNING The instrument is operating but the user should be aware of potential problems.

DEVICE STATUS Device dependent events.

The instrument can provide additional information about many of the events, particularly the errors reported in the Status Byte. After determining that the instrument requested service (by examining the STB) the controller may request the additional information by sending an error query (ERR?). In response, the instrument returns a code which defines the event. These codes are described in Table 3-1.

Table 3-3
STATUS BYTE BITS DEFINITION

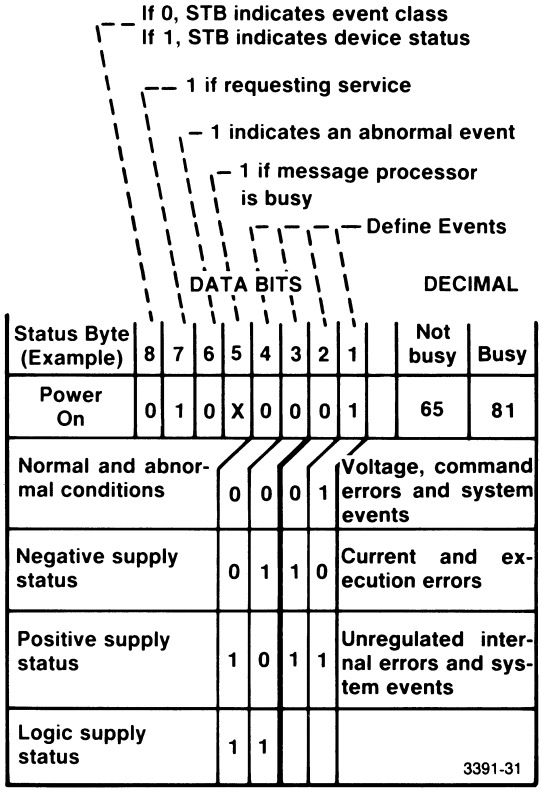

Fig. 3-3. Definition of status bytes.

Table 3-1

ERROR QUERY AND STATUS INFORMATION

Event	Bus response to ERR?	Response to serial poll[a]
Abnormal Conditions		
Command Errors		
Command header error	101	97 or 113
Header delimiter error	102	97 or 113
Command argument error	103	97 or 113
Argument delimiter error	104	97 or 113
Missing argument	106	97 or 113
Invalid message unit delimiter	107	97 or 113
Binary block checksum error	108	97 or 113
binary block byte counter error	109	97 or 113
Execution Errors		
Command not executable in local mode	201	98 or 114
Returned to local, new settings pending lost	202	98 or 114
I/O buffers full, output dumped	203	98 or 114
Settings conflicts	204	98 or 114
Argument out of range	205	98 or 114
Group execute trigger ignored	206	98 or 114
Internal Errors		
System error	302	99 or 115
Math pack error	303	99 or 115
Normal Conditions		
System Events		
Power on	401	65 or 81
User request	403	67 or 83
Device Dependent Events		
Negative supply goes to constant voltage mode	721	197 or 213
Negative supply goes to constant current mode	722	198 or 214
Negative supply goes to unregulated mode	723	199 or 215
Positive supply goes to constant voltage mode	724	201 or 217
Positive supply goes to constant current mode	725	202 or 218
Positive supply goes to unregulated mode	726	203 or 219
Logic supply goes to constant voltage mode	727	205 or 221
Logic supply goes to constant current mode	728	206 or 222
Logic supply goes to unregulated mode	729	207 or 223

[a]If the message processor is busy, the instrument returns the higher decimal number.

Table 3-2

FRONT PANEL ERROR CODES

Displayed	Abnormal Events
302	System error
303	Math pack error
340	System RAM error
341	System RAM error (low nibble)
372	C000 ROM placement error
373	D000 ROM placement error
374	E000 ROM placement error
375	F000 ROM placement error
392	C000 ROM checksum error
393	D000 ROM checksum error
394	E000 ROM checksum error
395	F000 ROM checksum error
521	Signature analysis mode

If there is more than one event to be reported, the instrument continues to assert SRQ until it reports all events. Each event is automatically cleared when it is reported via Serial Poll. The Device Clear (DCL) interface message may be used to clear all events except Power on.

Commands are provided to control the reporting of some individual events and to disable all service requests. For example, the User Request command (USEREQ) provides individual control over the reporting of the user request event which occurs when the front panel ID button is pushed. The Request for Service command (RQS) controls whether the instrument reports any events with SRQ.

RQS OFF inhibits all SRQs so in this mode the ERR? query allows the controller to find out about events without first performing a Serial Poll. With RQS OFF, the controller may send the ERR? query at any time and the instrument returns an event waiting to be reported. The controller can clear all events by sending the error query until a zero (0) code is returned, or clear all events except Power-on through the DCL interface message.

With RQS OFF the controller may perform a Serial Poll, but the Status Byte only contains Device Dependent Status information. With RQS ON, the STB contains the class of the event and a subsequent error reported in the STB.

Power Up (Initial) Conditions

During power up, the PS 5010 microprocessor performs a diagnostic routine (self test) to check the functionality of the ROM and RAM. If no error is found, the instrument enters the Local State (LOCS) with the default settings as listed in Table 3-3. The SRQ line on the GPIB is also asserted.

Table 3-3

POWER ON SETTINGS

The instrument goes to the following settings at power on and when the INIT command is executed. Characters in parenthesis are not entered as part of the argument.

Header	Argument
VPOSitive	0.0 (V)
IPOSitive	0.4 (A)
VNEGative	0.0 (V)
INEGative	0.4 (A)
VLOGic	5.0 (V)
ILOGic	1.0 (A)
FSOUTput	OFF
LSOUTput	OFF
PRI	OFF
NRI	OFF
LRI	OFF
RQS	ON
USEReq	OFF
DT	OFF

If an internal error is found, an error code is displayed in the front-panel readout. See Table 3-2 for error codes.

APPLICATIONS

Talker Listener Program For 4050 Series Controllers

This sample program allows sending the listed commands and receiving the data generated.

```
100 REM PS5010 TALKER/LISTENER PROGRAM
110 REM PS5010 PRIMARY ADDRESS = 22
120 INIT
130 ON SRQ THEN 240
140 DIM A$(200)
150 PRINT "ENTER MESSAGE(S): ";
160 INPUT C$
170 PRINT @22:C$
180 REM CHECK FOR QUERIES
190 IF POS(C$,"?",1)=0 THEN 150
200 REM INPUT FROM DEVICE
210 INPUT @22:A$
220 PRINT A$
230 GO TO 150
240 REM SERIAL POLL ROUTINE
250 POLL X,Y;22
260 PRINT "STATUS BYTE: ";Y
270 RETURN
```

4050 Series Talker Listener Program Description

This program must be typed into the 4050 series controller before the PS 5010 is powered up. The PS 5010 asserts SRQ on power up. The program will clear the SRQ by polling the instrument before proceeding. The program starts with two remark statements, one titling the program and the other listing the instruments factory set primary address, 22. Line 130 allows a transfer to line 240. Upon an SRQ interrupt, lines 250 and 260 clear the serial poll and print a status byte. The condition that generated the SRQ can be determined by reviewing Table 3-1. Statement 140 dimensions A character string (A$). The default length for A$ in the 4050 series is 72 characters (1 line). Line 150 prompts the user for a message (command or query). The message entered is assigned to C$. C$ is sent to the PS 5010 by the print statement at line 170. If the message is a settings command, the front panel displays change to reflect the value sent. Statement 180 is a remark statement. Statement 190 checks C$ for a question mark. If a question mark is included in C$, the message contained a query. The program moves on to statement 200, 210 and 220 which will input the response to the query from the PS 5010 and print it on the computer screen.

Talker Listener Program For the 4041 Controller

This sample program allows sending the listed commands and receiving the data generated.

```
90 REM PS5010 TALKER/LISTENER PROGRAM
95 REM PS5010 PRIMARY ADDRESS = 22
100 OPEN #1:"GPIB(PRI=22,EOM=<>):"
110 ON SRQ THEN GOSUB 240
115 ENABLE SRQ
120 DIM A$ TO (200)
130 PRINT "ENTER COMMAND(S) / QUERY "
140 INPUT C$
145 IF C$="EX"THEN GOTO 230
150 PRINT #1:C$
160 REM CHECK FOR QUERIES
170 IF POS(C$,"?",1)=0 THEN GOTO 130
190 REM INPUT FROM DEVICE
200 INPUT #1:A$
210 PRINT A$
220 GOTO 130
230 STOP
240 POLL SB,P,S,22
250 PRINT "SRQ SEEN, STATUS BYTE:",SB
260 RETURN
```

Sample Program

This program illustrates how the PS 5010 can be used to learn front panel settings. The program varies these settings by a selected percentage using only the INST ID button, which operates as a user interrupt.

Line 110 tells the controller the location of the poll routine.

Line 150 tells the PS 5010 that the INST ID button is to be used as a user interrupt.

Lines 290 and 300 are examples of commands assigning instrument settings to variables.

Line 390 shows the use of an arithmetic variable as a command argument.

Lines 450 through 530 are the SRQ service routine to do a poll, print out the POLL status and the error query response.

Line 470 checks if the SRQ was generated by the INST ID button. If so, control returns to the main program.

```
100 REM High level learn and tolerance change program
110 ON SRQ THEN 450
120 DELETE F$,C,D,F,P,S,T
130 REM     Default address for the PS5010
140 P=22
150 PRINT @P:"USER ON"
160 PAGE
170 PRINT
180 PRINT "    This program allows you to manually set up the PS5010  "
190 PRINT "    front panel and then change the floating supply voltages"
200 PRINT "    by plus and minus a selectable percentage, by using the"
210 PRINT "    INST ID button as a user interrupt."
220 PRINT
230 PRINT "    Enter percent tolerance change, then RETURN. ";
240 INPUT T
250 PRINT
260 PRINT "    Set up front panel for initial settings, then press "
270 PRINT "    PS5010 INST ID button."
280 WAIT
290 PRINT @P:"VNEG?;VPOS?"
300 INPUT @P:A,B
310 LET F=1+T/100
320 PRINT
330 PRINT "    Plus ";T;" percent tolerance."
340 PRINT @P:"VNEG ";A*F;";VPOS ";B*F
350 WAIT
360 LET F=1-T/100
370 PRINT
380 PRINT "    Minus ";T;" percent tolerance."
390 PRINT @P:"VNEG ";A*F;";VPOS ";B*F
400 WAIT
410 PRINT
420 PRINT "    Returned to initial settings."
430 PRINT @P:"VNEG ";A;";VPOS ";B
440 GO TO 220
450 REM                          SRQ Service routine
460 POLL D,S;P
470 IF S=67 OR S=83 THEN 540
480 PRINT
490 PRINT "SRQ serviced @ address ";P
500 PRINT "     POLL status returned: ";S
510 PRINT @P:"ERR?;"
520 INPUT @P:F$
530 PRINT "     Error Query response: ";F$
540 RETURN
```

The POLL Statement and Clearing SRQ

The POLL statement causes the BASIC interpreter in the 4050 series controllers to serially poll each peripheral device on the General Purpose Interface Bus (GPIB) and determine which device is requesting service. When the device is found, the device sends its status byte to the BASIC interpreter over the GPIB.

The POLL statement is normally executed in response to a service request from a peripheral device on the GPIB. Two numeric variables are specified as parameters in the POLL statement followed by a series of I/O addresses. The BASIC interpreter polls the first I/O address in the list, then the second I/O address, then the third, and so on, until the device requesting service is found. It is imperative that the I/O address of the device requesting service is in the list, or program execution is halted.

The PS 5010 asserts SRQ during power up or power down. The power up SRQ must be cleared before continuing.

```
POLL A,B;22
```

This statement shows a method of clearing the service request. The variables A and B in this example may be any undefined variables. Following the variables is the semicolon delimiter and the alpha character defined in the first line as the instruments primary address. The devices position in the list is assigned to the first variable specified in the POLL statement. The status word from the device is then sent over the GPIB and assigned to the second variable specified in the POLL statement.

Using Low Level Settings

```
P=22
DIM A(26)
PRINT @P:"LLSET?"
WBYTE @64+P:
RBYTE A
WBYTE @32+P:A
```

The above program lines retrieve the PS 5010 settings in low level binary format and return them at a later time. Transferring settings in a low level binary format requires considerably less bus time. The first statement assigns the PS 5010 factory set address to the undefined variable P. The next dimensions A to 26 characters. The low level settings query command is then sent to the PS 5010. The fourth statement makes the PS 5010 a talker and the following line reads the binary block into the computer memory. The last statement recovers the low level settings from the computer memory and sends them back to the PS 5010. For a definition of the binary block argument see the description for the LLSET command in this section. Further discussion of RBYTE and WBYTE may be found elsewhere in this section and in the computer programming manual.

Program Delays

The PS 5010 delays status reporting, via SRQ after changes in voltage, current or output, to allow instrument stabilization. If interrupts to detect changes in status are desired, a 100 ms delay must be inserted in the program after each change to insure the PS 5010 has sufficient time to report.

Information Available

Additional assistance in developing specific application oriented software is available in the following Tektronix manuals.

(1) 070-3985-00—GPIB Programming Guide. This manual is specifically written for applications of this instrument in IEEE-488 systems. It contains programming instructions, tips and some specific example programs.

(2) 070-2270-00—4051 GPIB Hardware Support Manual. This manual gives an indepth discussion of IEEE-488 bus operation, explanations of bus timing details and early bus interface circuitry.

(3) 070-2058-01—Programming In BASIC

(4) 070-2059-01—Graphic Programming In BASIC

(5) 51/00-700 4/0—4050 Series Programming Tips

(6) 070-2380-01—4907 File Manager Operators manual

(7) 070-2128-00—4924 Users manual

(8) 070-1940-01—4050 Series Graphic System Operators manual

(9) 070-2056-01—4050 Series Graphic System Reference manual

(10) 070-3918-00—4041 Operators manual

(11) 061-2546-00—4041 Programming Reference manual

WARNING

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

THEORY OF OPERATION

LOGIC AND FLOATING SUPPLY BLOCK DIAGRAM DESCRIPTION

Introduction

The PS 5010 has three regulated output and several internal supplies. The output supplies are the LOGIC supply, and the POSITIVE and NEGATIVE floating supplies.

Logic Supply Block Diagram

Referring to the first block diagram in the pullout pages at the rear of this manual, +26 V, −26 V, and +8 V from the mainframe are filtered in the input filter and control supply block. This supply provides all voltage is needed to operate the CPU and the control voltages for the logic supply.

The logic supply consists of an internally mounted pass-transistor whose collector is connected to the +8 V and the necessary control circuitry. The regulation and control circuitry is divided into three sections. The outputs of these three sections are ORd together at the base of the series pass-transistor. These circuits are the current loop, voltage loop, and the fold-back current limit circuit.

Remote voltage sensing is provided for the common and the output terminals. The output of the logic supply ranges from 4.5 V to 5.5 V. The reference voltage is generated from a 4.5 V signal that tracks the common or ground sense. This 4.5 V signal is summed with the output of a 0 to 1 V digital-to-analog converter driven by the CPU, resulting in a 4.5 V to 5.5 V signal referenced to the ground sense. This signal passes to the voltage error amplifier and is compared with the output voltage from the remote sense line.

The current sense resistor is in series with the pass-transistor and the output terminal. The voltage drop across this resistor is proportional to the logic supply current.

The output voltage of the logic current DAC is proportional to the programmed current limit.

The DAC voltage is compared to the sense resistor voltage by the current error amplifier.

If the voltage across the sense resistor exceeds the current DAC voltage, the output of the error amplifier takes control of the series pass-transistor and limits the output current to the value of the programmed current.

The fold-back current limit checks the output voltage and current. This circuit protects the pass-transistor from overdissipation when the supply is operated outside of the specified load range. This is done by lowering the current limit point until transistor dissipation is within a safe region. The outputs of the current and voltage loops are monitored by the loop balance status comparators. These comparators serve as inputs to the CPU. In normal operation one of the loops is balanced. In the fold-back condition or overvoltage condition neither loop is balanced.

Floating Supply Block Diagram

As shown on block diagram 2, floating supply power is derived from the isolated ac windings in the mainframe. The rectifier, filter, and control supply are two power supplies whose commons are not directly connected. The + and − commons are connected through the sense resistors to form the common for both floating supplies. This is the front-panel common return.

The ±15 V control supplies are referenced to the front-panel common terminal. These control supplies are used throughout the floating supply control circuitry.

The + collector supply voltages for the series pass-transistors are filtered but unregulated. The base drive for the series pass-transistors is regulated at either +24 V or +40 V depending on the position of the mode relay. If the power supply is programmed for a current greater than 750 mA, (400 mA in a standard compartment) the collector switches to the +24 V supply. The collector voltage changes range with the base drive to prevent overdissipation of the pass-transistors.

As the + and − floating supplies are identical, except for polarities, only the + supply is described. The voltage at the

base of the pass-transistor is controlled by ORing the outputs of the voltage and current loops through appropriate diodes. There is no fold-back circuitry for this supply as the voltage in the current mode can range from 0 to the set value. Since the supply is floating, information for the current and voltage digital-to-analog converters pass through an optical isolation link. The balance status comparator information to the CPU board also passes through an optical isolation link.

The floating supplies utilize remote sensing. There are three remote sensing lines, + supply, − supply, and common. In front-panel operation, the + sense is connected to the POSITIVE, the common to the common, and the negative sense to the NEGATIVE front-panel connectors. In rear interface operation, the sense lines and the output lines are separate.

The positive voltage digital-to-analog converter is referenced to the common sense line. One input of the voltage error amplifier is also referenced to the same point. The negative output voltage from the voltage DAC is summed with the positive output voltage on the sense line, and the difference signal is fed to the other input of the voltage error amplifier. The output of the voltage error amplifier is diode ORd with the current amplifier and also connects to the loop balance status comparator.

The + current DAC is referenced to COMMON for the supply. The negative output voltage from the current DAC is summed with the voltage across the sense resistor and the difference signal is fed to the other input of the current error amplifier and added to the voltage output from the + current DAC. The current across the sense resistor is equal to the output current of the supply. The output of the current error amplifier is ORd to the base of the series pass-transistor and also provides a signal that passes to the loop balance status comparator.

The current through the emitter of the pass-transistor passes through the output relay and the input-output select switch to the selected output terminal.

DETAILED CIRCUIT DESCRIPTION

GPIB ◇1

The GPIB communications are controlled by U1001, U1000, and U1010. Bidirectional buffers U1000 and U1010 provide drive capability for U1001, the GPIB interface. The IEEE 488-1975/78 standard protocol is handled automatically in both talker and listener modes by U1001. This instrument is assigned a 5 bit address to enable talker or listener addressing over the bus. This address is set on switch S1221 shown on schematic 4. The switch is located on the CPU board (A12). The switch settings are read by the microprocessor at power on and written into the address register of U1001.

CPU Regulator ◇1

Voltage comparator U1020A and the series pass-transistor Q1021 furnish the +5 V power to the Logic Supply Filter board, A13, Front-Panel board, A10, and CPU board, A12. When the current through the sense resistor R1018 is about 1.8 A, transistor Q1020 reduces base drive to Q1021. This provides foldback curent limiting. The foldback current limit is 0.6 A at 0 V. The output of the voltage comparator U1020A is ORd with the output of the current foldback Q1020 through CR1020. Reference voltage (5 V) is provided by Zener diode VR1011.

Power On ◇1

When the mainframe supply voltages are stable, the PWR line is TTL high. This PWR signal from the mainframe is applied to the + input of U1020B. This comparator provides signal hysteresis at +0.7 V to +2 V to eliminate the effects of noise on the PWR line. The output of U1020B at pin 7 is delayed about 10 ms by R1125 and C1120. This signal is compared to the 5 V reference on the + input of U1020C. IC U1020C drives Q1125, providing the open collector $\overline{\text{PON}}$ signal to the microprocessor.

The power on reset $\overline{\text{RES}}$, for the processor and related circuitry, is the $\overline{\text{PON}}$ signal ANDed with $\overline{\text{Ext Reset}}$.

Microprocessor ◇2

The M6800 microprocessor, U1111, controls the internal operation of the PS 5010. It accepts commands from either the front panel or GPIB. It sets the operating parameters in response to these commands. The M6800 is an 8 bit parallel processor with a 16 bit address bus. The data bus is buffered by U1202 and the lower 8 address lines, A0 through A7, are buffered by U1210.

System Clock 2

The M6800 is driven by a two-phase, nonoverlapping clock signal. The clock is generated by a three transistor (Q1120, Q1121, Q1122) RC oscillator that includes R1223, R1220, R1128, and C1122. The oscillator runs at 4 MHz. This signal is divided to 1 MHz by two flip-flops, U1220A and U1220B. Bus $\phi 2$ (1 MHz clock) is taken directly from pin 9 of U1220B. Clock signals (1 MHz) MPU $\phi 1$ and MPU $\phi 2$ are supplied from pins 13 and 10 of U1112D and U1112C, respectively. NOR gate U1112C and U1112D insures that MPU $\phi 1$ and MPU $\phi 2$ are nonoverlapping.

Chip Selects 2

Chip selects for the following are generated by U1120.

Table 4-1
U1120 CHIP SELECTS

Circuit Number	Type	Address
U1300, U1302	RAM	0000-1FFF
U1200, U1201	ROM	C000-DFFF
U1100, U1101	ROM	E000-FFFF
U1001	GPIB	8000-9FFF
U1212	Switch	A000-BFFF

VMA and $\phi 2$ are included in the chip enable for U1120.

Chip Selects 3

Chip selects for the following are generated by U1310.

Table 4-2
U1310 CHIP SELECTS

Circuit Number	Type	Address
U1201	ROM	C000-CFFF
U1200	ROM	D000-DFFF
U1101	ROM	E000-EFFF
U1100	ROM	F000-FFFF
U1411	Latch	3000-303F
U1314	Latch	3040-307F
U1315	Latch	3080-30BF

VMA is used only in U1411, U1314, and U1315.

The remaining chip selects are produced by U1311 and are:

Table 4-3
U1311 CHIP SELECTS

Circuit Number	Type	Address
U1420	Buffer	3C00-3FFF
U1421	Keyboard	2800-2BFF
U1410	Display	2400-27FF
U1400	Display	2000-23FF

VMA is included in all U1311 chip selects.

Memory 3

Located on the CPU board are 16k bytes of ROM containing the operating system firmware. This instrument has either 2 8kx8 or 4 4kx8 ROMs. Table 4-4 shows the location and addresses of these ROMs.

Table 4-4
OPERATING SYSTEM FIRMWARE LOCATIONS AND ADDRESSES

Circuit Number	Address	Circuit Number	Address
4k x 8		8k x 8	
U1201	C000-CFFF	U1201	C000-DFFF
U1200	D000-DFFF	U1101	E000-FFFF
U1101	E000-EFFF		
U1100	F000-FFFF		

Input Control 4

There are seven input lines from the analog boards. These pass information to the microprocessor via U1420, an 8 bit, tristate buffer.

Six of the seven inputs lines are status bits from the three supplies. These consist of two lines for each supply, a current and voltage regulation line. The status bits tell the microprocessor whether the supplies are in voltage or current regulation or unregulated. The seventh bit is a high power indicator. This informs the microprocessor that the PS 5010 is in the high power compartment of the power module.

System RAM 4

System RAM consists of U1300 and U1302. These provide temporary operating memory. These RAMs are 1024 x 4 bit arranged in a 1024 x 8 bit pattern at address 0000-03FF. These are fully static devices.

Keyboard ◇4◇ ◇6◇

The front panel of this instrument has 20 momentary contact SPST pushbutton switches shown on schematic 6. These buttons are arranged in a 4 x 5 matrix. They are encoded by U1421 shown on schematic 4. This device is a CMOS 20 key encoder. Scanning and debouncing circuitry are included on this chip. Also included on U1421 is an internal RAM that stores the last key pressed, even after the key is released. The output of U1421 is tristate and is placed directly on the data bus. When a key is pressed, pin 13 (data available) goes high. This signals the microprocessor that a keyboard entry has been made.

Output Control ◇4◇ ◇5◇

The CPU board outputs nine bits to the two analog boards. Four of the nine bits are the two clock and two data lines from U1411. The microprocessor programs the voltage and current DACs in serial format through these four bits. These lines go to shift registers on the analog boards.

The logic and floating supply output relays are controlled via U1411 pin 7 and U1315 pin 11, respectively, shown on schematic 5.

The data strobe line that transfers the shift register bits to the DACs is pin 10 of U1315 shown on schematic 5. Pins 7 and 9 of U1315 have control over the floating supply mode relays. These set the overhead voltage for either the high or low output voltage mode.

Front-Panel Display ◇4◇ ◇5◇ ◇6◇

The front panel of this instrument has nine 7-segment LEDs shown on schematic 6. The negative and positive supply LEDs (the first 6 counting from left to right) are multiplexed by U1400, shown on schematic 5. This multiplexer is a 6 digit BCD display controller and driver. This device has six RAM locations. These are selected by pins 26, 27, and 28. These RAMs contain the information that is written on the seven-segment LEDs. This device has an internal oscillator that runs at approximately 300 Hz. The display refreshing is automatically accomplished without intervention from the processor.

The first six common cathode seven-segment LEDs are driven from U1400 through transistors Q1040, Q1132, Q1131, Q1121, Q1120, and Q1122, shown on schematic 6. Pin 16 of U1400 is used for duty cycle brightness control. By varying the duty cycle of the waveform at pin 16, the displays are dimmed when the unit is in the program mode.

The duty cycle is controlled by U1301 (shown on schematic 5), a data selector and U1315, an addressable latch. When the microprocessor calls for a bright digit, it writes a logic 1 on U1315, the gates a logic 0 through U1301 to the display controller IC. If the microprocessor writes a logic 0 to U1315, the data selector gates a 20 kHz, 40% duty cycle signal to the display controller IC causing the seven-segment LEDs to dim.

The remaining three seven-segment LEDs are multiplexed by U1410. This integrated circuit is similar to U1400, except each LED segment is controlled independently rather than with BCD data. This multiplexer scans at a 500 Hz rate and is capable of driving four seven-segment LEDs. The LEDs that are equivalent electrically to the fourth segment are the AMPS and VOLTS lights for the three supplies, the ERROR and the NOT ENTERED lights. The three AMPS and VOLTS LEDs are either on, off, or flashing. The NOT ENTERED and ERROR LEDs are either off or flashing. To achieve the flash capability, bus $\phi 2$ is divided to 1.2 Hz by U1322 and U1221. This 1.2 Hz square wave is gated by an addressable latch, U1314, and fed to U1412, an octal buffer. To flash the LED, the M6800 writes a logic 1 into U1410 and a logic 1 into U1314. IC U1314 acts as a switch through AND gates U1321, U1323B, and U1321C. These pass the 1.2 Hz square wave to the cathodes of the LEDs. When the microprocessor writes a logic 0 into U1314, the flashing stops and the LED is continuously on.

The remaining three LEDs (REMOTE, ADDRESSED, and OUTPUT ON) are controlled by addressable latch U1411 shown on schematic 4. The REMOTE and ADDRESSED LEDs are illuminated with logic 0 into U1411. The OUTPUT LED is illuminated with a logic 1.

Ground Referenced Circuits ◇7◇

The +26 V from the mainframe is applied at interface pins 12A and B. This voltage passes through F1340 to the collector of Q1440. The base of Q1440 is set at about +16 V by VR1341. +15 V is available at the emitter of Q1440. The −26 V from the mainframe passes through F1341 to the collector of Q1441. The base of Q1441 is set by VR1340 at about −16 V. −15 V is available at the emitter of Q1441. +8 V from the mainframe passes through F1250, and is filtered by L1240, C1120 and C1231. A crowbar circuit is formed by Q1240. An RC time constant at the gate of Q1240 is formed by R1130 to C1230 and R1132. Drive for the crowbar is provided by Q1130 and Q1230. If either the +5 V at the emitter of Q1230 or logic supply sense at the emitter of Q1130 goes more than ≈700 mV positive than the base voltage, the respective transistor turns on. This action fires Q1240, which opens the input fuse or trips the mainframe current limit.

Five relays and drivers are shown on this schematic. They are the floating supply output relay, floating supply sense relay, logic supply output relay, + mode relay and −

mode relay. Each relay is operated from +26 V, except +5 V is used for the floating supply sense relay. The relay coils are in series with the collectors of the driving transistors. The relay contacts are shown on other schematics indicated by the numbers in the diamonds. The emitters of the logic supply output relay driver, Q1630, and the floating supply output and sense relay driver, Q1440, are connected together and to the collector of Q1729. This transistor is turned on by the power on (PWR) signal from the mainframe via rear interface pin 6B. This transistor keeps the output relays open during power up.

Also shown on this schematic are four of the seven optoisolators. These four isolators form the loop status translators. These devices isolate the floating circuitry from the ground reference CPU circuitry. Contact 11 of the high power compartment switch S1600 connects to contact 10 to provide a low when the unit is plugged into a high power compartment in the power module. This signal tells the CPU at turn on that the instrument is plugged into a high power compartment.

Logic Supply 8

Input information from the CPU for the digital-to-analog converters comes in serial form over the data, strobe, and clock inputs. This information passes to shift and store registers U1841 and U2041. These registers contain an output latch. The output of the shift register is transferred to the output latch on the rising edge of the strobe input. The output of the latches goes directly to the voltage and current digital to analog converters U2040 and U1840. The output stage of the DACs is the collector of a transistor which has a large voltage compliance.

The reference voltage is obtained through the ± reference inputs. These inputs (pins 14 and 15) connect directly to the summing nodes of an internal amplifier. When the DAC is functioning properly, the reference inputs are at the same voltage. The − input goes directly to the summing amplfier input, which has a high input impedance. The + input serves as a current reference to set the current sources inside the DAC. The current flowing into this input is equal to the current derived from the voltage drop across R2040 or for the current DAC, R1940. This voltage is derived from the voltage across VR2050. The ground reference for both DACs is a ground sense line connected to pin 1 of U1741A.

The reference voltage is generated across 6.2 V temperature compensated Zener diode VR2050. Constant current is provided by Q2050 with associated components. R1746 sinks this current into −15 V, minimizing the loading on follower U1741A. A voltage divider consisting of R1944, R1945, R1943, and R1950 provides 4.5 V at pin 5 of U1741B. This operational amplifier is a current to voltage converter for the logic supply. As this converter is referenced to 4.5 V, it effectively sums the current information from the DAC with the 4.5 V reference, thus creating a voltage between 4.5 V and 5.5 V at pin 7 of U1741B. The output of U1741B passes to the + input of U1740, which serves as a voltage error amplifier. The V+ sense line connects to the − input of U1740. The sense line is clamped by CR1110, CR1111, and CR1113 to the voltage output line. These diodes prevent the sense line from going more than one diode drop from the output line. This prevents damage to U1740 should the sense line be misconnected. The output of U1740 is clamped to the input through VR1741 and VR1740. These diodes form a window within which the error amplifier operates. If this amplifier is unbalanced, the output attempts to go to the + or − supply voltage. These diodes clamp the output at approximately +10 V or −2 V preventing amplifier output stage saturation. This speeds up recovery times.

The output of the voltage error amplifier passes through CR1740 and to the emitter of Q1650. The base to emitter junction of this transistor is used as a simple diode. The collector of this transistor provides status information concerning loop balance. The output of current error amplifier U1640 is ORd with the voltage error amplifier output at the base of Q1650 through CR1531. This information passes to the base of Q1400, which in turn drives the base of the series pass-transistor.

The output of U1740 also drives the base of Q1731. This is done to determine the balance status information of the voltage loop amplifier. When both Q1650 and Q1731 are conducting, the base of Q1640 is low. This causes a high at the collector of Q1640 that tells the CPU the voltage loop amplifier is balanced.

The output current flows through series pass-transistor Q1200, through the current sense resistor R1300, the 6 A fast blow fuse, through the output relay, and to the supply output.

The current DAC acts as a constant current sink to create a constant voltage across R1841. The + input to U1640 is the voltage drop acrosss R1300, the current sense resistor in the output circuit. If the output current exceeds the selected current limit, pin 3 of U1640 goes more negative than pin 2. This causes pin 6 to go more negative, reducing the conduction of the series pass-transistor until the current is at the selected limit. The output of U1640 also passes through divider R1631 and R1630 to the base of Q1730. The collector of Q1730 provides current loop balance information to the CPU. Whenever the current loop is in balance, U1640 has an output voltage of 6 V or less. This voltage is insufficient to turn Q1730 on. The collector, therefore, is at +5 V.

Fold-back current limit is provided by U1540. IC U1540 functions similar to current error amplifier U1640, except the reference voltage is related to the supply output voltage. This reference is produced by divider network R1541, R1542, and R1543. With an output voltage of 4 V, the current limit is about 3 A. At 0 V, output current limit is less than 1 A.

Floating Supply Rectifiers and Filters ◇9◇

Each of the floating supplies in the PS 5010 has two internal operating modes. These are the high voltage and low voltage modes. Output voltages from 0 V to 32 V are available in the high voltage mode, and 0 V to 15 V in the low voltage mode. The operating mode is determined by the programmed current limit. Low voltage mode above 400 mA in a standard mainframe compartment occurs with current limits, and above 750 mA in a high power compartment.

The + and − floating supply voltages come from four isolated 25 V ac windings located in the power module. As shown on the schematic, only the center two windings supply current in the low voltage modes. The maximum current available from these supplies depends on whether the plug-in is in a high power or standard compartment.

The return for the + supply is ground 3, and the return for the − supply is ground 4. These grounds are connected through current sensing resistors R1104 and R1105 to form the output common (ground 1). Grounds 3 and 4 are used throughout the circuitry to avoid generating errors in the current limit. Current drawn from any positive voltage and returned through ground 3 doesn't affect either current limit. Current drawn from ground 4 and returned through any negative voltage will not affect either current limit; however, any current drawn from the + output must return through the + sense resistor. The same occurs in the negative supply.

The ac from the power module is fused and passes to four bridge rectifiers. C1710, C1620, C1711, and C1910 reduce commutation noise entering the dc bus. The two diodes shown before the bridge rectifiers supply additional voltage for the base drive regulators as described later. After passing through the bridge rectifiers, the pulsating direct current is filtered by a choke input filter. Chokes L500A and L500B, as well as L510A and L510B, are mutually coupled.

The collector voltage for the series pass-transistors in the mainframe is relay switched depending on the output voltage mode selected. Relays K1510 and K2010 switch the collector and base drive voltages for the series pass-transistors. The supplies are stacked to obtain the higher dc voltages.

Base drive for the + supply series pass-transistor is provided by emitter followers Q1500 in the high voltage mode and Q1501 in the low voltage mode. Transistors Q2000 and Q1900 perform the same function for the − supply. Correct base voltages for these transistors are provided by Zener diodes VR1501 and VR1600 and in the − supply, VR2000 and VR1800. Constant current for these Zeners is provided by Q1600 and VR1500 (Q1901 and VR1900 in the − supply).

A constant current load for the + collector supply is provided by current source Q1800, R1811, and VR1701 (Q1700, R1711, and VR1700 in the − supply). A constant current of about 25 mA flows from Q1800 to the − supply output. Likewise, 25 mA flows from the + supply output, through Q1700, into the − collector supply. The positive current source is connected to the anode of CR1800. The negative current source is connected to the cathode of CR1700. When the supplies power down, the regulator ceases operation before the filter capacitors fully discharge. CR1800 becomes a positive current source and CR1700 a negative current sink. These diodes provide an alternate discharge path for capacitance in the opposite polarity supply during shutdown.

Floating Supply Digital-to-Analog Converter Circuits ◇10◇

The data, clock, and transfer strobe are applied to optoisolators U1030, U1041, and U1042. These isolators are necessary, as the CPU circuitry is referenced to chassis ground and the floating supply circuitry is not. The output of the optoisolators drives the emitters of level shifting transistors Q1140, Q1141, and Q1142. The base current for these transistors is provided by Q1143 with associated components. The output voltage of this emitter follower is 2 V. These level shift transistors permit higher speed operation for the transistors in the optoisolators, as only a small voltage change is required at the collectors of the optoisolator transistors.

The registers U1140, U1240, U1241, U1121 and U1242 are shift-and-store devices similar to the ones used in the logic supply. The serial data input is accumulated in time with the clock pulse inputs. When the transfer strobe pulse occurs, the registered data transfers to the device's internal latches. A total of 37 output bits are used. Bits 33 through 36 pass to the FET gain switches shown on schematics 11 and 12. Bit 37 disables the voltage reference. The remaining bits go directly to the digital-to-analog converters.

Four DACs are used in this circuit. The − current reference is generated by U1221 and U1111A. The + current reference is generated by U1230 and U1111B. The + voltage reference is generated by U1130 and U1330B, while the − voltage reference is generated by U1231 and U1330A.

Internally, all four DACs employ a current reference driving a ladder network. Each bit drives a binary weighted current switch that steers the current into either Iout or $\overline{\text{Iout}}$. The negative current sources (pins 2 and 4) in U1221 and U1230 are transistor collectors. This gives the Iout terminal a voltage compliance of −10 V to +18 V. The current sources in voltage DACs U1130 and U1231 are taps on the passive ladder network thus requiring termination of Iout and $\overline{\text{Iout}}$ into exactly the same voltage as the ladder ground (pin 3). The reference for the current DACs U1221 and U1230 is provided by VR1111. The reference current is determined the same as in the logic supply DACs, as previously described. However, in the floating supply, voltage divider R1100 and R1101 program the logic threshold of U1221 and U1230 to match the shift register output.

The entire voltage DAC reference circuit tracks the common sensing input (ground 2). A +6.2 V reference is generated by temperature compensated Zener VR1340. The Zener diode is driven by constant current source Q1340, R1347, R1346, and VR1341. R1530 sinks about the same current from ground 2 (common sensing input) to −15 V, minimizing the loading on the common sensing line. The current source is off when the reference disable line is high. When the current source is off, R1349 pulls the reference voltage negative. Diode CR1340 then clamps this level at about −700 mV. The reference is disabled during the output off sequence.

The reference voltage is buffered by U1330C and inverted by U1330D. The resulting + and −6.2 V drive the reference inputs of voltage DACs U1130 and U1231. Both voltages also drive a divider network with four zero adjustments. R1335 and R1334 null out the offset voltage in the +V and −V current to voltage converters, U1330B and U1330A respectively. To meet differential linearity specification (step size accuracy), this voltage must be nulled to ≤200 μV. R1345 and R1344 are zero adjustments for the + and − output voltage.

R1340 and R1327, along with C1231 and C1230, are compensation networks for the current to voltage converters. Schottky diodes CR1130 and CR1220 protect the Iout outputs from negative excursions on power up. The current to voltage converter feedback to resistor is connected to pin 16 inside the DAC.

The output of the − current DAC is converted to voltage via U1111A. The zero adjust for this converter is R1321 in conjunction with the associated resistive dividers. These dividers operate between +15 V and −15 V. Current to voltage conversions for the + current DAC is provided by R1211 and R1210. The 0 adjust for this converter is provided by R1311. This signal is buffered by unity gain follower U1111B.

+ Floating Supply 

The output of the + current DAC connects to pin 3 of U1100. The + current sense from sensing resistor R1104 connects to pin 2 of U1100. As the supply output current increases, the voltage at pin 2 of U1100 goes more negative with respect to the output common (ground 1). When the current sense voltage equals the current DAC voltage, the output, pin 6, of U1100 goes positive. This signal, along with the − voltage error amplifier output, increases conduction in Q1402. This lowers the base voltage on Q1401, Q1400, and the two series pass-transistors in the power module, resulting in a lower output voltage.

To set the output voltage, the +V sense is combined through a resistive divider consisting of R1533, R1545, R1543, R1542, R1544, and R1541 with the negative voltage from the +V DAC. If the 10 V range is selected, Q1640 is on and Q1641 is off. If the 32 V range is selected, Q1641 conducts, selecting the 32 V divider to be applied to pin 3 of U1420. The voltage at pin 2 of U1420 comes from R1345 and has a range of ±20 mV from the common sensing point. When a change in output load lowers the output voltage, the sense line voltage lowers the common input of dividers R1533 and R1541. This lowers pin 3 of U1420, which reduces conduction in Q1402. This action raises the base voltage of Q1401, which tracks through the Darlington triple output stage increasing the output voltage. CR1420 and VR1420 prevent saturation and slow recovery of U1420 in under and over-voltage conditions. The + sense line is connected to the + output terminal through CR1500 and CR1510. These diodes prevent the sense line from moving more than one diode drop from the + output bus. The emitter of Q1400 is connected to pin 3 of U1420 through C1410. This capacitor provides high frequency compensation for the amplifier.

A 10 ΩF capacitor, C1531, is connected from the + output terminal to common. A current sink contributes stability and provides a rapid discharge path for C1531.

S1500 selects the front panel or the rear interface outputs and sense lines. The unused ports are floating.

The emitters of the series pass-transistors are balanced through R1622, R1611, and R1612. When the power supply is operated in the standard compartment of a power module, the high power switch S1600A is open. The emitter resistor for the high power series pass-transistor is 0.75 Ω (R1611). In the high power compartment, S1600A is closed, shunting R1611 with R1612. This increases the current through the high power transistor to approximately two times that passing through the standard transistor.

The + voltage loop balance comparators U1110C and U1110D connect to the output of U1420. The output of the current error amplifier, U1100, connects to the inputs of U1110A and U1110B. A voltage divider formed by R1122, R1120, and R1121, connected between the +15 V and −15 V, provides a +8 V and −8 V comparison voltage for the + loop balance comparators. These comparators have open collector outputs. As long as the inputs to these comparators, from the voltage and current error amplifiers, remain within the window +8 V to −8 V, the outputs will remain high. These voltages are the normal window for balanced operation under worst case conditions. When a loop is unbalanced, the output of its comparator is approximately −15 V. The output of these comparators drive the opto-isolators shown on diagram 7.

Negative Floating Supply 

Except for value changes in frquency compensation networks, the negative supply is identical to the positive supply. Circuit operation is identical.

CALIBRATION

PERFORMANCE CHECK PROCEDURE

Introduction

This procedure checks the electrical performance requirements as listed in the Specification section in this manual. Perform the internal adjustment procedure if the instrument fails to meet these checks. If recalibration does not correct the discrepancy, circuit troubleshooting is indicated. Also, use this procedure to determine acceptability of performance in an incoming inspection facility. For convenience, many steps in this procedure check the performance of this instrument at only one value in the specified performance range. Any value within the specified range, within appropriate limits, may be substituted. The performance check may be done at any ambient temperature between 0°C and +50°C.

Test Equipment Required

The test equipment listed in Table 5-1, or equivalent, is suggested to do the performance check or the adjustment procedure.

All steps in the Performance Check procedure may be performed with the PS 5010 in the power module. All steps except source effect and transient recovery may be performed with the instrument connected to the power module through extender cables. See heading Adjustment Access in Internal Adjustment procedure later in this section for information on extender cables.

CAUTION

Some steps in this procedure require resistors connected to the front panel terminals. These resistors can become hot under certain conditions. Do not touch the resistors or allow them to contact the instrument front panel or other material easily damaged by heat.

Table 5-1
SUGGESTED TEST EQUIPMENT

Description	Minimum Requirements	Performance Check Step	Adjustment Procedure Step	Recommended Equipment
TM 5006 Power Module	High power compartment required in steps 7, 10	All steps. High power compartment required in steps 7 and 10	All steps. High power compartment required in steps 10, 11, 12	
Digital Multimeter	0 Vdc to 32 Vdc, <0.1%, 0 A to 2 A, <0.3%, 0 Vac to 1 Vac true rms	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 20, 21	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,12	TEKTRONIX DM 501A
Variable voltage transformer	1000 VA capability	1, 2, 14, 16		VARIAC WIOMT3W Autotransformer, General Radio USA.
Oscilloscope	5 mV/div, differential capability, 20 Hz to 20 MHz with 20 MHz bandwidth limit switch	5, 6, 7, 12, 13, 18, 19		TEKTRONIX 7A26 Amplifier, two 1x probes, with 7000-series mainframe and timebase.
Resistor	5 Ω, 5%, 25 W	4, 6, 10, 12, 13, 17, 19		Tektronix Part No. 308-0177-00
Resistor	560 Ω, 5%, 3 W	11		Tektronix Part No. 308-0298-00
Resistor, special four terminal	0.1 Ω, 0.1%, 3 W		2	Tektronix Part No. 308-0769-00
Resistor	45 Ω, 5%, 25 W	7		2 ea. Tektronix Part No. 308-0744-00
2A spst switch		6, 11, 19		
Patch cords		1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 20	1, 4, 5, 6, 7, 8, 9, 10, 11, 12	Tektronix Part No. 012-0031-00 red and 012-0039-00 black
Extender cables			All steps	2 ea. Tektronix Part No. 067-0645-02
Various values of resistance as chosen	Sufficient wattage rating	20		
Miscellaneous test connectors and leads		As required	As required	
Controller		22		TEKTRONIX 4050 series or desktop computer, TEKTRONIX 4041 computer/controller
GPIB cable		22		As required

PERFORMANCE CHECK SUMMARY SHEET

This sheet may be duplicated and used as a short form performance check procedure. Perform the check and record the reading in the "Measured" column. Compare the reading with the upper and lower limits. After maintenance or adjustment again perform the procedure and compare the readings.

Date _____

Serial Number _____ Tested by _____

Step	Description	Minimum	Measured	Maximum

1. Check Constant Voltage Range and Overall Accuracy

a. Make certain the power module is set to the correct line voltage.

b. Set the variable voltage transformer to nominal line voltage.

c. Connect the power module through the variable voltage transformer to the supply.

d. Connect the dvm to the front panel POSITIVE and common terminals.

e. Turn on the mainframe. Make certain the OUTPUT is ON.

f. Make certain the display for the POSITIVE supply is set for 0.00 V.

g. CHECK—for a dvm reading from −0.020 V to +0.020 V.

h. Press the following buttons in the order listed:

SUPPLY SELECT
POS
3
2
ENTER

i. Make certain the OUTPUT is ON.

j. CHECK—that the dvm reads from 31.82 V to 32.18 V.

k. Remove the POSITIVE connection from the PS 5010 front panel.

l. Connect this POSITIVE lead to the PS 5010 front panel NEGATIVE connector.

m. Press the following buttons in the order listed:

SUPPLY SELECT
NEG
0
ENTER

n. Make certain the OUTPUT is ON.

o. CHECK—that the dvm reads from −0.020 V to +0.020 V.

p. Press the following buttons in the order listed.

3
2
ENTER

q. CHECK—that the dvm reads from −32.18 V to −31.82 V.

r. Leave these connections for the next step.

2. Check Source Effect

a. Connect the dvm to the POSITIVE or NEGATIVE front panel connectors.

b. Determine the selected line voltage range of the power module.

c. With the power module connected to the variable voltage transformer, lower the voltage to the lower limit for the selected line voltage tap used.

d. Program the PS 5010 for any voltage POSITIVE or NEGATIVE within the range of the instrument.

e. Note the displayed voltage on the dvm.

f. Change the variable voltage transformer to the maximum for the line voltage range used.

g. CHECK—that the dvm display reads within 0.01% +2 mV from the reading noted in step e.

h. Repeat Source Effect check for the other floating supply.

i. Leave these front panel connections for the next step.

@

3. Check Step Size (Resolution)

a. Connect the POSITIVE connector through a jumper to the dvm positive input terminal.

b. Connect the front panel common terminal to the dvm common terminal.

c. Press the following buttons in the order listed:

SUPPLY SELECT
POS
5
.
1
1
ENTER

d. Make sure the OUTPUT is ON.

e. Record the dvm reading.

f. Press the INCREMENT ↑ button for one step change.

g. CHECK—that the dvm reads from 0 mV to +20 mV from the reading taken in step e.

h. Press the following buttons in the order listed:

2
0
ENTER

i. Record the dvm reading.

j. Press the INCREMENT ↑ button for one step change.

k. CHECK—that the dvm reads from +0.060 V to +0.140 V from the reading obtained in step i.

l. Remove the connector to the POSITIVE front panel terminal and connect it to the NEGATIVE front panel terminal.

m. Press the following buttons in the order listed:

SUPPLY SELECT
NEG
5
.
1
1
ENTER

n. Record the dvm reading.

o. Press the INCREMENT ↑ button for one step change.

p. CHECK—that the dvm reads from 0 mV to −20 mV from the reading obtained in step n.

q. Press the following buttons in the order listed:

2
0
ENTER

r. Note the dvm reading.

s. Press the INCREMENT ↑ button for one step change.

t. CHECK—that the display reads from −60 mV to −140 mV more negative than the reading obtained in step r.

u. Leave these connections for the next step.

4. Check Load Effect

a. Make certain the OUTPUT is OFF.

b. Connect the dvm directly to the front panel POSITIVE and common connectors.

c. Press the following buttons in the order listed:

SUPPLY SELECT
POS
5
ENTER
CURRENT
1
.
6
ENTER

d. Turn the OUTPUT ON.

e. Note the dvm reading (4.990 V to 5.010 V).

f. Turn the OUTPUT OFF.

g. Connect the 5 Ω resistor from the front panel POSITIVE terminal to the front panel common terminal.

h. Turn the OUTPUT ON.

i. CHECK—the dvm for a reading of ≤10 mV from the reading noted in step e.

CAUTION

To prevent resistor overheating do not leave the resistor connected for longer than necessary to make the check.

j. Repeat steps a through i for the NEGATIVE supply. Substitute the word NEGATIVE for POSITIVE in these steps. All tolerances and voltages are identical except for the sign change.

k. To verify the rear interface output load effect see Fig. 5-1.

l. All entered values are identical.

m. Change the front-rear switch on the rear panel of the instrument to rear.

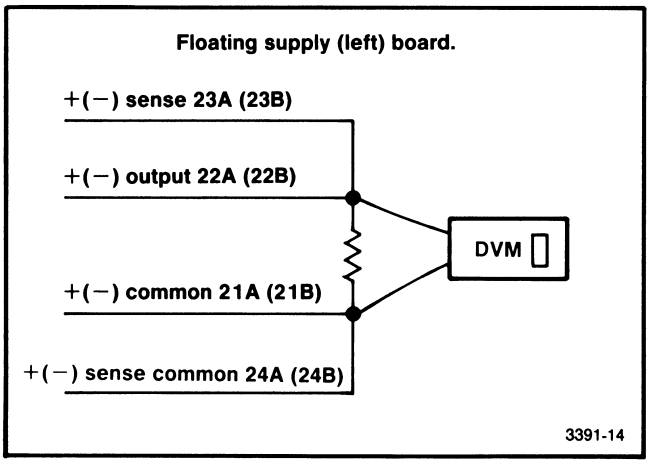

Fig. 5-1. Connections for rear interface load effect check. Dvm must be connected to same point as sense lines.

n. Connect the resistor and dvm as shown in the figure. Connections for the negative supply are shown in parenthesis.

o. Use the same control settings as listed previously.

p. The tolerance for the rear output load effect is ≤1 mV.

q. Remove all connections for the next step.

r. Change the front-rear switch to front panel output.

5. Check PARD (ripple and noise)

a. Connect the POSITIVE connector to the dvm ac input.

b. Connect the common to the dvm low terminal.

c. Set the dvm for ac true rms.

d. Select any specified voltage and current combination for the POSITIVE floating supply.

e. Make certain the PS 5010 OUTPUT is ON.

f. Allow up to 30 s for the dvm to stabilize.

g. CHECK—that the dvm display reads ≤1 mV rms.

h. Connect the oscilloscope vertical input to the front panel POSITIVE and common terminals through a 1X probe.

i. Ac couple the oscilloscope input. Set the bandwidth limit to 20 MHz.

j. CHECK—that the oscilloscope reads ≤10 mV peak-to-peak.

k. Repeat this check for the NEGATIVE floating supply. The specifications are identical.

l. Remove these connections for the next step.

6. Check Load Transient Recovery

a. Make certain the OUTPUT is OFF.

b. Connect the test fixture shown in Fig. 5-2 to the front panel common and POSITIVE output connectors.

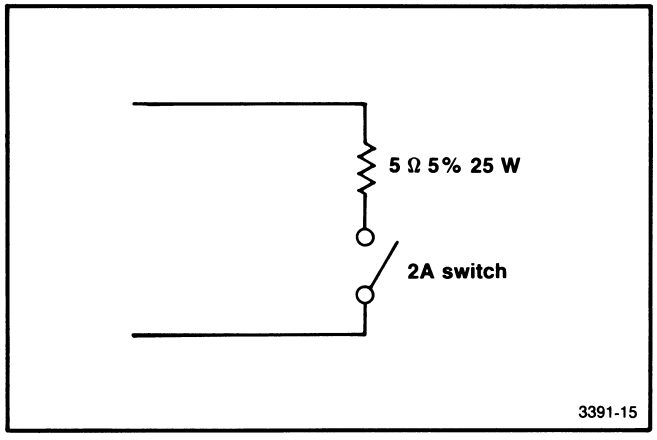

Fig. 5-2. Test fixture for load transient recovery.

c. Connect the oscilloscope to the front panel POSITIVE and common connectors.

d. Set the oscilloscope for ac coupled vertical input and the sweep speed to measure approximately a 500 μs waveform (20 mV/div and 100 μs/div).

e. Set the front panel pushbuttons for a 5 V 1.6 A output voltage.

f. Alternately open and close the switch in series with the 5 Ω load.

g. Adjust the oscilloscope triggering so that the transient waveform during switch opening and closing is visible on the oscilloscope display. See Fig. 5-3.

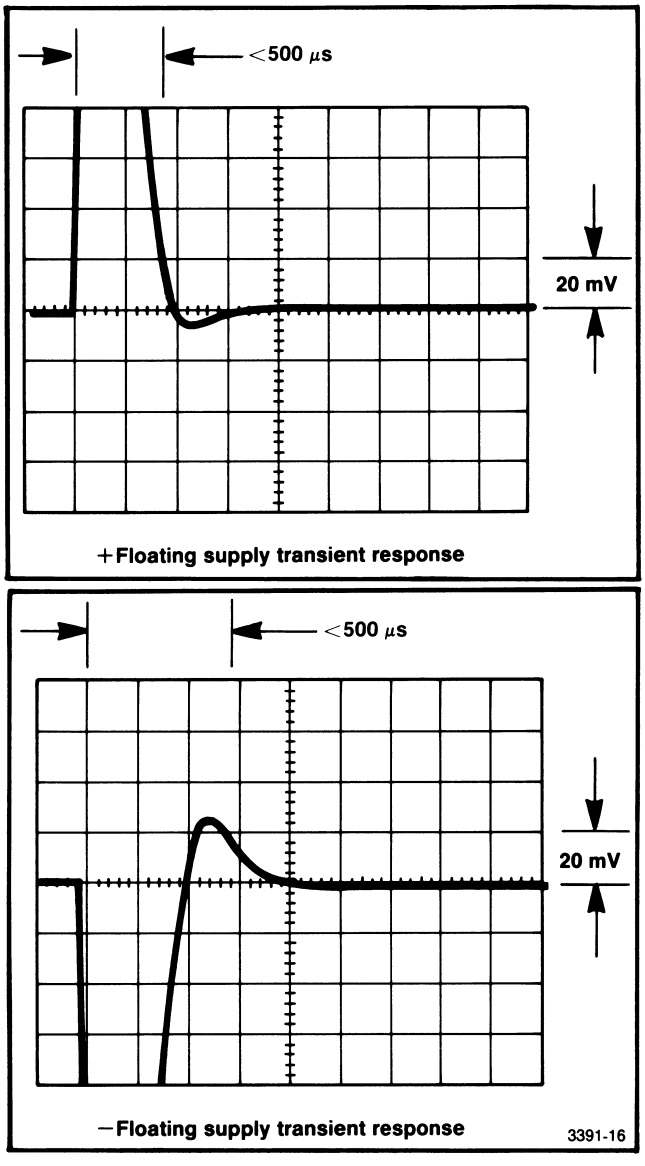

Fig. 5-3. Load transient recovery waveforms.

h. CHECK—that the time required for the waveform to return within 20 mV of the voltage before the switch is opened is ≤500 μs.

i. Repeat these steps for the NEGATIVE floating supply. All steps are identical with exception of the sign change. See Fig. 5-3.

j. Remove these connections for the next step.

7. Check Voltage Change Response Time

a. Make certain the PS 5010 is installed in the high power compartment of the power module.

b. Make certain the OUTPUT is OFF.

c. Press the following buttons in the order listed:

SUPPLY SELECT
TRACK
CURRENT
.
7
5
ENTER
VOLTAGE
0
ENTER

d. Connect an oscilloscope to the front panel POSITIVE and common terminals.

e. Turn the OUTPUT ON.

f. With 0 V output from the PS 5010, set the oscilloscope controls for dc input to the vertical amplifier and to trigger on a +32 V leading edge.

g. Press the 3 and the 2 pushbuttons.

h. While viewing the oscilloscope, press the ENTER button.

i. Note the 0 to 100% risetime of the waveform.

NOTE

It may be necessary to go from 0 V to 32 V several times to obtain proper oscilloscope triggering. This can be accomplished by pressing the OUTPUT ON/OFF pushbutton.

j. CHECK—that the time from 0 V to 32 V is ≤1 ms.

k. Retrigger the oscilloscope for a negative-going waveform from 32 V to 0 V.

l. CHECK—that the time from 32 V to 0 V is ≤20 ms.

m. Turn the OUTPUT OFF.

n. Connect a 45 Ω 25 W resistor across the POSITIVE and common front panel connectors.

o. Repeat steps e, f, g, h and i.

p. CHECK—for a 1 ms risetime from 0 V to +32 V.

q. Repeat steps k and l.

r. CHECK—for a falltime of ≤1 ms.

s. Repeat this entire procedure for the NEGATIVE supply. Substitute NEG for POS and use the NEGATIVE and common front panel connections.

t. Increase for the NEGATIVE supply means a larger absolute value.

u. Remove these connections for the next step.

8. Check Constant Current Range and Overall Accuracy

NOTE

The voltage selected in performing this check must be sufficient to force the selected current through the internal resistance of the current meter and associated leads.

a. Connect the front panel POSITIVE and common terminals to the digital current meter.

b. Select the POSITIVE supply and any voltage within the specified voltage range.

c. If the power module is in a high power compartment, select any current from 50 mA to 0.750 A.

d. If the power module is in a standard compartment, select any current from 50 mA to 400 mA.

e. CHECK—that the current meter reads within ±(5% +20 mA) of the selected current.

f. If the power supply is in the high power compartment, select any voltage from 15 V or less. See previous note.

g. Select any current from 1.6 A or less.

h. CHECK—that the current meter reads within ±(5% +20 mA) of the current selected.

i. If the power module is in a standard compartment, select any voltage from 15 V or less.

j. Select any current from 0.750 A or less.

k. CHECK—that the current meter reads within ±(5% +20 mA) of the current selected.

l. Repeat steps a through k for the NEGATIVE supply. Change the POSITIVE to NEGATIVE. The voltages, currents and tolerances remain the same. Only the sign changes.

m. Leave these connections for the next step.

9. Check Constant Current Step Size

a. Turn the OUTPUT OFF.

b. Connect the current meter to the front panel POSITIVE and common terminals.

c. Select any voltage within the range of the instrument. The selected voltage must be sufficient to force the selected current through the internal resistance of the current meter and associated leads.

d. Select any current within the specified range of the instrument.

e. Turn the OUTPUT ON.

f. Note the current meter reading.

g. Change the current output up or down by 50 mA.

h. Note the new meter reading.

i. CHECK—that the second reading is from 35 mA to 65 mA from the reading obtained in step f.

j. Repeat the above steps for the NEGATIVE supply.

k. Leave these connections for the next step.

10. Check Constant Current Source Effect

a. Make certain the PS 5010 is in the high power compartment.

b. Make certain the OUTPUT is OFF.

c. Connect a current meter from the front panel POSITIVE connector to the common connector.

d. Set the PS 5010 for 15 V output at 1.6 A.

e. Turn the OUTPUT ON. Allow the PS 5010 to stabilize for 1 minute before proceeding.

f. Vary the line voltage to the power module from the lower limit to the upper limit for the nominal line voltage used.

g. CHECK—that the current meter changes ≤1 mA while changing the line voltage.

h. Repeat steps a through g for the NEGATIVE supply. All values except for the sign change remain the same.

i. Remove these connections for the next step.

11. Check Constant Current Load Effect

a. Turn the PS 5010 OUTPUT OFF.

b. Connect the test setup as shown in Fig. 5-4 to the POSITIVE and common front panel terminals.

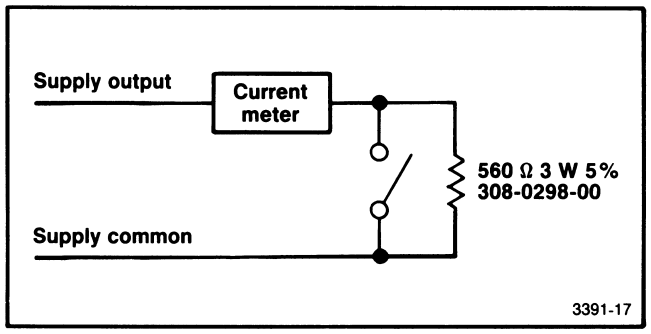

Fig. 5-4. Test setup for checking load effect in the constant current mode.

c. Set the POSITIVE supply for 32 V at 50 mA current limit.

d. Open the switch on the test setup.

e. Turn the OUTPUT ON.

f. Note the current on the current meter.

g. Close the switch on the test setup.

h. CHECK—that the current deviates ≤10 mA from the reading taken in step f.

i. Turn the OUTPUT off.

j. Repeat the procedure for the NEGATIVE supply. All specifications remain the same.

k. Remove these connections for the next step.

12. Check Constant Current PARD

a. Turn the OUTPUT OFF.

b. Connect a known value resistor across the front panel POSITIVE and common terminals. The suggested value is 5 Ω with sufficient wattage for the current limit desired.

c. Connect the oscilloscope across the resistor. Ac couple the vertical input and limit the bandwidth to 20 MHz.

d. Select the current limit desired with sufficient voltage to force the supply into current limit.

e. Using Ohms law, determine the vertical deflection of the oscilloscope necessary to conveniently read a current change of 10 mA through the resistor.

f. Turn the OUTPUT ON.

g. CHECK—that the peak-to-peak current variations through the resistor are less than or equal to 10 mA peak-to-peak.

h. Turn the OUTPUT OFF.

i. Remove the resistor and oscilloscope from the front panel terminals.

j. Connect the current meter directly across the front panel POSITIVE and common terminals.

k. Turn the OUTPUT ON.

l. CHECK—for ≤5 mA rms for the supply in current limit.

m. Repeat this procedure for the NEGATIVE supply. Specifications remain the same.

@

n. Remove these connections for the next step.

13. Check Current Change Response Time

a. Make certain the OUTPUT is OFF.

b. Connect the 5 Ω resistor from the front panel POSITIVE connector to the common connector.

c. Connect the oscilloscope across this resistor. Dc couple the vertical amplifier.

d. Set the POSITIVE supply for 32 V.

e. Set the POSITIVE supply for 50 mA.

f. Turn the OUTPUT ON.

g. Change the front panel setting to 0.75 A.

h. Adjust the oscilloscope to trigger on the rising waveform.

i. Change back and forth from 50 mA to 0.75 A until the entire rising waveform is visible on the oscilloscope. Use the OUTPUT ON/OFF switch to properly set the oscilloscope trigger.

j. CHECK—that the risetime of the waveform from 0.25 V to 3.75 V is ≤20 ms.

k. Switch the supply from 0.75 A to 50 mA.

l. Change the oscilloscope to trigger on the falling waveform.

m. CHECK—that the time for the voltage to decrease from 3.75 V to 0.25 V is ≤20 ms.

n. Turn the OUTPUT OFF.

o. Repeat the procedure for the NEGATIVE supply. The absolute values are identical.

p. Remove these connections for the next step.

14. Check Logic Supply Constant Voltage Range and Overall Accuracy

a. Make certain the OUTPUT is OFF.

b. Connect the dvm to the front panel LOGIC and ground terminals.

c. Connect the power module through the variable voltage transformer to the supply.

d. Set the variable voltage transformer to nominal line voltage.

e. Make certain the power module is set to the correct line voltage.

f. Press the following buttons in the order listed:

SUPPLY SELECT
LOGIC
4
.
5
ENTER

g. Turn the OUTPUT ON.

h. CHECK—that the dvm reads from 4.45 V to 4.55 V.

i. Press the following buttons in the order listed:

5
.
5
ENTER

j. CHECK—that the dvm reads from 5.45 V to 5.55 V.

k. Leave these connections for the next step.

15. Check Logic Supply Step Size (Resolution)

a. Connect the LOGIC and ground connectors to the dvm input terminals.

b. Press the following buttons in the order listed:

SUPPLY SELECT
LOGIC
5
.
1
1
ENTER

c. Make sure the OUTPUT is ON.

d. Record the dvm reading.

e. Press the INCREMENT ↑ button for a one step change.

f. CHECK—that the dvm reads from 0 mV to +20 mV from the reading taken in step d.

g. Leave these connections for the next step.

16. Check Logic Supply Source Effect

a. Connect the dvm to the LOGIC supply front panel connectors.

b. Determine the line voltage range of the power module.

c. With the power module connected to the variable voltage transformer, lower the voltage to the lower limit for the line voltage used.

d. Program the PS 5010 for any voltage within the range of the logic suppy.

e. Note the displayed voltage on the dvm.

f. Change the varible voltage transformer to the maximum for the line voltage range used.

g. CHECK—that the dvm display reads within 1 mV from the reading noted in step e.

h. Leave these connections for the next step.

17. Check Logic Supply Load Effect

a. Make certain the OUTPUT is OFF.

b. Connect the dvm directly to the front panel LOGIC connectors.

c. Press the following buttons in the order listed:

SUPPLY SELECT
LOGIC
5
ENTER
CURRENT
2
.
0
ENTER

d. Turn the OUTPUT ON.

e. Note the dvm reading.

f. Turn the OUTPUT OFF.

g. Connect the 5 Ω resistor between the front panel LOGIC terminals.

h. Turn the OUTPUT ON.

i. CHECK—the dvm for a reading of ≤10 mV from the reading noted in step e.

CAUTION

To prevent resistor overheating do not leave the resistor connected for longer than necessary to make the check.

j. To verify the rear interface output load effect see Fig. 5-5.

k. Connect the resistor and dvm as shown in the figure.

l. Use the same entered settings as listed previously.

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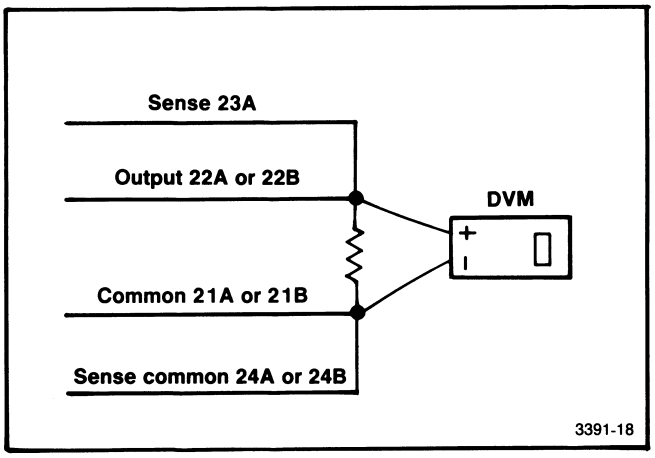

Fig. 5-5. Connections for rear interface logic supply load effect check Dvm must be connected to same point as sense lines.

m. The tolerance for the rear load effect is ≤1 mV.

n. Remove all connections for the next step.

18. Check Logic Supply PARD (ripple and noise)

a. Connect the LOGIC connectors to the dvm ac input.

b. Set the dvm for ac true rms.

c. Select any specified voltage and current combination for the logic supply.

d. Make certain the PS 5010 OUTPUT is ON.

e. Allow up to 30 s for the dvm to stabilize.

f. CHECK—that the dvm display reads ≤2 mV rms.

g. Remove the dvm from the front panel connectors.

h. Connect the oscilloscope vertical input to the front panel LOGIC terminals. Use the 1x probe.

i. Ac couple the oscilloscope input. Set the bandwidth to 20 MHz.

j. CHECK—that the oscilloscope reads ≤10 mV peak-to-peak.

NOTE

If the Logic Supply fails to meet the 10 mV p-p PARD specification due to a line frequency component superimposed on the output waveform, a ground loop may exist from the Logic Supply ground to the oscilloscope through the probe lead. Under these conditions, to determine PARD, operate the oscilloscope vertical amplifier in the differential mode. Set the oscilloscope vertical amplifier for 5 mV/div, ac coupled with a 20 MHz bandwidth.

k. Remove these connections for the next step.

19. Check Logic Supply Load Transient Recovery

a. Make certain the OUTPUT is OFF.

b. Connect the test fixture shown in Fig. 5-2 to the front panel LOGIC output connectors.

c. Connect the oscilloscope to the front panel LOGIC connectors.

d. Set the oscilloscope for ac vertical input and the sweep speed to measure approximately a 500 μs waveform (20 mV/div, 100 μs/div). The waveforms are similar to those shown in Fig. 5-3.

e. Set the front panel pushbuttons for a 5 V 2.0 A output.

f. Turn the OUTPUT ON.

g. Alternately open and close the switch in series with the 5 Ω load.

h. Adjust the oscilloscope triggering so that the transient waveform during switch opening and closing is visible on the oscilloscope display.

i. CHECK—that the time required for the waveform to return within 20 mV of the voltage before the switch is opened is ≤500 μs.

j. Remove these connections for the next step.

20. Check Logic Supply Constant Current Range, Step Size and Accuracy

a. Determine the current to be verified within the specified range of the instrument.

b. Divide 5 V by the chosen current. This determines the resistor required. If the exact resistor value is not obtainable, make certain that the resistor selected provides a voltage drop from 4.5 V to 5.5 V at the chosen current. Make certain the resistor has sufficient wattage rating.

c. Press the following buttons in the order listed:

SUPPLY SELECT
LOGIC
5
.
5
ENTER
CURRENT

d. Select the current desired and press ENTER.

e. Make certain the OUTPUT is OFF.

f. Connect the selected resistor across the LOGIC front panel terminals.

g. Connect the dvm across the resistor.

h. Using the resistor value selected determine the voltage drop across the resistor for the desired current.

i. Turn the OUTPUT ON.

j. CHECK—that the dvm reads a voltage indicating a current through the resistor within ±(5% +20 mA) of the current value selected.

k. Reduce the current limit by 100 mA (press the INCREMENT ↓ pushbutton once).

l. CHECK—that the current flowing through the resistor is from 70 mA to 130 mA less than the original current selected.

m. Remove the dvm for the next step.

21. Check Logic Supply Scaled Current Out

a. Using the same setup in the previous step connect the dvm to rear interface terminals 28A (+ lead) and 27A (− lead). These terminals are not ground referenced.

b. Determine the current flowing through the front panel resistor connected to the LOGIC terminals.

c. CHECK—that the dvm reads 1 mV ±(2% + 1 mV) for every 10 mA of current flowing through the resistor.

d. Remove all connections.

22. Check the GPIB Bus via the Controller

a. Refer to the talker-listener programs in the Programming section of this manual.

b. Send commands using the program and observe the front panel changes. Send SET? and note the data returned to the controller.

c. CHECK—that the PS 5010 displays the voltages and curents as sent and sends the correct voltages and currents when queried.

d. Remove all connections.

This completes the Performance Check procedure.

INTERNAL ADJUSTMENT PROCEDURE

Introduction

This procedure should be performed if the instrument fails to meet the performance requirements of the electrical characteristics listed in the Specification section of this manual. To ensure continued instrument accuracy, it is recommended that adjustment be performed every 1000 hours of operation or every 6 months if used infrequently. Adjustment is also recommended following instrument repair or modification. The adjustments must be made at an ambient temperature of +20°C to +30°C.

Services Available

Tektronix, Inc. provides complete instrument repair and adjustment at local field service centers and at the factory service center. Contact your local Tektronix field office or representative for further information.

Test Equipment Required

The test equipment (or equivalent) listed in Table 5-1 is required for adjustment of the PS 5010. Specifications given for the test equipment are the minimum necessary for accurate adjustment. All test equipment is assumed to be correctly calibrated and operating within specification. If other test equipment is substituted, the calibration may need to be altered to meet the requirements of the equipment used.

Adjustment Access

Use two extender cables (Tektronix Part No. 067-0645-02) to operate the plug-in outside the power module. When connecting the plug-in to the power module via the plug-in extenders, make certain the top of the extender in the power module is connected to the top of the plug-in. Remove the right side cover of the PS 5010. All adjustments are located on the right side and bottom of the PS 5010. See Figs. 9-10 and 9-11 in the pullout pages in the rear of this manual.

Fig. 5-6 shows adjustment interactions.

CAUTION

To prevent damage to the power module series pass transistors do not operate the PS 5010 on extender cables at high loads for extended periods of time.

1. Adjust 4.5 V Adj and Gain Adj

a. Connect the negative terminal of the digital voltmeter to the ground terminal of the LOGIC output. Connect the positive terminal to the positive terminal of the LOGIC output.

b. Make certain the PS 5010 output button is illuminated (ON).

c. Press the following buttons in the order listed:

SUPPLY SELECT
LOGIC
4
.
5
ENTER

d. CHECK—that the dvm reads from 4.499 V to 4.501 V.

e. ADJUST—R1950, 4.5 V Adj, for a dvm reading of 4.499 V to 4.501 V.

f. Press the following buttons in the order listed:

5
.
5
ENTER

g. CHECK—that the display reads from 5.499 V to 5.501 V.

h. ADJUST—R1851, Gain Adj, for a reading from 5.499 V to 5.501 V.

i. Remove these connections for the next step.

2. Adjust Max I Adj

a. Make certain the OUTPUT light is OFF.

b. Connect the PS 5010, dvm and 0.1 Ω resistor as shown in Fig. 5-7.

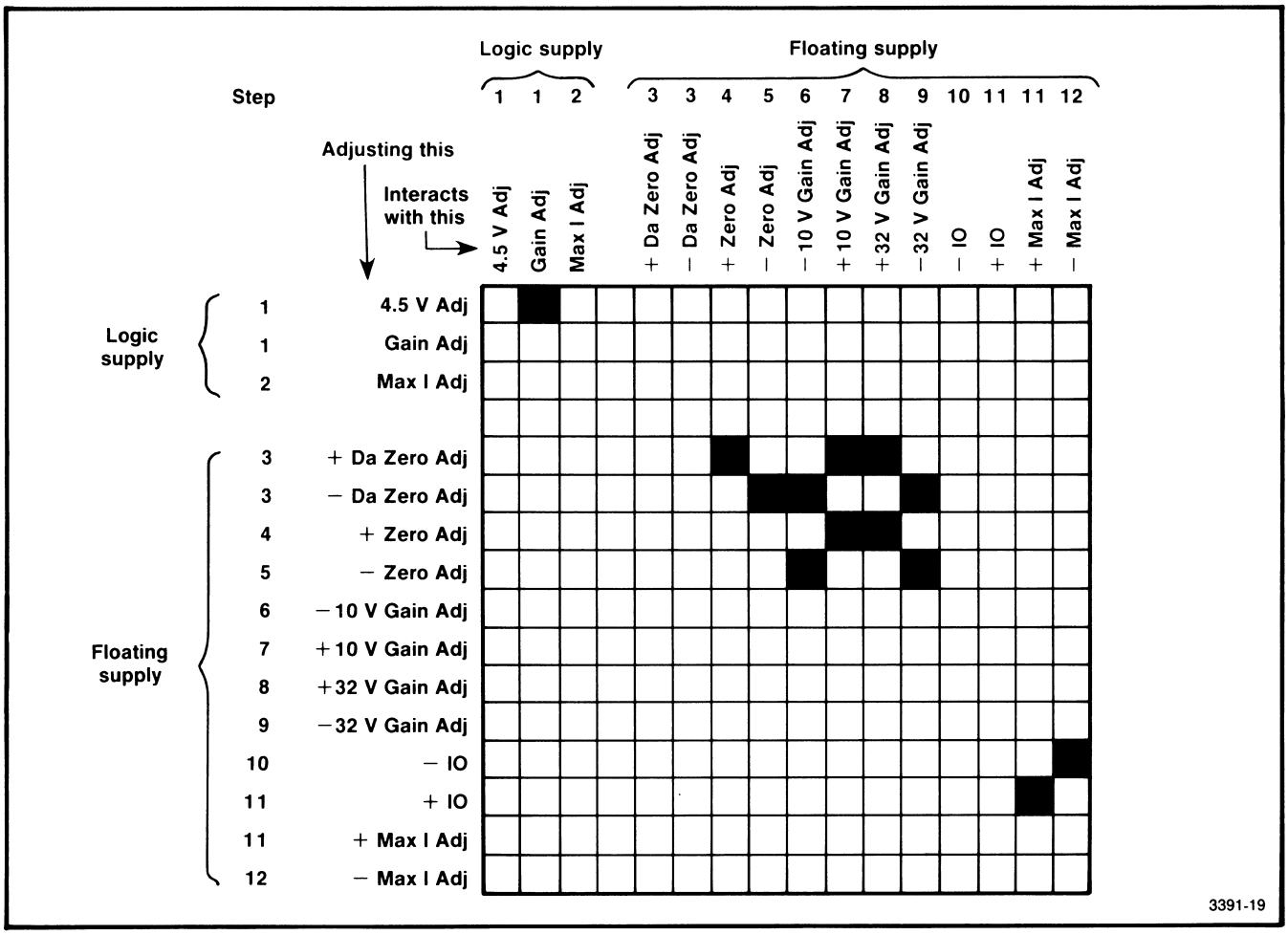

Fig. 5-6. Adjustment interactions. If the intersecting square is darkened the adjustment interact.

c. Press the following buttons in the order listed:

SUPPLY SELECT
LOGIC
CURRENT
3.0
ENTER
CLEAR

d. Short TP1550, Foldback Defeat Test Point, to ground with a screwdriver.

CAUTION

Do not ground this test point any longer than necessary.

e. Turn the OUTPUT ON.

f. CHECK—that the dvm reads from 0.2950 V to 0.3050 V.

g. ADJUST—R1850, Max I Adj, for a dvm reading of 0.2950 V to 0.3050 V.

h. Remove the foldback defeat short.

NOTE

A dvm reading of 0.05 V to 0.15 V verifies proper foldback operation.

i. Remove these connections for the next step.

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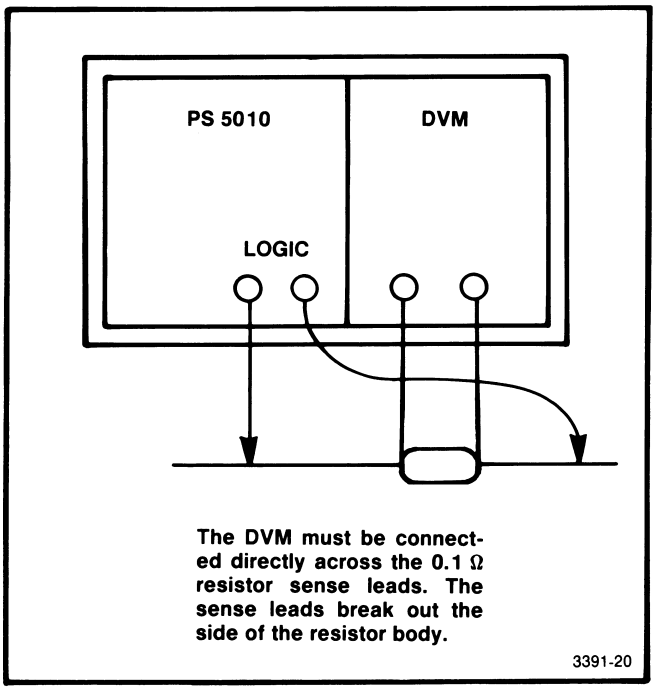


Fig. 5-7. Test setup for Max I Adj., step 2.

3. Adjust + and − Da 0 Adj

a. Turn power module off.

b. Move the J1320 jumper to the calibration position. Its location is shown in Fig. 6-1.

NOTE

J1320 remains in the calibration positon for the remaining adjustments.

c. Connect the dvm negative lead to TP1330, the Ref Com test point.

d. Connect the dvm positive lead to TP1431, the V + Dac test point.

e. Turn the power module on.

f. Program the positive and negative supplies for 0 V output.

g. Make certain the OUTPUT front panel button is illuminated.

h. CHECK—that the dvm reads from −0.20 mV to +0.20 mV.

i. ADJUST—R1335, + Da 0 Adj, for a dvm reading of −0.20 mV to +0.20 mV.

j. Move the dvm positive lead to TP 1430, the V–Dac test point.

k. CHECK—for a dvm reading from −0.20 mV to +0.20 mV.

l. ADJUST—R1334, −Da 0 Adj, for a dvm reading from −0.20 mV to +0.20 mV.

m. Remove these connections for the next step.

4. Adjust +0 Adj

a. Connect the dvm + lead to the floating supply POSITIVE connector and the dvm −lead to the front panel common (ground) connector.

b. Make certain the positive supply is programmed for 0 V output, and the OUTPUT is ON.

c. CHECK—for a dvm reading from −1.00 mV to +1.00 mV.

d. ADJUST—R1345, +0 Adj, for a dvm reading of −1.00 mV to +1.00 mV.

e. Remove the connection to the front panel POSITIVE terminal for the next step.

5. Adjust −0 Adj

a. Connect the dvm positive lead to the PS 5010 NEGATIVE terminal and the dvm negative lead to the front panel common terminal.

b. Make certain the negative floating supply is programmed for 0 V output, and the OUTPUT is ON.

c. CHECK—for a dvm reading from −31.99 V to −32.01 V.

d. ADJUST—R1344, −0 Adj, for a dvm reading from −1.00 mV to +1.00 mV.

e. Leave these connections for the next step.

6. Adjust −10 V Gain Adj

a. Connect the dvm positive lead to the PS 5010 NEGATIVE front panel connector and the dvm −lead to the front panel common (ground) connector.

b. Press the following buttons in the order listed:

SUPPLY SELECT
TRACK
1
0
ENTER

c. Make certain the OUTPUT pushbutton is illuminated and 10.0 appears in the negative display.

d. CHECK—for a dvm reading from −9.999 V to −10.001 V.

e. ADJUST—R1443, −10 V Gain Adj, for a dvm reading from −9.999 V to −10.001 V.

f. Remove the lead to the POSITIVE connector for the next step.

7. Adjust +10 V Gain Adj

a. Turn the PS 5010 OUTPUT OFF.

b. Connect the dvm + lead to the PS 5010 front panel POSITIVE connector. The dvm −lead is connected to the common connector.

c. Make certain 10.0 V appears in the positive display.

d. Turn the OUTPUT ON.

e. CHECK—the dvm for a reading from +9.999 V to +10.001 V.

f. ADJUST—R1545, +10 V Gain Adj, for a dvm reading from +9.999 V to +10.001 V.

g. Leave these connections for the next step.

8. Adjust +32 V Gain Adj

a. Make certain the dvm is connected to read the POSITIVE PS 5010 output voltage.

b. Make certain the PS 5010 is in the TRACK mode.

c. Press the following buttons in the order listed:

3
2
ENTER

d. CHECK—that the dvm reads from +31.99 V to +32.01 V.

e. ADJUST—R1544, +32 V Gain Adj, for a dvm reading from +31.99 V to +32.01 V.

f. Remove the dvm lead to the POSITIVE front panel connector.

9. Adjust −32 V Gain Adj

a. Make certain the dvm + lead is connected to the PS 5010 NEGATIVE connector and the dvm −lead is connected to the PS 5010 common terminal.

b. Maker certain −32.0 V appears in the negative display.

c. CHECK—for a dvm reading from −31.99 V to 32.01 V.

d. ADJUST—R1442, −32 V Gain Adj, for a dvm reading from −31.99 V to −32.01 V.

@

e. Remove all front panel connections for the next step.

NOTE

To complete the remaining four steps the PS 5010 must be in the high power mode. To accomplish this; 1) turn the power module power off, 2) hold switch S1600 in (Fig. 5-8), 3) turn the power module on, 4) release the switch after self test is completed (the word CAL shows in the LOGIC display).

CAUTION

To prevent damage to the series pass transistors in the mainframe do not leave the PS 5010 in the high power mode on the flexible extenders with maximum current supplied to the current meter for longer than necessary to complete an adjustment.

10. Adjust −I 0

a. Make certain the PS 5010 is in the high power mode.

b. Connect the POSITIVE terminal to the 2 A current meter input. Connect the common terminal to the −input.

c. Press these buttons in the order listed:

SUPPLY SELECT
TRACK
1
0
ENTER
CURRENT
0
ENTER

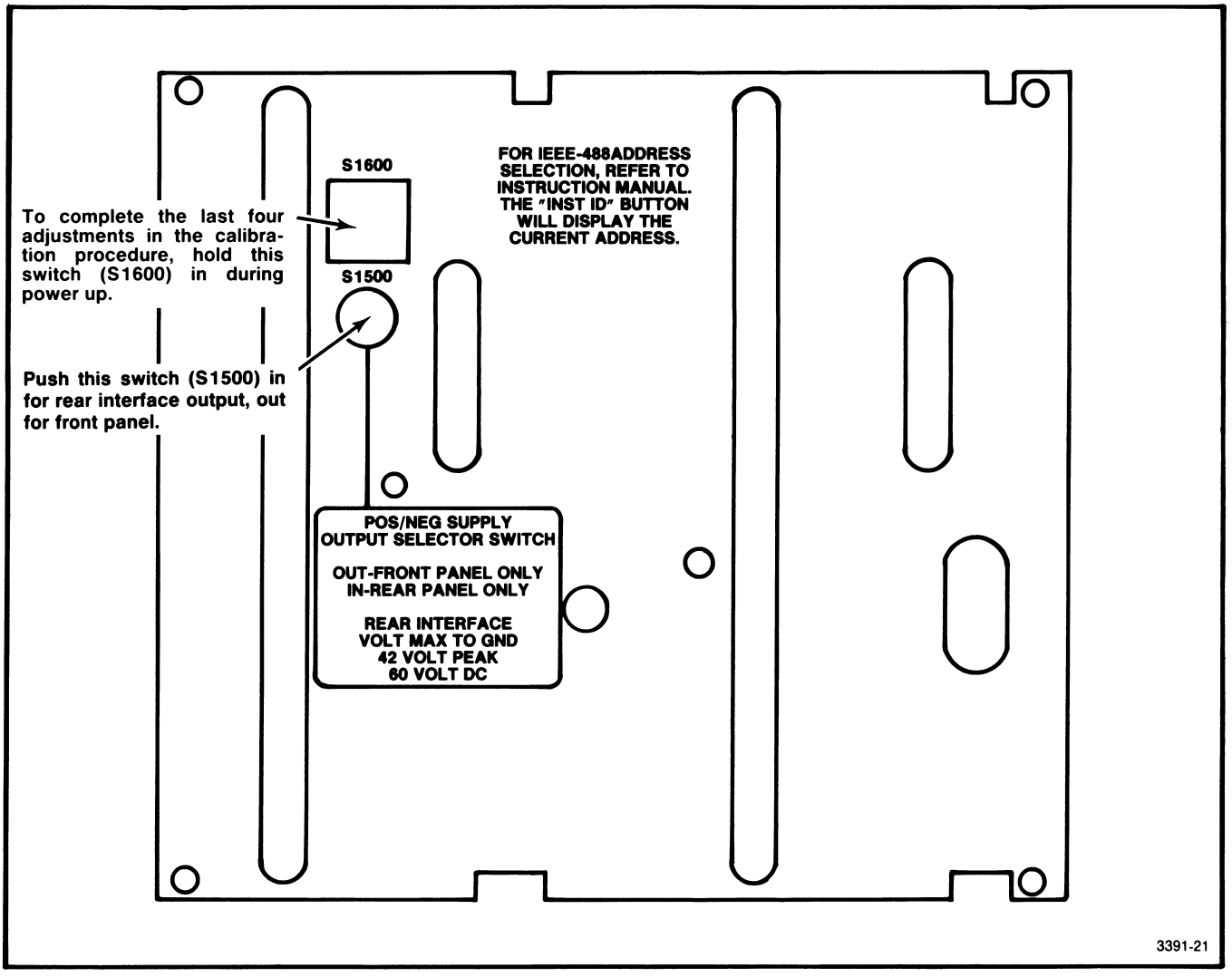


Fig. 5-8. Locations of S1600 and S1500 on rear of instrument.

d. CHECK—that the dmm display reads from −1.0 mA to +1.0 mA.

e. ADJUST—R1321, −I 0, for a dmm reading from −1.0 mA to +1.0 mA.

f. Turn the OUTPUT OFF.

g. Remove the lead from the POSITIVE connector on the PS 5010 front panel.

11. Adjust +I 0 and + Max I Adj

a. Connect the POSITIVE front panel connector through a jumper to the + current input on the dmm. Connect the common terminal to the − current input on the dmm.

b. Press the following buttons in the order listed (10 V output from both supplies):

SUPPLY SELECT
TRACK
CURRENT
0
ENTER

c. CHECK—that the display reads from −1.0 mA to +1.0 mA.

d. ADJUST—R1311, +I 0, for a display reading from −1.0 mA to +1.0 mA.

e. Turn the OUTPUT OFF.

f. Press the following buttons in the order listed (10 V output from both supplies):

SUPPLY SELECT
TRACK
CURRENT
1
.
6
ENTER

g. Turn the OUTPUT on.

h. CHECK—for a dmm reading from +1595 mA to +1605 mA.

i. ADJUST—R1211, + Max I Adj, for a dmm reading from +1595 mA to +1605 mA.

j. Turn the OUTPUT OFF.

k. Remove the lead from the POSITIVE connector on the PS 5010.

12. Adjust −Max I Adj

a. Connect the positive lead of the dmm to the front panel NEGATIVE connector. Connect the − lead of the dmm to the front panel common terminal.

b. Press the following buttons in the order listed (10 V output from both supplies):

SUPPLY SELECT
TRACK
CURRENT
1
.
6
ENTER

c. Turn the OUTPUT ON. .

d. CHECK—for a dmm display reading from +1595 mA to +1605 mA.

e. ADJUST—R1111, −Max I Adj, for a display reading from +1595 mA to +1605 mA.

f. Turn the OUTPUT OFF.

g. Remove all connections from the PS 5010.

h. Turn the power module off.

i. Replace the jumper J1320 in the normal position. See Fig. 6-1.

This completes the internal adjustment procedure.

@

MAINTENANCE

GENERAL MAINTENANCE INFORMATION

Bus Address Switch

The address switch for the PS 5010 is located on the CPU board. This board is the leftmost board when facing the front panel of the instrument. The address switch is factory set for address 22. No secondary address capability exists. Fig. 6-1 shows the switch. The leftmost toggle selects the message delimiters the PS 5010 responds to. These delimiters are either LF (line feed) and EOI (end or identify) or EOI only. Switches 1 through 5 can set any binary address from 0 to 31. An address setting of 31 causes the PS 5010 to ignore GPIB commands.

Internal Jumpers

Also located on the CPU board are two jumpers. The mode jumper J1320 has three positions. See Fig. 6-1. This jumper should be in the Normal mode for instrument operation. Place the jumper in the Signature analysis mode or the Calibration mode when instructed to do so in this manual. The normal operating position for J1220 is the Run mode position. The Force data position is only used in the signature analysis mode.

Static-Sensitive Components

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 6-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

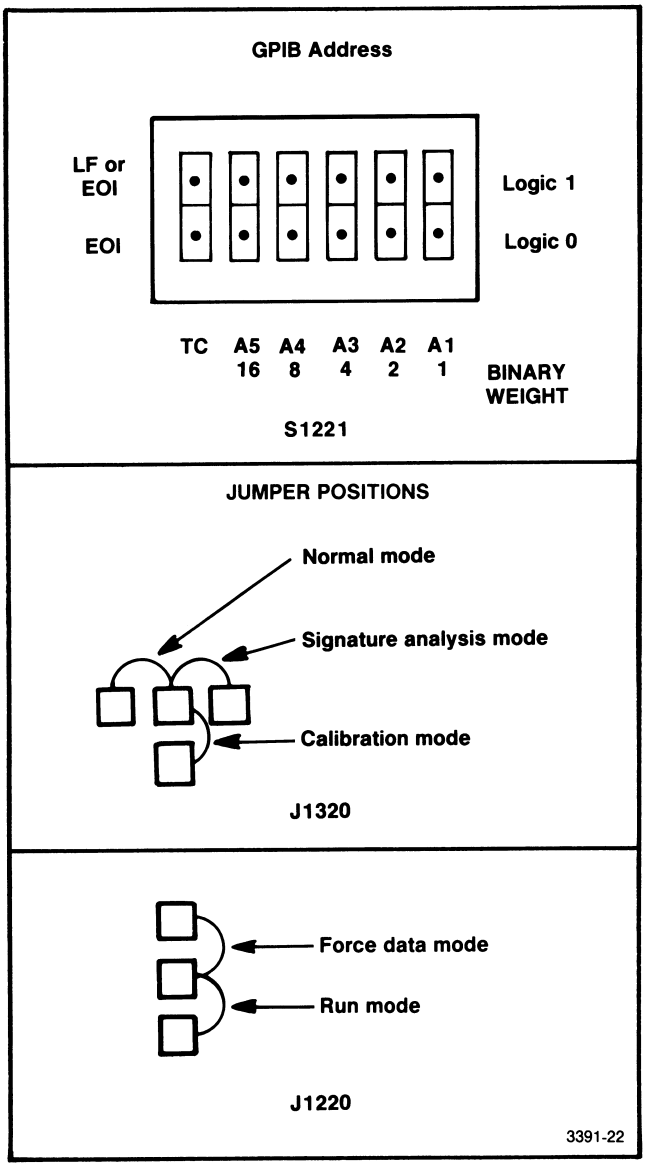


Fig. 6-1. Address switch and jumpers.

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction type or wick type desoldering tools.

Table 6-1
RELATIVE SUSCEPTIBILITY TO TO STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a] **Voltage equivalent for levels:**

1 = 100 to 500 V 4 = 500 V 7 = 400 to 1000 V(est.)
2 = 200 to 500 V 5 = 400 to 600 V 8 = 900 V
3 = 250 V 6 = 600 to 800 V 9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 Ω.)

Cleaning

This instrument should be cleaned as often as operating conditions require. Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. Remove dirt that remains with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

CAUTION

To clean the front panel use freon, isopropyl alcohol, or denatured ethyl alcohol. Do not use petroleum based cleansing agents. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Do not use air or any solvent to clean the front panel circuit board unless the pushbutton switches are removed.

The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (approximately 5 lb/in^2) or use a soft brush or cloth dampened with a mild detergent and water solution.

Hold the board so the cleaning residue runs away from the connectors. Do not scrape or use an eraser to clean the edge connector contacts. Abrasive cleaning can remove the gold plating.

CAUTION

Circuit boards and components must be dry before applying power.

Obtaining Replacement Parts

Electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, it may be possible to obtain many of the standard electronic components from a local commercial source. Before purchasing or ordering a part from a source other than Tektronix, Inc., check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument.

Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. To determine the manufacturer, refer to the Replaceable Parts list and the Cross Reference index, Mfr. Code Number to Manufacturer.

When ordering replacement parts from Tektronix, Inc. include the following information:

1. Instrument type and option number.
2. Instrument serial number.
3. A description of the part (if electrical, include complete circuit number).
4. Tektronix part number.

Soldering Techniques

WARNING

To avoid electric-shock hazard, disconnect the instrument from the power source before soldering.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core, electronic grade solder. The choice of soldering iron is determined by the repair to be made.

CAUTION

All circuit boards in the PS 5010 are multilayer type boards with a conductive path laminated between the top and bottom layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to this conductive path. Only experienced maintenance personnel should attempt to repair these boards.

When soldering on circuit boards or small wiring, use only a 15 watt, pencil type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering iron tip properly tined to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder removing wick to remove excess solder from connections or to clean circuit board pads.

Semiconductors

To remove in-line integrated circuits use an extracting tool. This tool is available from Tektronix, Inc.; order Tektronix Part Number 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid disengaging one end before the other end.

Multipin Connectors

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the wires. To replace damaged multipin connectors, remove the old pin connector from the holder. Do this by inserting a scribe between the connector and the holder and prying the connector from the holder. Clamp the replacement connector to the wire. Reinstall the connector in the holder.

If the individual end lead pin connectors are removed from the plastic holder, note the order of the individual wires for correct replacement in the holder. For proper replacement see Fig. 6-2.

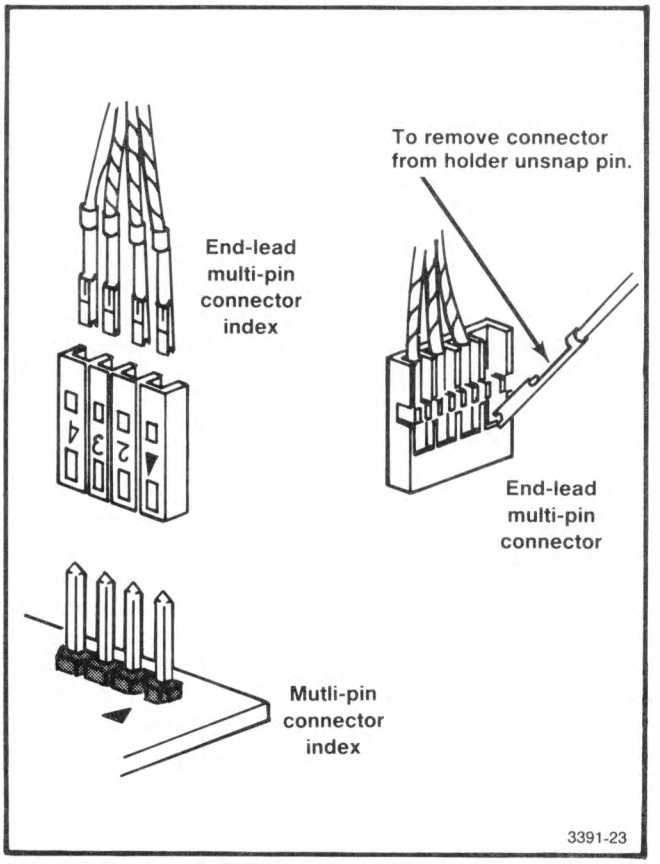


Fig. 6-2. Orientation and disassembly of multipin connectors.

Instrument Disassembly

To remove the circuit boards, first remove the two side covers. Then remove the instrument back. This is accomplished by removing the two screws at the top of the back and the two fasteners at the bottom. Use a 3/16 in. wrench on the bottom fasteners. Next, remove all screws in the top cover and remove the cover. Now, remove the screws as shown in Fig. 6-3 for the board of interest. (To remove the Logic Supply board it is necessary to first remove the Floating Supply board.) After disconnecting the plugs to the particular board, pull the board toward the rear of the instrument until free of the interconnect board.

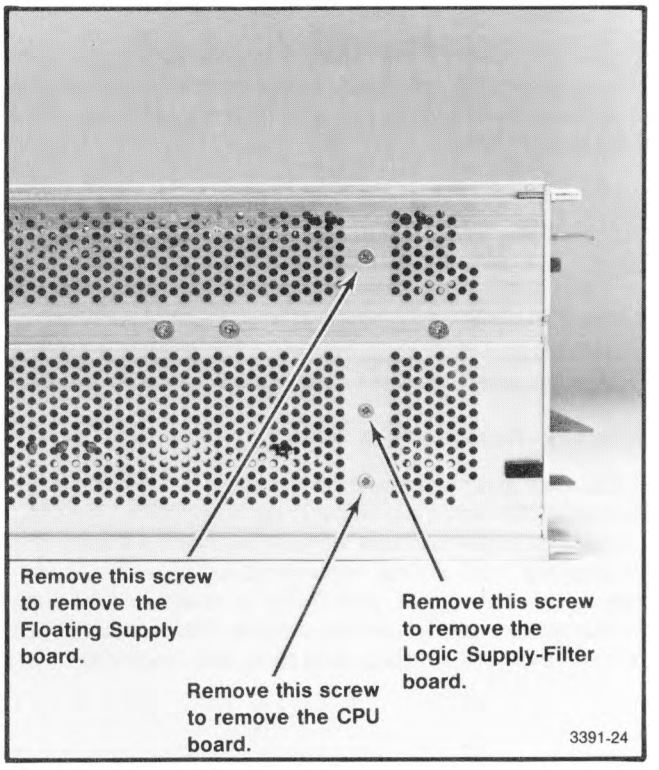


Fig. 6-3. Bottom view of instrument showing screws holding boards.

A calibration fixture (Tektronix Part No. 067-1028-00) permits operating the CPU board on a flexible extender. The logic supply filter board is then extended a short distance to the rear by using the solid extender between the board and the interface board. This permits access to all components on the logic supply filter board.

Figure 6-4 shows removal procedures for the Front Panel circuit board. The front panel bezel covering the LEDs can be removed by pressing down on the two tabs located on top of the front panel casting about 1 inch in from the sides.

CAUTION

Attempting to remove the bezel without first removing the front panel circuit board will destroy the LEDs.

To remove the switches from the front panel circuit board, push the switches out from the rear of the board. If the switch is illuminated first unsolder the wires from the circuit board. Use care when replacing the switches. Press

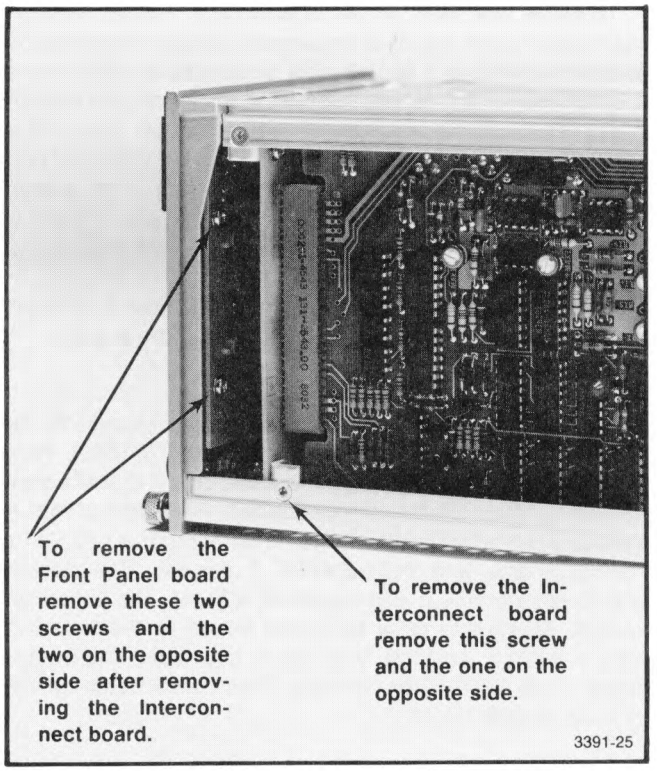


Fig. 6-4. Interface board removal.

them back into the board with a socket wrench that contacts the periphery (case) of the switch. If pressure is applied to the clear plastic near the center of the switch the switch may come apart. Once apart the switch is difficult to reassemble.

GENERAL TROUBLESHOOTING

Troubleshooting Information

Generally, locating a problem area in the PS 5010 circuits is straightforward. Review the related section of the detailed circuit description as an aid. Some subtle problems may affect circuits not apparently related, or may not show up while performing the Performance Check Procedure. As an aid in locating some of these problem areas, the following descriptions and tests are provided.

CPU Board

Intermittent failure of the instrument processor is often caused by a timing problem. This is especially true if the instrument fails after warmup. The timing margins of the CPU board components are susceptible to power supply tolerance and clock duty factor. The Vcc acceptable range for the CPU board is 4.75 V to 5.25 V measured from TP1020 to TP1011. Clock timing tolerance is shown in Fig. 6-5.

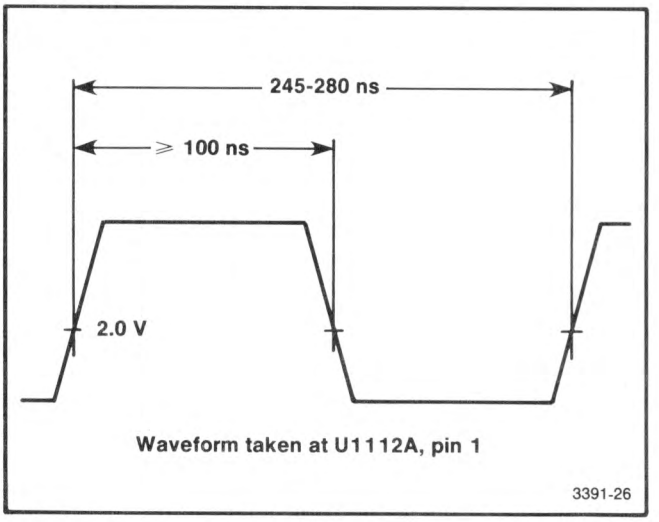


Fig. 6-5. CPU clock waveform timing tolerances. This waveform is TTL compatible.

Logic Supply

Overvoltage protection for both the logic supply output and CPU power supply is provided by an SCR across the +8 V input. To verify proper opration remove all other instruments from the power module. Program 5.5 V into the + floating supply. Connect the floating supply common terminal to ground and the + floating supply output to the logic supply output. Turn the output on. While carefully observing the display, press and hold the INCREMENT ↑ button. When the crowbar trips, the entire supply will shut down for a few seconds and then go through a power on restart. The normal trip range for the crowbar is 5.9 V to 7.1 V.

Since the crowbar reference is powered by +26 V, the crowbar constantly trips if the +26 V fuse is open.

An inoperative foldback circuit may cause pass transistor failure. Check this by programming in 3.0 A and shorting the supply into a low impedance ammeter. With an output voltage less than 500 mV, the logic supply should source less than 1.75 A and, with the logic supply in the nonprogram mode, the display should blank out. Pass transistor failure or shorted output may be caused by a serious fault such as a reversed polarity source placed on the output, destroying clamp diode CR1200.

The intended return path for the logic supply is from the ground terminal through the chassis, and finally through the locating pins on the rear panel of the instrument. To facilitate operating the instrument on extenders, an etched circuit board run provides an alternate return path through the lower mounting nut block of the Logic Supply-Filter board. This path is broken when the board is placed on the rigid extender. When necessary to extend this board for servicing, a clip lead should be connected between the lower nut block (angle mounting bracket on the bottom of the board) and the instrument chassis.

Floating Supplies

Isolation faults are indicated by a supply going into current limit when only one output lead is grounded. If an isolation fault occurs, start by checking for a bent lug on an output terminal touching the chassis.

Failure to meet transient recovery, or no load down time specifications, or insufficient adjust range for a floating supply I zero adjust can be caused by a failure in the associated current source. Current source operation can be verified by measuring the voltage across the 274 Ω emitter resistors R1811 and R1711 located on the Logic Supply-Filter board. This should measure approximately 7.5 V.

Unstable constant current operation or insufficient floating supply I zero adjust or maximum I adjust range can be caused by either a ±15 V control supply out of tolerance or a circuit fault which results in drawing too much bias current which returns through a current sense resistor. The ±15 V supplies can be checked from the emitters of Q1100 and Q1101 to TP1620 (Floating Supply board). The normal range is 14.4 V to 16.2 V.

No positive supply current limit can be caused by a short between $\downarrow_3$ and $\downarrow_1$ or $\downarrow_4$ and $\downarrow_1$ for the negative supply.

Mainframe pass transistor failure can be caused by an inoperative high power compartment switch (S1600). With the instrument out of the power module, check to make sure the spring return pushes the switch out. Reinstall the instrument in a pair of standard compartments, program 20 V in a floating supply and INCREMENT ↑ current. The current should not increment and remain at 400 mA, the power up current. Mainframe pass transistor failure may also result from a serious external fault which destroyed the output clamp diode CR1522 or CR1621. These are located on the Floating Supply board.

Loop Balance Status Indicators (Floating and Logic Supplies)

Proper operation of all modes of status indication can be verified with a pair of banana plug test leads. To verify voltage status circuits, program a voltage in the floating supplies and turn the OUTPUT on. All supplies should indicate a balanced voltage loop. (For a detailed description of how to interpret balance status, see the Operating Instructions section in this manual.) Program 0.1 A in logic supply. Individually short each supply output. The corresponding supplies display should indicate current loop balanced (constant current) while the output is shorted. Program 3.0 A in the logic supply and short the output. The display should indicate neither loop balanced due to foldback operation. Program 4.5 V into the + floating supply, 5.0 V into logic supply and interconnect them with jumpers, common to ground, + to +. The + floating supply should indicate neither loop balanced, while the logic supply indicates voltage loop balance (due to overvoltage condition in the floating supply). Enter 5.5 V in the + floating supply. The + floating supply now indicates voltage balance and the logic supply indicates neither loop balanced. Repeat the above test with the negative supply, connecting the − output to ground, and the common output to the logic supply + output.

Problems in the loop balance status circuits can be isolated by monitoring the digital outputs from either the logic supply board or the floating supply board, while performing the above tests. These signals are TTL compatible, with logic-1 (high) indicating loop balance.

SIGNATURE ANALYSIS

Introduction

Signature analysis provides a simple and direct method of troubleshooting complex digital circuitry to the component level. There are two signature analysis modes available. The first is called kernel test mode. This mode is used to check the basic processing functions of the instrument. It covers the CPU, ROM, address bus, and address decoding. The second mode is a firmware routine referred to as the signature analysis mode. This mode requires a working CPU, ROM, RAM, address, and data bus. To verify these, the normal power-up self-test is performed. Refer to the pullout pages at the rear of this manual for detailed test procedures for each test.

Mode Descriptions

The kernel test mode is implemented by forcing an instruction on the data bus. This causes the CPU to increment through memory. The instruction used is an LSRA (Logic Shift Right-Accumulator A) which is a Hex 44. This is accomplished by setting the run/force data jumper (J1220), mode jumper (J1320), and GPIB address switch (S1221) as shown in the tests.

Three tests are provided. They are:

1. GPIB address switch and buffer test. This test is used if the kernel test mode or signature analysis mode does not work, and other electrical conditions necessary (listed with each test) have been verified.

2. CPU/address test. Use this test when a system error, unknown power-up condition, address bus or address decoding problem is suspected or reported via the front panel error codes.

3. ROM test. Used when a ROM error is reported via the front panel error codes or a power-up condition is incorrect.

The signature analysis mode is implemented by setting the mode jumper (J1320) to the signature analysis mode. This runs a firmware routine, which exercises the hardware in the instrument.

There are six tests provided. They are:

1. Power-up/display checks. These checks are automatic. Power-up self-test runs when the instrument is turned on. This verifies CPU, ROM, RAM, and bus lines. The display check is the way the display illuminates in signature analysis mode. The 521 on each display (if correct) verifies that adjacent lines on the display drivers are not shorted and the lines used are functioning.

2. Address/data buffer test. Verify address buffer with this test (checks unbuffered address lines, but they should be good if self-test works). Also checks data bus and buffer, which indicates if keyboard encoder (U1421) and GPIB chip (U1001) are putting out correct data.

3. Addressable latch test. Checks the three addressable latches.

   Verifies operation of:

   a. Dim and relay latch (U1315)

   b. Serial output and partial display (R1411)

   c. Blink control latch (U1314)

4. GPIB chip test. Checks for correct data output from U1001. This is not a functional test of the IC. It is used to detect data bus errors from the address/data buffer test.

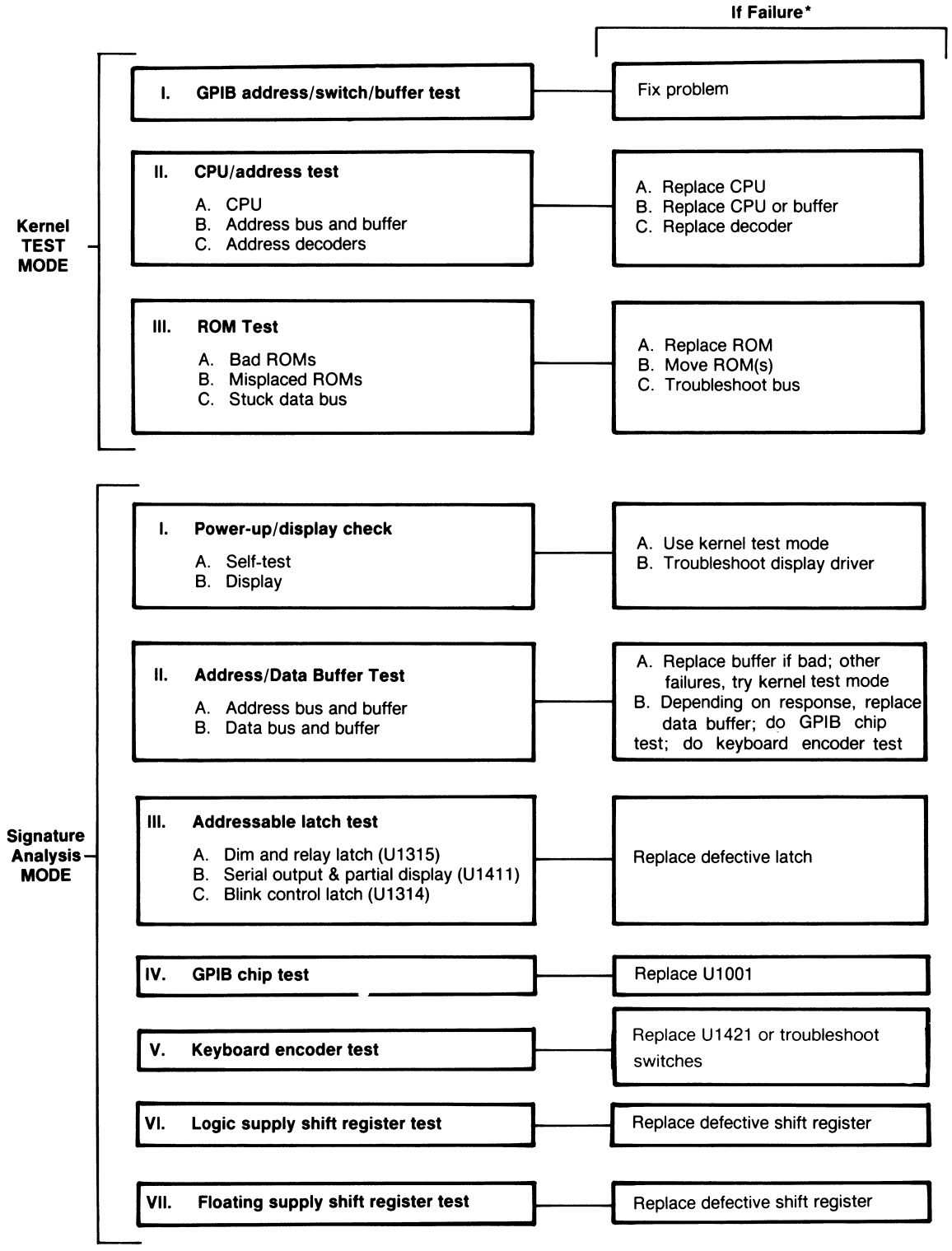
5. Keyboard encoder test. Provides a complete functional check of keyboard encoder (U1421). Use it to find data bus errors from address/data buffer test. Also, mechanical problems can be traced (such as front panel switch problems) since necessary input conditions are given.

6. Logic supply shift register test. Provides a troubleshooting method for finding faults in the logic supply shift registers (such as incorrect data transferred to D-to-A converters).

How To Use Signature Analysis

The Troubleshooting Chart, Table 6-2, shows the available tests and what is covered by each. The tests may be performed in any order as long as the Electrical Conditions Necessary to Perform Test listed with each test procedure are met. The If Failure section indicates suggested action if a failure is found on that test.

Table 6-2
TROUBLESHOOTING CHART PS 5010



*Assumes that electrical conditions necessary to perform test (listed with each test) are functioning.

3391-30

By using the CPU board block diagram, front panel indications and instrument operation troubleshooting time can be reduced. An example problem is given to explain the process involved.

Problem Observed: Logic supply output offset by 80 mV from the programmed voltage except when a voltage that includes an 80 mV multiple is selected. Example:

Programmed Voltage	Voltage Output
4.5 V	4.58 V
4.58 V	4.58 V
4.51 V	4.59 V

Step 1. Assumptions that can be made from this information:

A. Power-up self-test passed, so CPU, ROM, RAM, address and data bus are operational.

B. From the nature of the problem, we can assume that for some reason the data bit that controls the 80 mV offset is stuck or the D-to-A converter is not responding correctly.

C. By checking the block diagram, we find that the logic supply D-to-A converters data comes from the Serial I/O section of the CPU board. This data is transferred via a shift register on the logic supply board.

D. We assume the instrument is calibrated correctly since the output is correct when 80 mV multiples are programmed.

Step 2: Procedure

Since checking signals on the logic supply board requires extender boards, it may be a good idea to check the data going from the Serial I/O section of the CPU board. Use the Signature Analysis Mode, Addressable Latch Test. If this shows an error, fix the problem (verify that the output of the PS 5010 is correct). If outputs of latches are correct, then use Logic Supply Shift Register Test. If the shift registers are all right, then most likely the D-to-A converter is defective.

REAR INTERFACE INFORMATION

Functions Available at Rear Connector

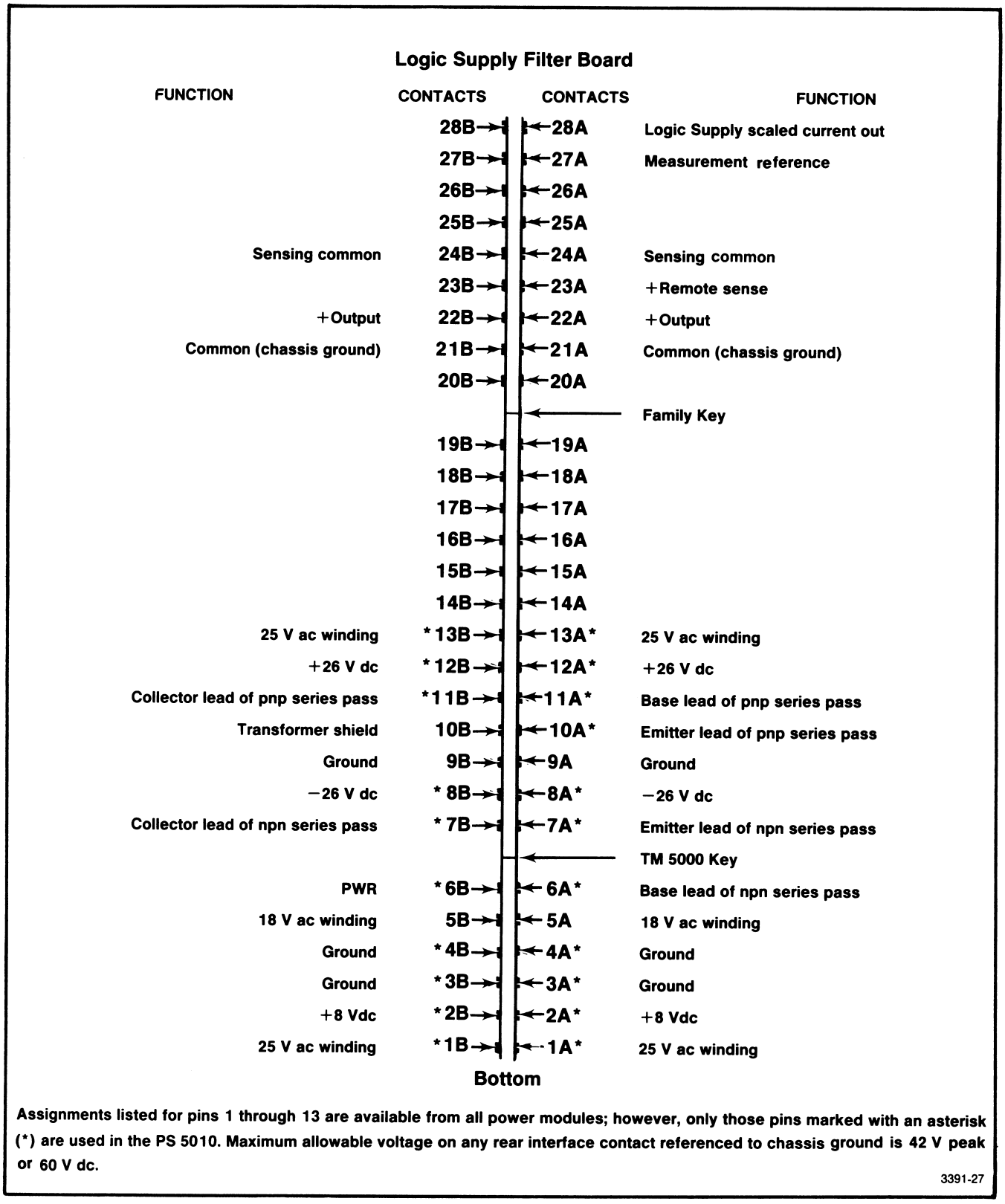
Slots exist between pins 19 and 20 and 6 and 7 on the rear interface connectors. The slot between pins 19 and 20 is the family key slot. The slot between pins 6 and 7 identifies the PS 5010 as a member of the TM 500-TM 5000 family. Insert a barrier in the corresponding position of the power module jack to prevent noncompatible plug-ins from being inserted in slots wired for the PS 5010. This protects the plug-in if specialized connections are made to that compartment. Consult the power module manual for further information. Signal inputs, outputs and other specialized connections may be made to the rear interface connectors as shown in the input/output assignments illustrations (Figs. 6-6 and 6-7). The location and operation of the rear interface switch is shown in Fig. 5-6. A description of these connections follows. GPIB connector assignments are shown in Fig. 6-8.

WARNING

Maximum allowable voltage on any rear interface pin is 42 V peak ac or 60 Vdc with respect to chassis (earth) ground.

Logic Supply Scaled Current Out (Logic Board 28A)

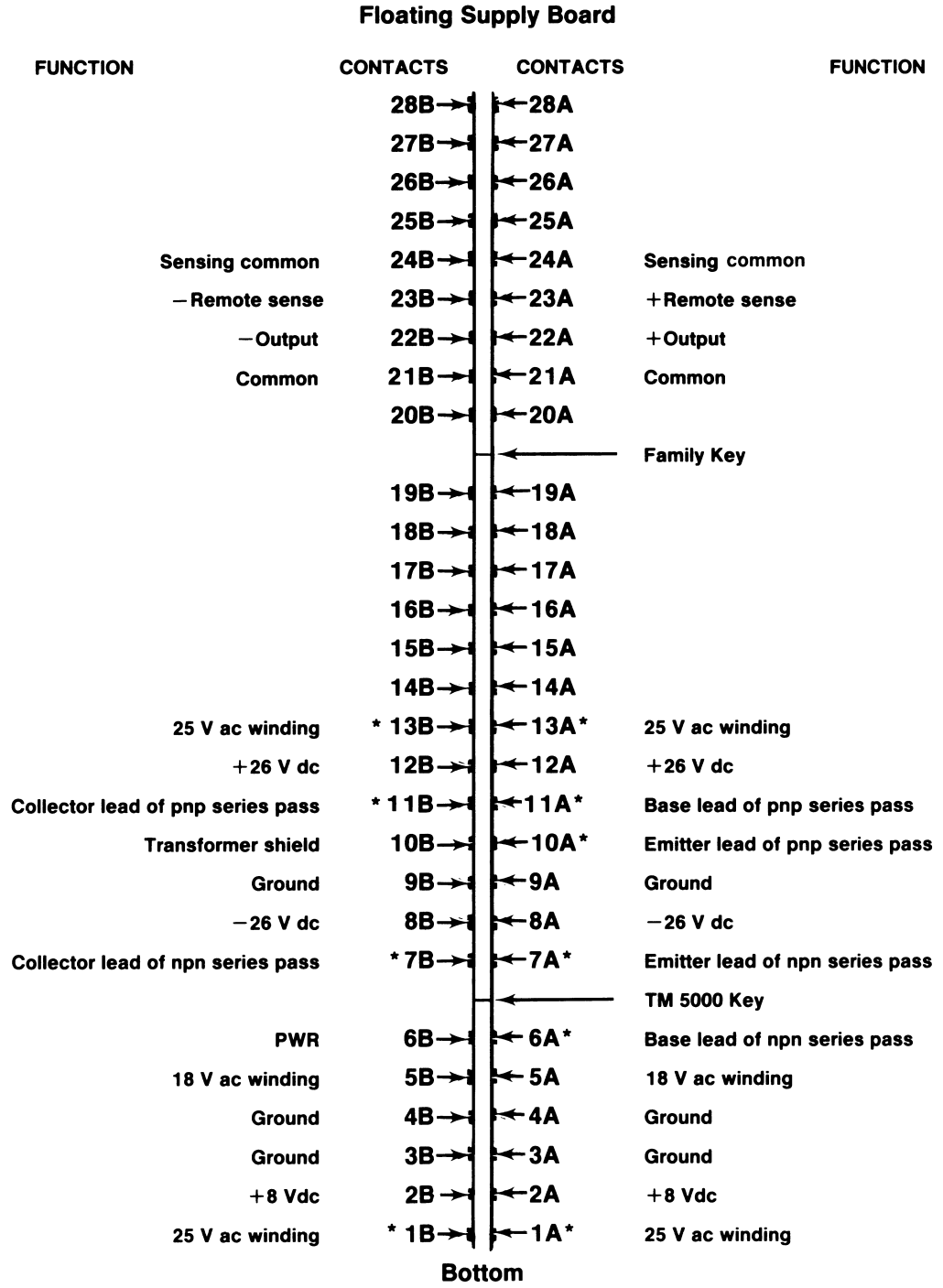
This connector provides a voltage in relationship to the current supplied by the logic supply. See the specification section of this manual for the specified voltge. This output is not ground referenced. Use pin 27A as the return.



Assignments listed for pins 1 through 13 are available from all power modules; however, only those pins marked with an asterisk (*) are used in the PS 5010. Maximum allowable voltage on any rear interface contact referenced to chassis ground is 42 V peak or 60 V dc.

3391-27

Fig. 6-6. Assignments for rightmost connector as viewed from rear of instrument.



Assignments listed for pins 1 through 13 are available from all power modules; however, only those pins marked with an asterisk (*) are used in the PS 5010. Maximum allowable voltage on any rear interface contact referenced to chassis ground is 42 V peak or 60 V dc.

3391-28

Fig. 6-7. Assignments for leftmost connector as viewed from rear of instrument.

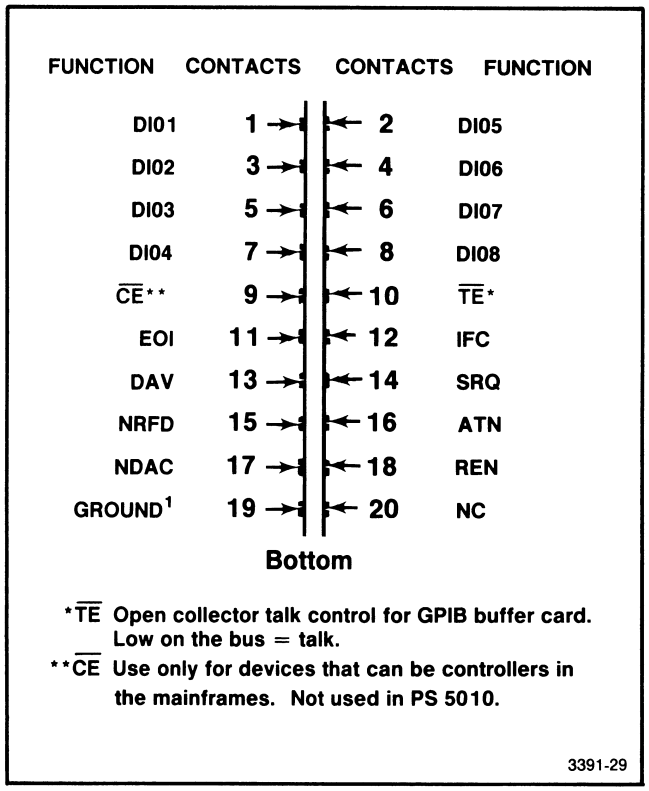


Fig. 6-8. Assignments for GPIB connetor as viewed from rear of instrument.

Measurement Reference (Logic Board 27A)

This connection serves as the return for the logic supply scaled current out. This connection is not connected to chassis ground.

+ Remote Sense and Sensing Common (Logic Board 23A, 24A and 24B)

These connections function only when using the rear interface output. These sense lines are diode clamped to the respective outputs to prevent uncontrolled regulator response if the sense lines are misconnected. See the heading Remote Sense in the Operating Instructions of this manual for more information.

+ Output (Logic Board 22A and 22B)

These connections are the + logic supply output.

Common (Logic Supply 21A and 21B)

These connections provide the return path for the + logic supply output voltage. They are connected to chassis ground.

+ and − Remote Sense and Sensing Common (Floating Supply Board 23A, 23B, 24A and 24B)

These Connections function only in the rear interface mode. The sense lines are diode clamped to the respective outputs to prevent uncontrolled regulator response if the sense lines are misconnected. See the heading Remote Sense in the Operating Instructions of this manual for more information.

+ Output (Floating Supply Board 22A)

This is the positive supply output for the rear interface.

− Output (Floating Supply Board 22B)

This is the negative supply output for the rear interface.

Common (Floating Supply Board 21A and 21B)

These are the return connections for the + and − floating supply outputs.

NOTE

Remote sense must be used with the rear interface floating supply outputs. Overvoltage damage to delicate loads may result from operating the PS 5010 with S1600 pushed in (rear interface output) and the sense lines open.

OPTIONS

No options exist for the PS 5010 at this time.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

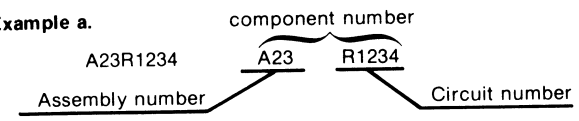
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

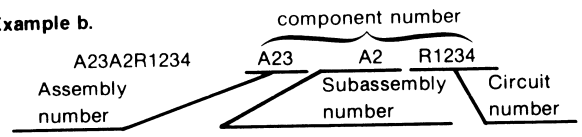
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
0000L	MATSUSHITA ELECTRIC	200 PARK AVENUE, 54TH FLOOR	NEW YORK, NY 10017
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02289	HI-G CO., INC.	SPRING ST. & RT 75	WINDSOR LOCKS, CT 06096
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
14552	MICRO SEMICONDUCTOR CORP.	2830 F FAIRVIEW ST.	SANTA ANA, CA 92704
15636	ELEC-TROL INC.	26477 N. GOLDEN VALLEY RD.	SAUGUS, CA 91350
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
50522	MONSANTO CO., ELECTRONIC SPECIAL PRODUCTS	3400 HILLVIEW AVENUE	PALO ALTO, CA 94304
51642	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801
54473	MATSUSHITA ELECTRIC, CORP. OF AMERICA	1 PANASONIC WAY	SECAUCUS, NJ 07094
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A10	670-6682-00			CKT BOARD ASSY:FRONT PANEL	80009	670-6682-00
A11	670-6680-00			CKT BOARD ASSY:INTERCONNECT	80009	670-6680-00
A12	670-6676-00			CKT BOARD ASSY:CPU	80009	670-6676-00
A13	670-6681-00			CKT BOARD ASSY:LOGIC SUPPLY/FILTER	80009	670-6681-00
A14	670-6677-00			CKT BOARD ASSY:FLOATING SUPPLY	80009	670-6677-00
A10	----- -----			CKT BOARD ASSY:FRONT PANEL		
A10C1040	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A10DS1001	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1002	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1011	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1012	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1030	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1101	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1102	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1103	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1111	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1112	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1201	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1202	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1203	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1210	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1211	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1301	150-1048-00			LAMP,LED,DSPL:ORANGE,7 SEG,0.4 DIGIT	50522	MAN4640A
A10DS1302	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1303	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1304	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10DS1305	150-1036-00			LAMP,LED:RED,3.0V,40MA	01295	TIL 209A
A10P1021	131-2174-00			CONN,RCPT,ELEC:CIRCUIT BD,125 CONTACTS	22526	65780-025
A10P1240	131-2174-00			CONN,RCPT,ELEC:CIRCUIT BD,125 CONTACTS	22526	65780-025
A10Q1039	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1040	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1120	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1121	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1122	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1123	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1131	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1132	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1320	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1330	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10R1001	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1002	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1010	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1011	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1020	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1021	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1022	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1023	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1024	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1025	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1026	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1031	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1032	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1039	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A10R1040	315-0910-00			RES.,FXD,CMPSN:91 OHM,5%,0.25W	01121	CB9105
A10R1140	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A10R1141	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1142	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1143	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1144	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1145	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1210	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1240	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1241	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1242	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1245	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	91637	MSP06A01-103J
A10R1310	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1311	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A10R1312	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A10R1313	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A10S1030	263-0019-01	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1030	263-0019-35	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1120	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1120	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1121	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1121	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1130	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1130	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1131	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1131	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1133	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1133	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1220	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1220	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1221	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1221	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1222	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1222	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1223	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1223	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1230	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1230	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1231	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1231	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1232	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1232	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1233	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1233	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1320	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1320	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1321	263-0019-36			SWITCH,PB ASSY:MOMENTARY	80009	263-0019-36
A10S1322	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1322	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1330	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1330	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1331	263-0019-03	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1331	263-0019-38	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1332	263-0019-04	B010100	B020209	ACTR ASSY,PB:MOMENTARY	80009	263-0019-04
A10S1332	263-0019-37	B020210		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-37

@

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11	----- -----			CKT BOARD ASSY:INTERCONNECT		
A11J1020	131-2543-00			CONN,RCPT,ELEC:CKT BD,25/50,FEMALE	05574	000201-4543
A11J1021	131-1614-00			CONTACT ASSY,EL:	22526	65502-136
A11J1240	131-1614-00			CONTACT ASSY,EL:	22526	65502-136
A11J1400	131-2545-00			CONN,RCPT,ELEC:CKT BD,36/72 CONT,FEMALE	05574	000201-3774
A11J1500	131-2543-00			CONN,RCPT,ELEC:CKT BD,25/50,FEMALE	05574	000201-4543

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12	----- -----			CKT BOARD ASSY:CPU		
A12C1022	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
A12C1000	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1010	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1011	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1021	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
A12C1023	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
A12C1100	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1101	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1110	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1112	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1120	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1122	283-0690-00			CAP.,FXD,MICA D:560PF,0.5%,300V	00853	D153F561E0
A12C1123	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1200	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1201	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1300	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1310	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1311	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1312	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1320	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1321	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1400	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1401	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1411	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1412	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1413	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1420	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1421	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1422	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A12C1423	290-0891-00			CAP.,FXD,ELCTLT:1UF,+75-10%,50V	55680	25U1A10V-T
A12CR1020	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12J1111	131-1857-00			TERM. SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	22526	65500136
A12J1220	131-1857-00			TERM. SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	22526	65500136
A12J1320	131-1857-00			TERM. SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	22526	65500136
A12Q1020	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A12Q1021	151-0405-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE800	04713	SJE943
A12Q1120	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A12Q1121	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A12Q1122	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A12Q1125	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A12R1000	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1012	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1013	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1014	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
A12R1015	321-0639-00			RES.,FXD,FILM:9.6K OHM,1%,0.125W	91637	MFF1816G96000F
A12R1016	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A12R1017	321-0756-00			RES.,FXD,FILM:50K OHM,1%,0.125W	24546	NA55D5002F
A12R1018	308-0702-00			RES.,FXD,WW:0.33 OHM,5%,2W	75042	BWH-R3300J
A12R1022	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
A12R1023	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
A12R1024	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F
A12R1025	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
A12R1111	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A12R1112	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A12R1113	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A12R1120	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R1121	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1122	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A12R1123	321-0328-00			RES.,FXD,FILM:25.5K OHM,1%,0.125W	91637	MFF1816G25501F
A12R1124	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A12R1125	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
A12R1126	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A12R1127	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A12R1128	321-0108-00			RES.,FXD,FILM:130 OHM,1%,0.125W	91637	MFF1816G130R0F
A12R1210	307-0445-00			RES,NTWK,FXD,FI:4.7K OHM,20%,(9) RES	91637	MSP10A01-472M
A12R1211	307-1137-00			RES NTWK,FXD,FI:8.5M OHM,50%,0.125W	03888	A3UT17
A12R1220	321-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.125W	91637	MFF1816G37400F
A12R1222	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A12R1223	321-0233-00			RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
A12R1310	307-0445-00			RES,NTWK,FXD,FI:4.7K OHM,20%,(9) RES	91637	MSP10A01-472M
A12R1410	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A12S1221	260-1589-01			SWITCH,ROCKER:(6)SPST,125MA,30VDC	00779	435166-4
A12TP1011	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A12TP1020	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A12TP1401	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A12TP1410	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A12U1000	156-1415-00			MICROCIRCUIT,DI:OCTAL GPIB XCVR MGT BUS	01295	SN75161
A12U1001	156-1444-00			MICROCIRCUIT,DI:GPIB ADAPTER	01295	TMS9914
A12U1010	156-1414-00			MICROCIRCUIT,DI:OCTAL GPIB XCVR DATA	01295	SN75160
A12U1020	156-0495-02			MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	01295	LM324J/P3
A12U1100	160-1334-00			MICROCIRCUIT,DI:4096 X 8 EPROM	80009	160-1334-00
A12U1101	160-1333-00			MICROCIRCUIT,DI:4096 X 8 EPROM	80009	160-1333-00
A12U1111	156-0426-00			MICROCIRCUIT,DI:MICROPROCESSOR	04713	MC6800L
A12U1112	156-0043-03			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE,SCRN	80009	156-0043-03
A12U1120	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A12U1200	160-1332-00			MICROCIRCUIT,DI:4096 X 8 EPROM	80009	160-1332-00
A12U1201	160-1331-00			MICROCIRCUIT,DI:4096 X 8 EPROM	80009	160-1331-00
A12U1202	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	80009	156-1111-02
A12U1210	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTALBFR	80009	156-1277-00
A12U1212	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTALBFR	80009	156-1277-00
A12U1213	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP ORGATE	01295	SN74LS32NP3
A12U1220	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74D
A12U1221	156-0895-01			MICROCIRCUIT,DI:14 BIT BINARYCNTR,BURN-IN	04713	MC14020BCLD
A12U1300	156-1461-01			MICROCIRCUIT,DI:1024 X 4 SCRAM	80009	156-1461-01
A12U1301	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A12U1302	156-1461-01			MICROCIRCUIT,DI:1024 X 4 SCRAM	80009	156-1461-01
A12U1310	156-0541-02			MICROCIRCUIT,DI:DUAL 2 TO 4 LINE DCDR	01295	SN74LS139NP3
A12U1311	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A12U1313	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	80009	156-0718-03
A12U1314	156-0874-02			MICROCIRCUIT,DI:8 BIT ADDRESSABLE LCH	80009	156-0874-02
A12U1315	156-0874-02			MICROCIRCUIT,DI:8 BIT ADDRESSABLE LCH	80009	156-0874-02
A12U1320	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04N3
A12U1321	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A12U1322	156-0910-02			MICROCIRCUIT,DI:DUAL DECADE COUNTER	80009	156-0910-02
A12U1323	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A12U1400	156-1431-00			MICROCIRCUIT,DI:6 DIGIT DSPL CONT/DRIVER	27014	MM74C912
A12U1410	156-1430-00			MICROCIRCUIT,DI:4 DIGIT EXP SEG DSPL CONT	27014	MM74C911
A12U1411	156-0874-02			MICROCIRCUIT,DI:8 BIT ADDRESSABLE LCH	80009	156-0874-02
A12U1412	156-0955-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE	04713	SN74LS241
A12U1420	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTALBFR	80009	156-1277-00
A12U1421	156-1215-00			MICROCIRCUIT,DI:20 KEY ENCODER	80009	156-1215-00
A12VR1011	152-0662-00			SEMICOND DEVICE:ZENER,0.4W,5V,1%	04713	SZG195
A12VR1121	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4

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A13	----- -----			CKT BOARD ASSY:LOGIC SUPPLY/FILTER		
A13C1100	290-0768-00			CAP.,FXD,ELCTLT:10UF,+50-10%,100V	54473	ECE-A100V10L
A13C1120	290-0632-00			CAP.,FXD,ELCTLT:6200UF,+75-10%,15V	56289	39D357
A13C1230	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
A13C1231	290-0759-00			CAP.,FXD,ELCTLT:290UF,+75-10%,15V	90201	TTX291U015C1A3
A13C1300	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1301	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1310	290-0714-00			CAP.,FXD,ELCTLT:2000UF,+75-10%,40V	56289	39D641
A13C1311	290-0714-00			CAP.,FXD,ELCTLT:2000UF,+75-10%,40V	56289	39D641
A13C1320	290-0714-00			CAP.,FXD,ELCTLT:2000UF,+75-10%,40V	56289	39D641
A13C1340	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1341	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1430	290-0772-00			CAP.,FXD,ELCTLT:330UF,+50-10%,25V	0000L	ECE-B25Z330
A13C1540	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A13C1600	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1620	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
A13C1630	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
A13C1631	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1710	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
A13C1711	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
A13C1720	290-0839-00			CAP.,FXD,ELCTLT:330UF,+50-10%,35V	54473	ECE-B35V330LS
A13C1732	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1740	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	72982	8013T2ADDC1G201J
A13C1800	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1830	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
A13C1831	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1832	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C1840	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A13C1841	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A13C1910	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
A13C1920	290-0772-00			CAP.,FXD,ELCTLT:330UF,+50-10%,25V	0000L	ECE-B25Z330
A13C1930	290-0839-00			CAP.,FXD,ELCTLT:330UF,+50-10%,35V	54473	ECE-B35V330LS
A13C2010	290-0714-00			CAP.,FXD,ELCTLT:2000UF,+75-10%,40V	56289	39D641
A13C2011	290-0714-00			CAP.,FXD,ELCTLT:2000UF,+75-10%,40V	56289	39D641
A13C2020	290-0714-00			CAP.,FXD,ELCTLT:2000UF,+75-10%,40V	56289	39D641
A13C2040	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A13C2041	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A13CR1110	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1111	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1112	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1113	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1200	152-0659-00			SEMICOND DEVICE:SILICON,100V,6A	04713	MR751
A13CR1201	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1330	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1410	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1411	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1412	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1413	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1420	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1421	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1422	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1423	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1450	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1451	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1452	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1520	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR1521	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624

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A13CR1530	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1531	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1540	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1600	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1601	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR1620	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR1621	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR1641	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1642	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1700	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A13CR1710	152-0585-00			SEMICOND DEVICE:SILICON,BRIDGE,200V,1A	80009	152-0585-00
A13CR1740	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1741	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR1800	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A13CR1810	152-0585-00			SEMICOND DEVICE:SILICON,BRIDGE,200V,1A	80009	152-0585-00
A13CR1910	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR1911	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR1912	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR2010	152-0198-00			SEMICOND DEVICE:SILICON,200V,3A	03508	1N5624
A13CR2030	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13CR2110	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A13CR2111	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A13F1110	159-0013-00			FUSE,CARTRIDGE:3AG,6A,125V,7SEC	71400	MTH6
A13F1250	159-0013-00			FUSE,CARTRIDGE:3AG,6A,125V,7SEC	71400	MTH6
A13F1340	159-0022-00			FUSE,CARTRIDGE:3AG,1A,250V,FAST-BLOW	71400	AGC 1
A13F1341	159-0022-00			FUSE,CARTRIDGE:3AG,1A,250V,FAST-BLOW	71400	AGC 1
A13F1410	159-0003-00			FUSE,CARTRIDGE:3AG,1.6A,250V,SLOW-BLOW	71400	MDX 1 6/10
A13F1411	159-0003-00			FUSE,CARTRIDGE:3AG,1.6A,250V,SLOW-BLOW	71400	MDX 1 6/10
A13F1420	159-0055-00			FUSE,CARTRIDGE:3AG,2.5A,125V,1 SEC	71400	MDL 2 1/2
A13F1421	159-0055-00			FUSE,CARTRIDGE:3AG,2.5A,125V,1 SEC	71400	MDL 2 1/2
A13J1120	131-1939-00			TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
A13J1140	131-1939-00			TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
A13J1530	131-1939-00			TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
A13J1930	131-1939-00			TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
A13K1110	148-0135-00			RELAY,ARMATURE:2 FORM C 24V COIL,870 OHMS	02289	FS2-2A-124P
A13K1510	148-0135-00			RELAY,ARMATURE:2 FORM C 24V COIL,870 OHMS	02289	FS2-2A-124P
A13K2010	148-0135-00			RELAY,ARMATURE:2 FORM C 24V COIL,870 OHMS	02289	FS2-2A-124P
A13L1240	108-1045-00			COIL,RF:FXD,TOROID,25.7UH ON CORE	80009	108-1045-00
A13Q1130	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A13Q1200	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A13Q1230	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A13Q1240	151-0515-01			SCR:SILICON	04713	2N4441
A13Q1400	151-0426-00			TRANSISTOR:SILICON,NPN	80009	151-0426-00
A13Q1430	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A13Q1440	151-0352-00			TRANSISTOR:SILICON,NPN	03508	X44C282
A13Q1441	151-0366-00			TRANSISTOR:SILICON,PNP	80009	151-0366-00
A13Q1500	151-0464-00			TRANSISTOR:SILICON,NPN	80009	151-0464-00
A13Q1501	151-0464-00			TRANSISTOR:SILICON,NPN	80009	151-0464-00
A13Q1600	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
A13Q1630	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A13Q1640	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A13Q1650	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A13Q1700	151-0464-00			TRANSISTOR:SILICON,NPN	80009	151-0464-00
A13Q1729	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A13Q1730	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A13Q1731	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A13Q1800	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A13Q1900	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C
A13Q1901	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
A13Q2000	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C
A13Q2030	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A13Q2050	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
A13R1100	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A13R1101	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A13R1110	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
A13R1111	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1112	315-0684-00			RES.,FXD,CMPSN:680K OHM,5%,0.25W	01121	CB6845
A13R1130	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A13R1132	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A13R1133	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
A13R1229	321-0160-00			RES.,FXD,FILM:453 OHM,1%,0.125W	91637	MFF1816G453R0F
A13R1230	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	MFF1816G86600F
A13R1300	308-0828-00			RES.,FXD,WW;0.1 OHM,1%,3W	91637	RS-2B-ER1000F
A13R1330	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A13R1341	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
A13R1440	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
A13R1441	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
A13R1442	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1500	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A13R1540	301-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.50W	01121	EB1015
A13R1541	321-0195-00			RES.,FXD,FILM:1.05K OHM,1%,0.125W	91637	MFF1816G10500F
A13R1542	321-0407-00			RES.,FXD,FILM:169K OHM,1%,0.125W	91637	MFF1816G16902F
A13R1543	321-0328-00			RES.,FXD,FILM:25.5K OHM,1%,0.125W	91637	MFF1816G25501F
A13R1544	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
A13R1545	301-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.50W	01121	EB1515
A13R1550	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A13R1600	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
A13R1630	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A13R1631	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A13R1632	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A13R1642	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1643	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1644	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A13R1645	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1646	315-0433-00			RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
A13R1701	301-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.50W	01121	EB9125
A13R1710	301-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.50W	01121	EB9125
A13R1711	322-0139-00			RES.,FXD,FILM:274 OHM,1%,0.25W	91637	MFF1421G274R0F
A13R1732	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A13R1740	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1741	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A13R1743	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1744	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A13R1745	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A13R1746	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A13R1800	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
A13R1811	322-0139-00			RES.,FXD,FILM:274 OHM,1%,0.25W	91637	MFF1421G274R0F
A13R1841	321-1145-08			RES.,FXD,FILM:320 OHM,1%,0.125W	24546	NA55C3200F
A13R1843	321-0171-00			RES.,FXD,FILM:590 OHM,1%,0.125W	91637	MFF1816G590R0F
A13R1844	321-0203-00			RES.,FXD,FILM:1.27K OHM,1%,0.125W	91637	MFF1816G12700F
A13R1850	311-1917-00			RES.,VAR,NONWIR:TRMR,5K OHM,10%,0.5W	73138	72-198-0
A13R1851	311-1140-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.5W	32997	3386JT07101
A13R1900	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A13R1940	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	91637	MFF1816G27400F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A13R1941	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A13R1942	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
A13R1943	321-1613-02			RES.,FXD,FILM:1.75K OHM,0.5%,0.125W	91637	MFF1816D17500D
A13R1944	321-1170-03			RES.,FXD,FILM:583 OHM,0.25%,0.125W	91637	MFF1816D583R0C
A13R1945	321-0916-03			RES.,FXD,FILM:289 OHM,0.25%,0.125W	91637	MFF1816D289R0C
A13R1950	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
A13R2030	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A13R2040	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
A13R2050	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A13R2140	321-0151-00			RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
A13TP1550	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A13TP1751	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A13U1540	156-0067-10			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-10
A13U1640	156-0067-05			MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-05
A13U1740	156-0105-01			MICROCIRCUIT,LI:OPNL AMPL,CHECKED	80009	156-0105-01
A13U1741	156-0158-07			MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	04713	MC1458UDS
A13U1840	156-1255-01			MICROCIRCUIT,LI:DA CONVERTER,BURN-IN	80009	156-1255-01
A13U1841	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01
A13U2040	156-1255-01			MICROCIRCUIT,LI:DA CONVERTER,BURN-IN	80009	156-1255-01
A13U2041	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01
A13VR1340	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A13VR1341	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A13VR1500	152-0217-00			SEMICOND DEVICE:ZENER,0.4W,8.2V,5%	04713	SZG20
A13VR1501	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A13VR1600	152-0265-00			SEMICOND DEVICE:ZENER,0.4W,24V,5%	04713	SZG35009K8
A13VR1700	152-0217-00			SEMICOND DEVICE:ZENER,0.4W,8.2V,5%	04713	SZG20
A13VR1701	152-0217-00			SEMICOND DEVICE:ZENER,0.4W,8.2V,5%	04713	SZG20
A13VR1740	152-0395-00			SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	14552	TD332317
A13VR1741	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
A13VR1800	152-0265-00			SEMICOND DEVICE:ZENER,0.4W,24V,5%	04713	SZG35009K8
A13VR1900	152-0217-00			SEMICOND DEVICE:ZENER,0.4W,8.2V,5%	04713	SZG20
A13VR2000	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A13VR2050	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	04713	SZG20012
A13VR2140	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A14	----- -----			CKT BOARD ASSY:FLOATING SUPPLY		
A14C1000	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1101	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1102	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1103	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A14C1111	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1130	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1131	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1132	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	56289	162D275X9020CD2
A14C1140	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1200	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1201	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A14C1202	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1203	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1220	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A14C1221	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A14C1230	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
A14C1231	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
A14C1232	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1233	290-0573-00			CAP.,FXD,ELCTLT:2.7UF,20%,50V	56289	196D275X0050JA1
A14C1300	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1310	285-0695-00			CAP.,FXD,PLSTC:0.01UF,10%,200V	56289	292P10392
A14C1330	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1340	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1400	283-0083-00			CAP.,FXD,CER DI:0.0047UF,20%,500V	72982	811-565C472J
A14C1401	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-509B152J
A14C1402	281-0765-00			CAP.,FXD,CER DI:100PF,5%,100V	51642	G1710100X5P101J
A14C1410	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-509B152J
A14C1420	283-0083-00			CAP.,FXD,CER DI:0.0047UF,20%,500V	72982	811-565C472J
A14C1421	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1422	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1423	281-0765-00			CAP.,FXD,CER DI:100PF,5%,100V	51642	G1710100X5P101J
A14C1520	290-0768-00			CAP.,FXD,ELCTLT:10UF,+50-10%,100V	54473	ECE-A100V10L
A14C1531	290-0768-00			CAP.,FXD,ELCTLT:10UF,+50-10%,100V	54473	ECE-A100V10L
A14C1630	283-0208-00			CAP.,FXD,CER DI:0.22UF,10%,200V	72982	8151N230 C 224K
A14C1631	283-0208-00			CAP.,FXD,CER DI:0.22UF,10%,200V	72982	8151N230 C 224K
A14C1632	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1633	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A14C1640	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A14C1641	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A14C1642	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A14C1644	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A14CR1130	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A14CR1131	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1132	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1220	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A14CR1300	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1310	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1311	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1320	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1321	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1340	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1400	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1401	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1402	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1410	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1411	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A14CR1412	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1420	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1421	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1422	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1430	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1431	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1500	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1510	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1511	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1520	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1521	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A14CR1522	152-0659-00			SEMICOND DEVICE:SILICON,100V,6A	04713	MR751
A14CR1530	152-0071-00			SEMICOND DEVICE:GERMANIUM,15V,40MA	14433	G865
A14CR1540	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1541	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1620	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A14CR1621	152-0659-00			SEMICOND DEVICE:SILICON,100V,6A	04713	MR751
A14J1500	131-1939-00			TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
A14J1630	131-1939-00			TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
A14K1420	148-0102-00			RELAY,REED:DPST,100VDC,0.5A	15636	RA30212941
A14K1520	148-0135-00			RELAY,ARMATURE:2 FORMSC 24V COIL,870 OHM	02289	FS2-2A-124P
A14L1601	108-0593-00			COIL,RF:FIXED,395NH ON FORM	80009	108-0593-00
A14Q1100	151-0464-00			TRANSISTOR:SILICON,NPN	80009	151-0464-00
A14Q1101	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C
A14Q1140	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A14Q1141	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A14Q1142	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A14Q1143	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A14Q1300	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C
A14Q1301	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
A14Q1310	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
A14Q1340	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A14Q1400	151-0464-00			TRANSISTOR:SILICON,NPN	80009	151-0464-00
A14Q1401	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
A14Q1402	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
A14Q1430	151-1045-00			TRANSISTOR:SILICON,JFE,P-CHANNEL	80009	151-1045-00
A14Q1440	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A14Q1530	151-1045-00			TRANSISTOR:SILICON,JFE,P-CHANNEL	80009	151-1045-00
A14Q1640	151-1045-00			TRANSISTOR:SILICON,JFE,P-CHANNEL	80009	151-1045-00
A14Q1641	151-1045-00			TRANSISTOR:SILICON,JFE,P-CHANNEL	80009	151-1045-00
A14R1001	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1002	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1010	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A14R1020	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A14R1021	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A14R1030	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1031	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1032	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1033	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1034	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1035	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A14R1040	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A14R1041	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A14R1042	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A14R1043	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A14R1044	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A14R1100	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125

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A14R1101	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A14R1102	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A14R1103	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
A14R1104	308-0828-00			RES.,FXD,WW:0.1 OHM,1%,3W	91637	RS-2B-ER1000F
A14R1105	308-0828-00			RES.,FXD,WW:0.1 OHM,1%,3W	91637	RS-2B-ER1000F
A14R1111	311-0643-00			RES.,VAR,NONWIR:50 OHM,10%,0.50W	73138	82-33-2
A14R1112	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
A14R1120	321-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
A14R1121	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
A14R1122	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
A14R1123	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
A14R1140	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
A14R1141	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1142	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1143	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1144	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
A14R1200	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A14R1201	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
A14R1202	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	91637	MFF1816G64901F
A14R1210	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
A14R1211	311-0643-00			RES.,VAR,NONWIR:50 OHM,10%,0.50W	73138	82-33-2
A14R1212	321-0094-00			RES.,FXD,FILM:93.1 OHM,1%,0.125W	91637	MFF1816G93R10F
A14R1213	321-0094-00			RES.,FXD,FILM:93.1 OHM,1%,0.125W	91637	MFF1816G93R10F
A14R1220	321-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
A14R1221	321-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
A14R1222	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A14R1223	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A14R1300	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
A14R1301	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
A14R1302	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	91637	MFF1816G64901F
A14R1303	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1304	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A14R1311	311-0633-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	82-30-1
A14R1312	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
A14R1313	321-0639-00			RES.,FXD,FILM:9.6K OHM,1%,0.125W	91637	MFF1816G96000F
A14R1321	311-0633-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	82-30-1
A14R1322	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1323	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A14R1324	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A14R1325	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
A14R1327	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
A14R1330	321-0298-09			RES.,FXD,FILM:12.4K OHM,1%,0.125W	24546	NE55E1242F
A14R1331	321-0298-09			RES.,FXD,FILM:12.4K OHM,1%,0.125W	24546	NE55E1242F
A14R1332	321-0684-00			RES.,FXD,FILM:15K OHM,0.5%,0.125W	91637	MFF1816D15001D
A14R1333	321-0030-02			RES.,FXD,FILM:20 OHM,0.5%,0.125W	91637	LFF18D20R00D
A14R1334	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0
A14R1335	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0
A14R1340	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
A14R1341	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1342	321-0684-00			RES.,FXD,FILM:15K OHM,0.5%,0.125W	91637	MFF1816D15001D
A14R1343	321-0030-02			RES.,FXD,FILM:20 OHM,0.5%,0.125W	91637	LFF18D20R00D
A14R1344	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0
A14R1345	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0
A14R1346	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A14R1347	321-0171-00			RES.,FXD,FILM:590 OHM,1%,0.125W	91637	MFF1816G590R0F
A14R1349	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
A14R1400	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935

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A14R1401	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1411	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
A14R1412	321-0639-00			RES.,FXD,FILM:9.6K OHM,1%,0.125W	91637	MFF1816G96000F
A14R1413	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
A14R1420	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1422	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A14R1423	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A14R1430	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A14R1431	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A14R1432	321-1296-03			RES.,FXD,FILM:12K OHM,0.25%,0.125W	91637	MFF1816D12001C
A14R1442	311-1340-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	02111	43P102T621
A14R1443	311-1340-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	02111	43P102T621
A14R1444	321-0670-00			RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	24546	NC55C6811D
A14R1445	321-0670-00			RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	24546	NC55C6811D
A14R1500	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1530	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A14R1531	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1532	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A14R1533	321-1296-03			RES.,FXD,FILM:12K OHM,0.25%,0.125W	91637	MFF1816D12001C
A14R1540	321-0966-03			RES.,FXD,FILM:40K OHM,0.25%,0.125W	91637	MFF1816D40001C
A14R1541	321-0966-03			RES.,FXD,FILM:40K OHM,0.25%,0.125W	91637	MFF1816D40001C
A14R1542	321-0670-00			RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	24546	NC55C6811D
A14R1543	321-0670-00			RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	24546	NC55C6811D
A14R1544	311-1340-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	02111	43P102T621
A14R1545	311-1340-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	02111	43P102T621
A14R1600	307-0113-00			RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
A14R1610	308-0795-00			RES.,FXD,WW:0.2 OHM,5%,3W	91637	RS2BR2000J
A14R1611	308-0755-00			RES.,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
A14R1612	308-0795-00			RES.,FXD,WW:0.2 OHM,5%,3W	91637	RS2BR2000J
A14R1620	308-0755-00			RES.,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
A14R1621	308-0755-00			RES.,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
A14R1622	308-0755-00			RES.,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
A14R1631	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A14R1632	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A14R1640	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A14R1641	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A14R1642	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A14R1643	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A14S1500	260-1504-01			SWITCH,PUSH:1 BUTTON,PB400,6P,PUSH-PUSH	80009	260-1504-01
A14S1600	260-1310-01			SWITCH,PUSH:4PDT MOMENTARY,NON-SHORTING	80009	260-1310-01
A14TP1330	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A14TP1340	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A14TP1430	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A14TP1431	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A14TP1630	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A14U1010	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1020	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1021	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1022	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1030	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1041	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1042	156-0885-00			MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR	04713	SOC123A
A14U1100	156-0067-10			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-10
A14U1110	156-0411-02			MICROCIRCUIT,LI:QUAD COMPARATOR,SEL	04713	MLM339LDS
A14U1111	156-0158-07			MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	04713	MC1458UDS
A14U1120	156-0411-02			MICROCIRCUIT,LI:QUAD COMPARATOR,SEL	04713	MLM339LDS
A14U1121	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01

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A14U1130	156-0719-00			MICROCIRCUIT,LI:10 BIT MULTIPLYING DAC	80009	156-0719-00
A14U1140	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01
A14U1200	156-0067-10			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-10
A14U1221	156-1255-01			MICROCIRCUIT,LI:DA CONVERTER,BURN-IN	80009	156-1255-01
A14U1230	156-1255-01			MICROCIRCUIT,LI:DA CONVERTER,BURN-IN	80009	156-1255-01
A14U1231	156-0719-00			MICROCIRCUIT,LI:10 BIT MULTIPLYING DAC	80009	156-0719-00
A14U1240	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01
A14U1241	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01
A14U1242	156-0796-01			MICROCIRCUIT,DI:8 STG SHF & STORE BUS	80009	156-0796-01
A14U1330	156-0495-02			MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	01295	LM324J/P3
A14U1420	156-0067-10			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-10
A14U1430	156-0067-10			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-10
A14VR1000	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A14VR1001	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A14VR1111	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	04713	SZG20012
A14VR1340	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	04713	SZG20012
A14VR1341	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZ11755
A14VR1420	152-0149-00			SEMICOND DEVICE:ZENER,0.4W,10V,5%	80009	152-0149-00
A14VR1422	152-0149-00			SEMICOND DEVICE:ZENER,0.4W,10V,5%	80009	152-0149-00

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
C500	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C550	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
C610	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
J500	131-2487-00			JACK,TIP:GREEN	80009	131-2487-00
J510	136-0732-00			JACK,TIP:RED	80009	136-0732-00
J520	131-2488-00			JACK,TIP:WHITE	80009	131-2488-00
J600	136-0732-00			JACK,TIP:RED	80009	136-0732-00
J610	136-0731-00			JACK,TIP:BLACK	80009	136-0731-00
L500	108-1015-00			COIL ASSY,AF:FIXED,2 INDUCTORS,SWINGING	80009	108-1015-00
L510	108-1015-00			COIL ASSY,AF:FIXED,2 INDUCTORS,SWINGING	80009	108-1015-00
R500	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R510	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

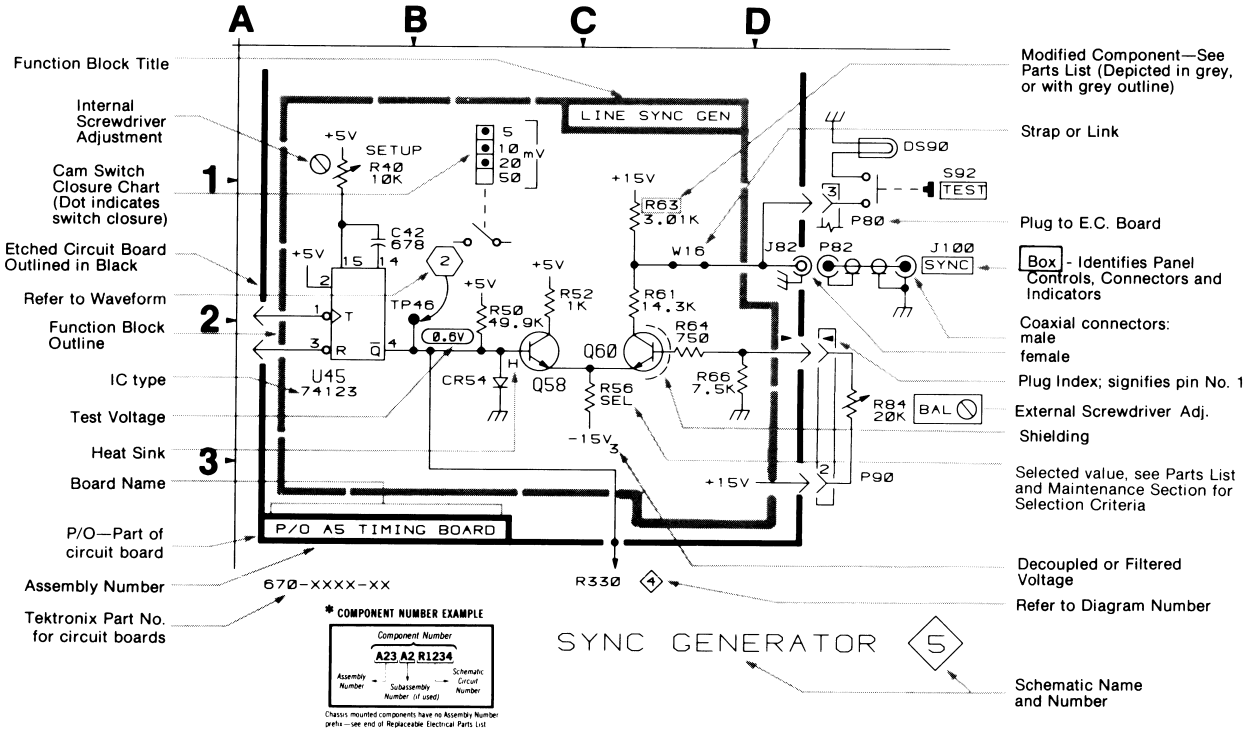
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



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GPIB ADDRESS SWITCH AND BUFFER TEST

I. Purpose

Check operation of GPIB buffer and address switch.

II. Equipment required

A. Oscilloscope
B. TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02
C. Voltmeter

III. Electrical conditions necessary to perform test

A. Check U1212 pin 20 for +5 V
B. Check U1212 pin 14 with oscilloscope for approximately a 1 MHz signal.
C. Set J1220 as shown.

Force data

IV. Setup (PS 5010)

A. Remove CPU U1111 (to free up data bus).
B. Remove R1211 (to open data bus).

V. Measurements

Using oscilloscope connected to U1212 as shown and checking for highs and lows, exercise GPIB address switch and mode jumper (J1320). Check for stuck, shorted or open signal paths. If problems are found trace to buffer, switch, pull-up resistors or circuit board.

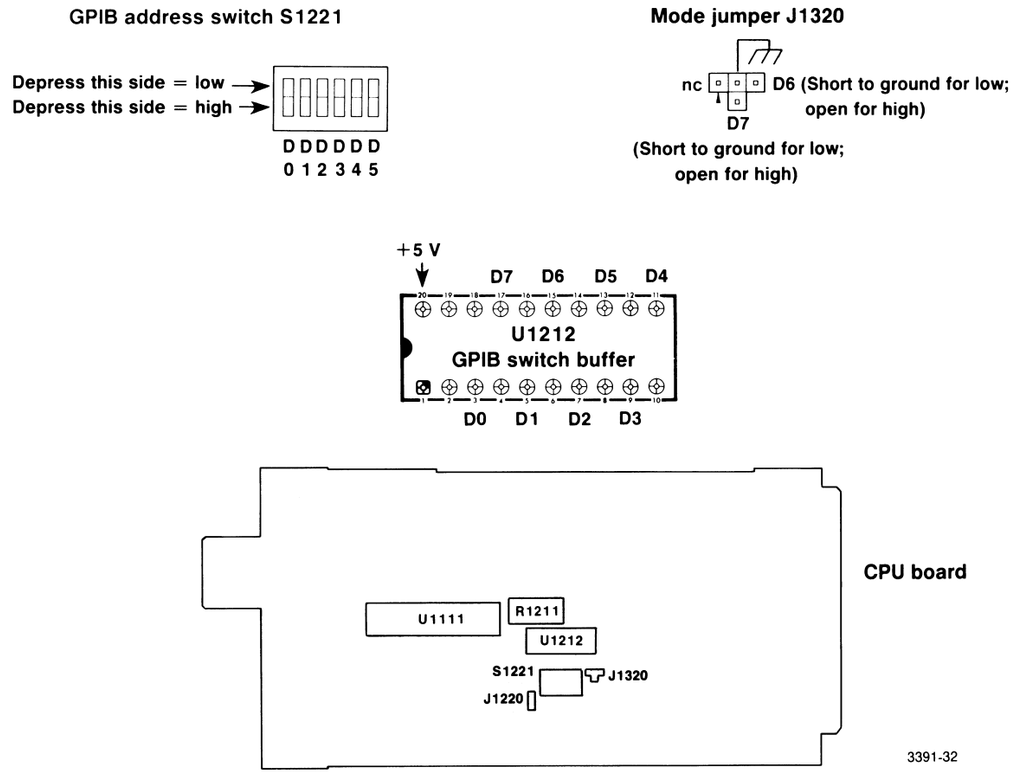


Fig. 9-1.

I. Purpose

To diagnose component failures in CPU, address lines or address decoding. Use this test when the instrument does not power up correctly or gives unknown error codes.

II. Equipment required

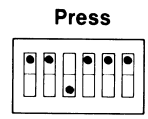
A. Tektronix SA 501 Signature Analyzer (or equivalent)
B. Two TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02
C. 16-pin DIP clip, Tektronix Part Number 003-0709-00
D. Oscilloscope

III. Electrical conditions necessary to perform test

A. MPU 01, MPU 02, 02 functional (02 is clock for signature analyzer). Check U1111 pins 3, 36, 37 and U1320 pin 2 for approximately a 1 MHz toggle.
B. No interrupts set. Check U1111 pins 2, 4, 6 and 40 for TTL highs.
C. A15 address line functioning (start/stop for signature analyzer). Check J1111 pin 34 for approximately a 7 Hz waveform (140 ms).

IV. Setup

A. PS5010 (on extenders)
   1. GPIB address switch (S1221) as shown.



   2. Mode jumper (J1320) as shown.

   3. Run/force data jumper (J1220) as shown.

   4. Remove R1211 (data bus jumper).

B. Signature analyzer
   Connect to CPU board and set as follows:
   Threshold = TTL

   Start = ⌐ Connect to A15, J1111, pin 34

   Stop = ⌐ Connect to A15, J1111, pin 34

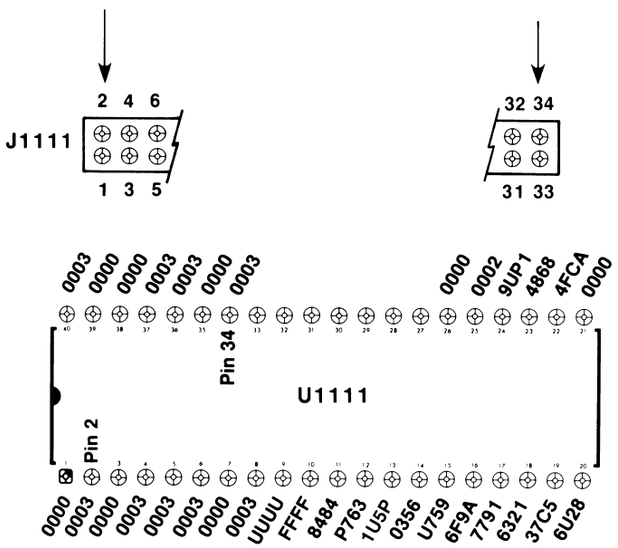
   Clock = ⌐ Connect to ϕ2 test point, J1111, pin 2 (clock)

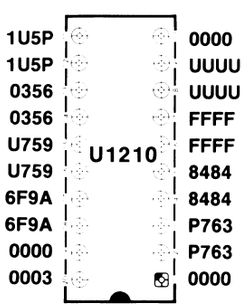
   Gnd = Connect to ground test point (TP1011)

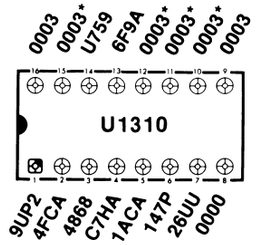
V. Measurements

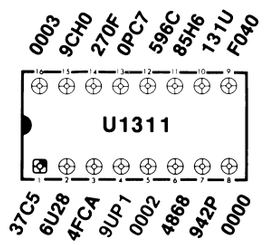
Verify +5 signature. Start with CPU (U1111) and check signatures. No data bus signatures are given as the RAM contents and keyboard encoder outputs are not predictable in a free run mode. Once CPU is verified check U1120 (RAM/ROM decoder), U1210 (address buffer), U1310 (address decoder), and U1311 (address decoder).

KERNEL TEST—CPU ADDRESS LINES AND ADDRESS CODING

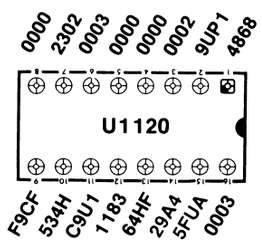


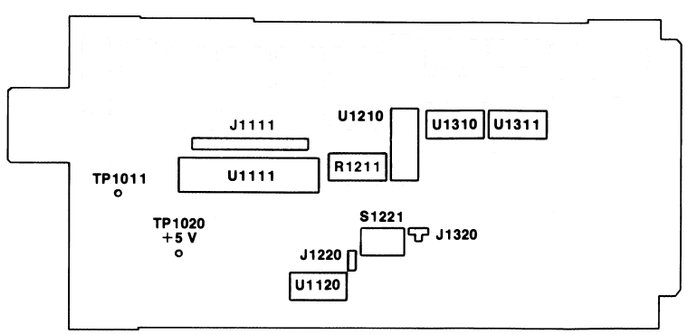






* These signatures are valid but do not exercise the nodes completely. Check these nodes with the Addressable Latch Firmware test.





CPU board

3391-33

Fig. 9-2.

@

I. Purpose

Verifies that correct and functioning ROMs are installed. This test can also find misplaced ROMs. The data bus is checked for stuck-at-zero or stuck-at-one states.

II. Equipment required

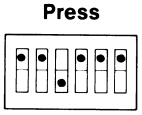
A. Tektronix SA 501 Signature Analyzer (or equivalent with qualify input)
B. Two 16-pin DIP clips, Tektronix Part Number 003-0709-00 or equivalent
C. TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02.

III. Electrical conditions necessary to perform test

A. 02, $\overline{02}$, CPU, address lines and address decoding functional. Verify with kernel test for CPU, address lines and address decoding.
B. $\overline{C/D\ ROM\ Enable}$ and $\overline{E/F\ ROM\ Enable}$ working (U1120, pins 9 and 7). Verify with CPU, address lines and address decoding kernel test.
C. $\overline{C\ ROM\ Enable}$, $\overline{D\ ROM\ Enable}$, $\overline{E\ ROM\ Enable}$, $\overline{F\ ROM\ Enable}$ working (U1310, pins 4, 5, 6, and 7). Verify with CPU, address lines, and address decoding kernel test.

IV. Setup

A. PS 5010 (set conditions with power off)
1. Place PS 5010 on flexible extenders
2. Set GPIB address switch (S1221) as shown.



3. Set run/force data jumper (J1220) as shown.

4. Remove R1211 (data bus jumper).
5. Set mode jumper (J1320) as shown.

B. Signature analyzer
Connect and set as follows:
Threshold = TTL

Start = ⌐ Connect to U1120, pin 7 or pin 9 (see chart)

Stop = ⌐ Connect to U1120, pin 7 or pin 9 (see chart)

Clock = ⌐ Connect to ϕ2 test point, J1111, pin 2 (clock)

Qual = ⌐ Connect to U1310 (see chart). Set QUAL to ON.

Gnd = Connect to ground test point (TP1011)

KERNEL TEST—ROM VERIFICATION

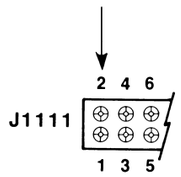
V. Measurements

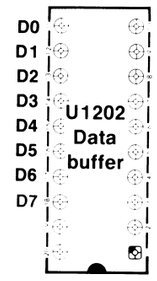
A. Use U1202, data buffer, pins 11-18 to take signatures. (This test assumes that address and data lines are good out to the ROMs).

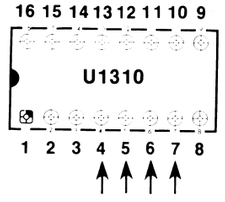
SA 501 Connections	C ROM (U1201)	D ROM (U1200)	E ROM (U1101)	F ROM (U1100)
Start/ stop	U1120 pin 9	U1120 pin 9	U1120 pin 7	U1120 pin 7
Qualify	U1310 pin 4	U1310 pin 5	U1310 pin 6	U1310 pin 7
		Signature signals		
+5 V	P254 (F4A9)	F4A9 (P254)	P254 (F4A9)	F4A9 (P254)
D0	H699 (U064)	3HF0 (1C3H)	6U9U (4962)	UAAP (UAAP)
D1	4617 (60PA)	4685 (6078)	5545 (73C8)	CA59 (CA59)
D2	H871 (UP8F)	F536 (P3FC)	1318 (35P5)	6FC2 (6FC2)
D3	058P (2373)	F07F (P681)	H58A (U377)	6PF2 (483U)
D4	0C37 (2HFA)	U263 (H49P)	7U26 (59HC)	H7UA (H7UA)
D5	1418 (32P5)	21PF (0711)	PP61 (F89F)	CH06 (CH06)
D6	576A (7197)	2P88 (0875)	690H (4UU0)	82P6 (82P6)
D7	9407 (C2UA)	9525 (C3H8)	7306 (55UC)	2C27 (0HHA)

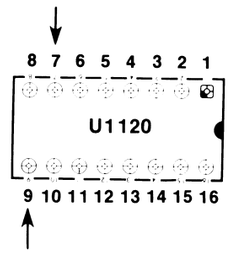
Explanation of signatures:

The start/stop and qualify connections are given first. Use +5 V signature to verify correct setup. The signatures given in parentheses are provided to locate misplaced ROMs. There are timing differences between the C/E and D/F ROM positions, which account for the different signatures on +5 V. ROM positions C and E give the same signatures for a particular ROM. ROM positions D and F will also give the same signatures for a particular ROM, but the C/E and D/F signatures will not match. In summary match +5 V signatures to correct data signatures, i.e., match +5 V in parentheses to data in parentheses and +5 without parentheses to data without parentheses.









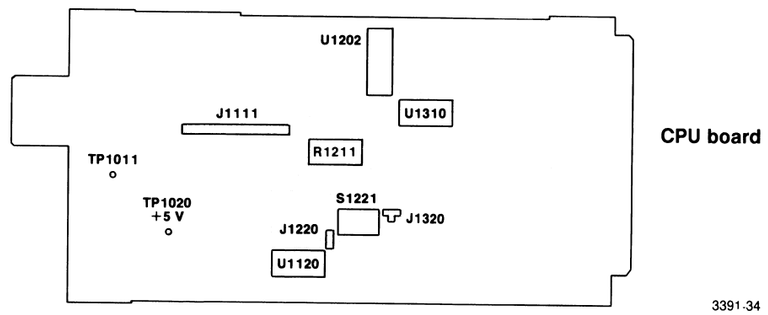


Fig. 9-3.

FIRMWARE SIGNATURE ANALYSIS—ADDRESS/DATA BUS

I. Purpose

Verify address lines and buffer, and data bus and buffer. Data bus checks verify correct outputs of GPIB chip (U1001) and keyboard encoder (U1421). If data bus signatures are not correct, use GPIB chip or keyboard encoder tests to locate problem. Also included are data bus signatures with keyboard encoder IC pulled to aid in troubleshooting. (Note that power-up self-test runs before signature analysis routine, so CPU, ROM, and RAM must be working.)

II. Equipment required

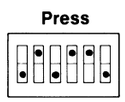
A. Tektronix SA 501 Signature Analyzer (or equivalent)
B. Two TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02

III. Electrical conditions necessary to perform test

A. CPU, ROM, and RAM functional (verified by power-up self-test)
B. Start/stop test point functional. Check for pulses approximately 5.5 ms apart (low true).

IV. Setup

A. PS 5010 (on extenders)
1. GPIB address switch to instrument ID 22.



2. Mode jumper (J1320) as shown.

3. Run/force data jumper (J1220) to run position. After power-up self-test (displays 521.), push front panel ID button.

B. Signature analyzer
Connect to CPU board and set as follows:
Threshold = TTL

Start = ⌐ Connect to S/S test point (TP1401)

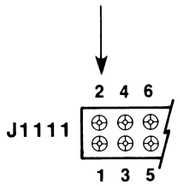
Stop = ⌐ Connect to S/S test point (TP1401)

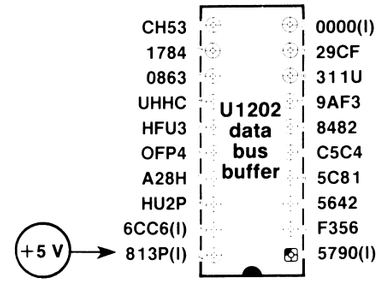
Clock = ⌐ Connect to ϕ2 test point, J1111, pin 2 (clock)

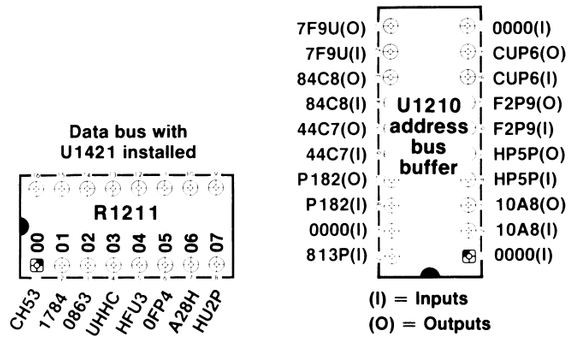
Gnd = Connect to ground test point (TP1011)

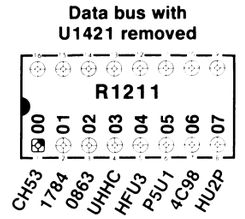
V. Measurements

Verify setup by taking +5 V signature (813p). Take signatures on address buffer (U1210) and then data buffer (U1202). This covers both buffered and unbuffered lines. U1211 signatures are given for keyboard encoder (U1421) installed or removed.









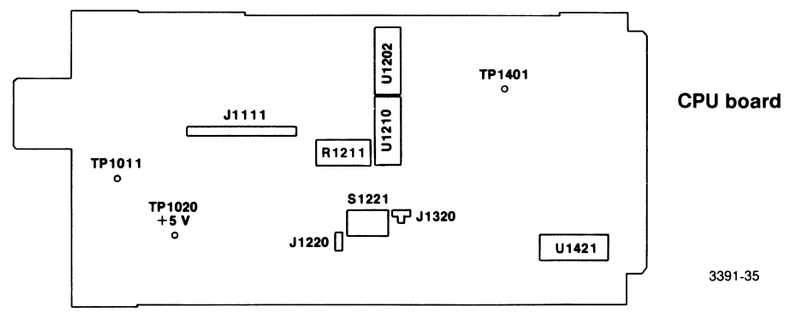


Fig. 9-4.

FIRMWARE SIGNATURE ANALYSIS—ADDRESSABLE LATCHES

I. Purpose

To troubleshoot the three addressable latches. Use this test to check the following ICs and their functions.

A. Dim and relay latch—U1315
B. Serial output and partial display latch—U1411
C. Blink control latch—U1314

II. Equipment required

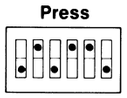
A. Tektronix SA 501 Signature Analyzer (or equivalent)
B. Two TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02
C. 16-pin DIP clip, Tektronix Part Number 003-0709-00 or equivalent

III. Electrical conditions necessary to perform tests

A. CPU, RAM, ROM data, and address lines functional (verified by power-up self test).
B. Start/stop test point (TP1401) functional. Check for pulses approximately 5.5 ms apart (low true).
C. U1220, pin 6, clock signal functional. Check for approximately a 1 MHz toggle.

IV. Setup

A. PS 5010 (on extenders)
1. Set GPIB address switch S1221 to ID 22.



2. Set mode jumper (J1320) as shown.

3. Set run/force data jumper (J1220) as shown.

B. Signature analyzer
Connect to CPU board and set as follows:
Threshold = TTL

Start = ⌐ Connect to S/S test point (TP1401)

Stop = ⌙ Connect to S/S test point (TP1401)

Clock = ⌐ Connect to U1220, pin 6 (via DIP clip)

Gnd = Connect to ground test point (TP1011)

V. Measurements

Verify setup by taking +5 V and start signatures. Take measurements directly on U1314, U1315, and U1411. If the chip enable signals are bad (pin 14), check U1310 (address decoder).

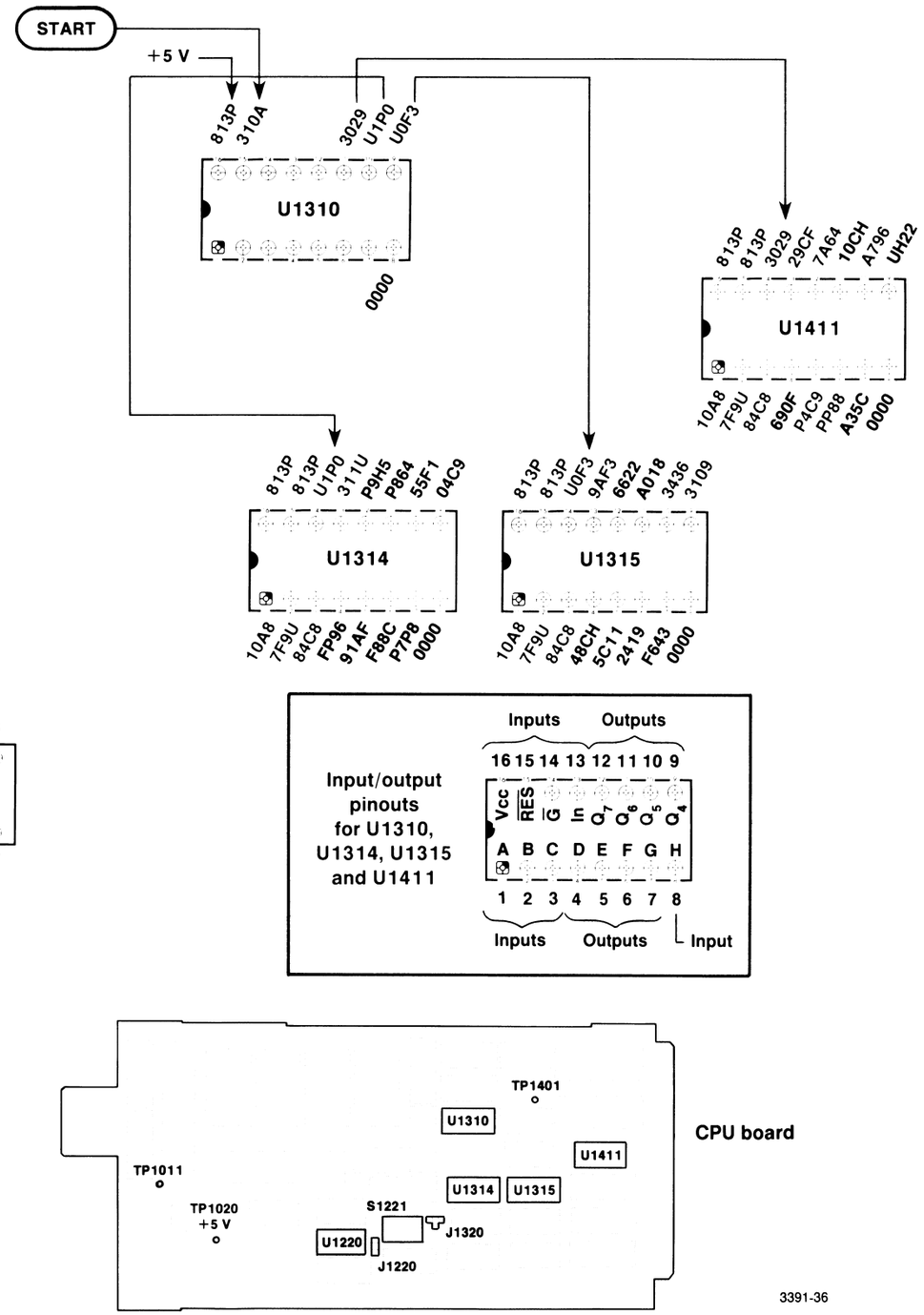


Fig. 9-5.

FIRMWARE SIGNATURE ANALYSIS—GPIB CHIP TEST (U1001)

I. Purpose

Use this test to determine if GPIB chip (U1001) is causing data bus signature errors.

II. Equipment Required

A. Tektronix SA 501 Signature Analyzer (or equivalent)
B. Two TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02
C. 16-pin DIP clip, Tektronix Part Number 003-0709-00

III. Electrical conditions necessary to perform test

A. CPU, ROM, and RAM address and data lines functional (verified by power-up self test).
B. Chip select for GPIB chip functional (U1120, pin 11). Check U1120 pin 11 for pulses approximately 5.5 ms apart (low true).

IV. Setup

PS 5010 (on extenders):

A. Set mode jumper (J1320) as shown

Signature mode

B. Set run/force data jumper (J1220) as shown

Run

C. Signature analyzer
Connect to CPU board and set as follows:
Threshold = TTL

Start = ⌐ Connect to U1120, pin 11 via DIP clip

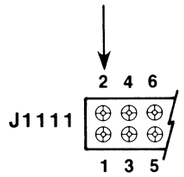
Stop = ⌐ Connect to U1120, pin 11 via DIP clip

Clock = ⌐ Connect to ϕ2, J1111, pin 2 (clock)

Gnd = Connect to ground test point (TP1011)

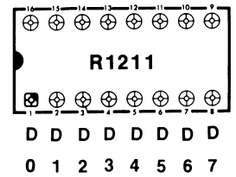
V. Measurements

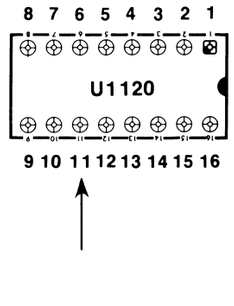
Verify setup by taking signature on +5 V test point. Read data bus by checking pins 1 through 8 on R1211 (data bus jumper).



All data lines should read 0000

+5 V test point 0001





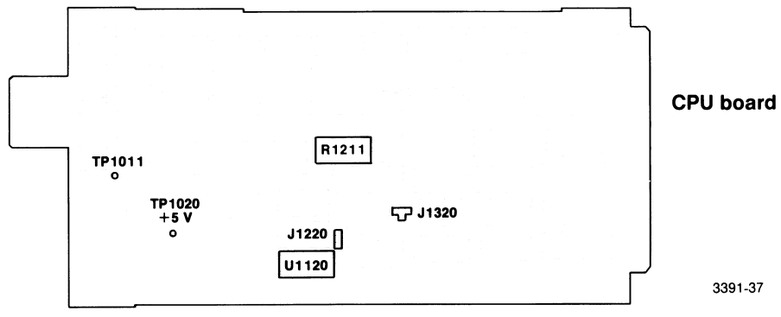


Fig. 9-6.

FIRMWARE SIGNATURE ANALYSIS—KEYBOARD ENCODER (U1421)

I. Purpose

To provide a complete checkout of the keyboard encoder, front panel pushbuttons and signal lines to aid in troubleshooting key entry problems.

II. Equipment required

A. Tektronix SA 501 Signature Analyzer (or equivalent)
B. Two TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02
C. 16-pin DIP clip, Tektronix Part Number 003-0709-00

III. Electrical conditions necessary to perform tests

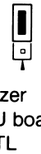
A. CPU, ROM, RAM, data and address bus working properly (verified by power-up self test)
B. $\overline{\text{Sel}}$ keyboard (U1311, pin 13) working. Check U1311 pin 13 for pulses. Approximately 5.5 ms apart.

IV. Setup

A. PS 5010 (on extenders)
   1. Set mode jumper (J1320) as shown.

Signature mode

   2. Set run/force data jumper (J1220) as shown.



Force data

B. Signature analyzer
   Connect to CPU board and set as follows:
   Threshold = TTL

   Start = ⌊ Connect to U1311, pin 13 via DIP clip

   Stop = ⌈ Connect to U1311, pin 13 via DIP clip

   Clock = ⌊ Connect to Φ2 via J1111, pin 2 (clock)

   Gnd = Connect to ground test point (TP1011)

V. Measurements

Using the following chart, verify stimulus and response for each front panel key. Start by verifying +5 V signature, then push the problem button(s) and read data bus at U1211, pins 1-8 for correct code. Note that data bits 0, 1, and 2 are not affected by keyboard encoder.

If incorrect data is received check the states of the X and Y inputs to U1421 (keyboard encoder) according to those in the chart. X is a pulse (approximately 1—5 ms); Y is a low as long as the key is down. Whenever a key is down, U1421, pin 13 (data available) is high. When key is released this signal should go low.

+5 V Signature = 0001

Key Name	D0, D1 D2	X (Pulse)	Y (Low)	D3	D4	D5	D6	D7
INST ID	0001	X4	Y5	0001	0001	0000	0000	0001
ENTER	0001	X1	Y4	0000	0000	0001	0001	0000
CLEAR	0001	X4	Y3	0001	0001	0000	0001	0000
3	0001	X4	Y1	0001	0001	0000	0000	0000
6	0001	X3	Y2	0000	0001	0001	0000	0000
9	0001	X2	Y3	0001	0000	0000	0001	0000
8	0001	X1	Y3	0000	0000	0000	0001	0000
5	0001	X2	Y2	0001	0000	0001	0000	0000
2	0001	X3	Y1	0000	0001	0000	0000	0000
•	0001	X3	Y3	0000	0001	0000	0001	0000
0	0001	X1	Y1	0000	0000	0000	0000	0000
1	0001	X2	Y1	0001	0000	0000	0000	0000
4	0001	X1	Y2	0000	0000	0001	0000	0000
7	0001	X4	Y2	0001	0001	0001	0000	0000
INCREMENT ↑	0001	X2	Y5	0001	0000	0000	0000	0001
SUPPLY SELECT	0001	X2	Y4	0001	0000	0001	0001	0000
CURRENT	0001	X4	Y4	0001	0001	0001	0001	0000
VOLTAGE	0001	X1	Y5	0000	0000	0000	0000	0001
INCREMENT ↓	0001	X3	Y5	0000	0001	0000	0000	0001
OUTPUT	0001	X3	Y4	0000	0001	0001	0001	0000

@

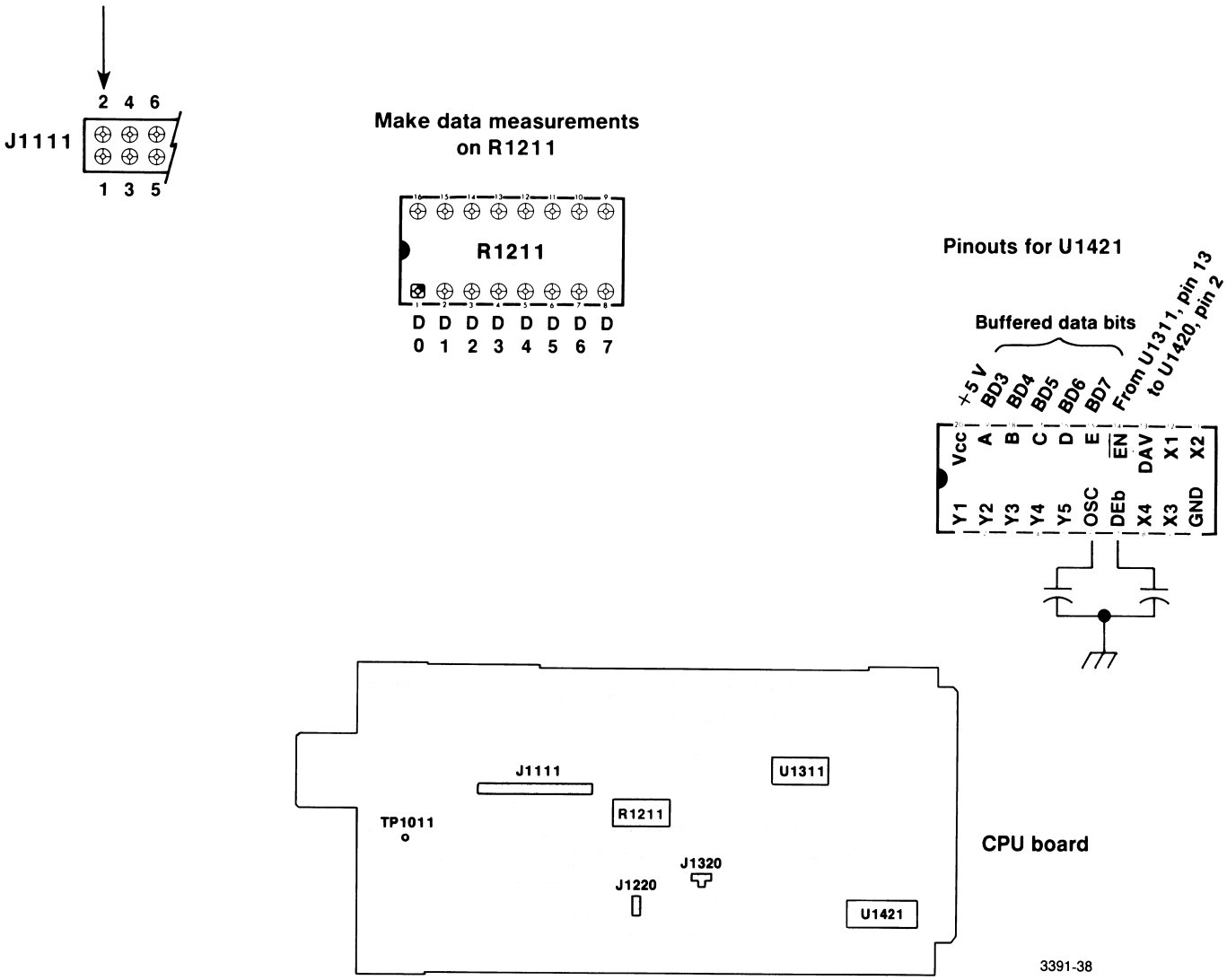

2 4 6
J1111
1 3 5
Make data measurements
on R1211
R1211
D D D D D D D D
0 1 2 3 4 5 6 7
Pinouts for U1421
Buffered data bits
+5 V
BD3
BD4
BD5
BD6
BD7
From U1311, pin 13
to U1420, pin 2
Vcc A B C D E EN DAV X1 X2
Y1 Y2 Y3 Y4 Y5 OSC DEb X4 X3 GND
J1111
U1311
R1211
TP1011
J1320
J1220
U1421
CPU board
3391-38

Fig. 9-7.

FIRMWARE SIGNATURE ANALYSIS—LOGIC SUPPLY SHIFT REGISTERS

I. Purpose

To diagnose component failures in the logic supply shift registers.

II. Equipment required

A. Tektronix SA 501 Signature Analyzer (or equivalent)
B. CPU Board Extender (067-1028-00 kit)
C. Logic Board Extender (067-1028-00 kit)
D. Two TM 500 Flexible Extenders, Tektronix Part Number 067-0645-02

III. Electrical conditions necessary to perform test

A. CPU, ROM and RAM functional (verified by power-up self test)
B. Serial outputs from CPU board functional. Verify with addressable latch test.
C. Start/stop test point (TP1401 functional). Check S/S test point (TP1401) for pulses approximately 5.5 ms apart.

IV. Setup

A. PS 5010 (extend boards with power off)
1. Place logic supply board on extender.
2. Place CPU board on extender.
3. Set mode jumper (J1320) as shown.

4. Set run/force data jumper (J1220) as shown.

B. Signature analyzer
Connect to CPU board and set as follows:
Threshold = TTL

Start = ⎍ Connect to CPU board s/s test point (TP1401)

Stop = ⎍ Connect to CPU board s/s test point (TP1401)

Clock = ⎣ Connect to CPU board ϕ2 test point, J1111, pin 2 (clock)

Gnd = Connect to ground test point (TP1011)

V. Measurements

Start by checking +5 V signature (pin 14, U1841) to verify correct setup. Take measurements on shift registers starting with U1841, then U2041. If inputs (I) to either chip are correct and outputs (O) are incorrect that chip may be defective.

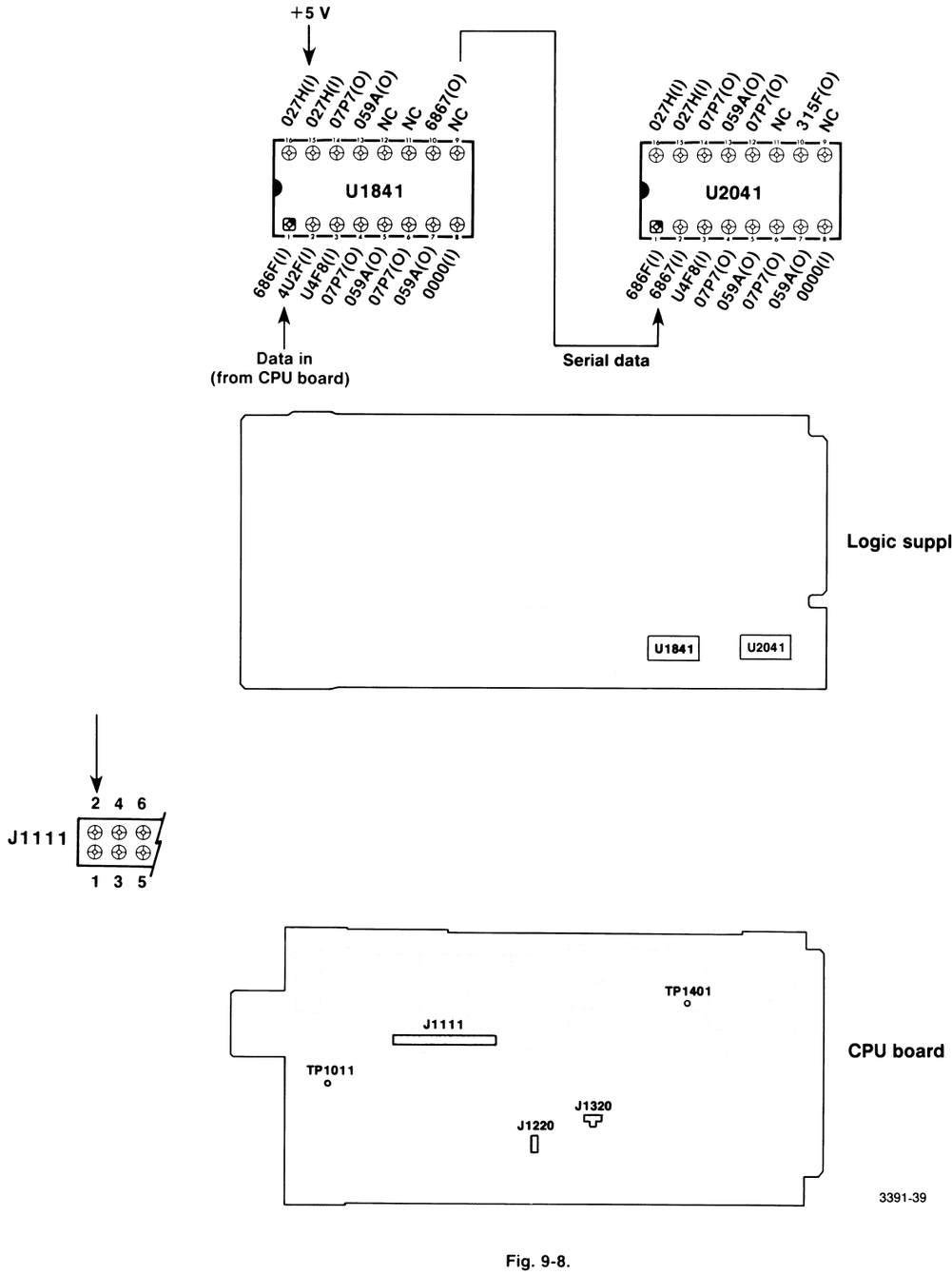
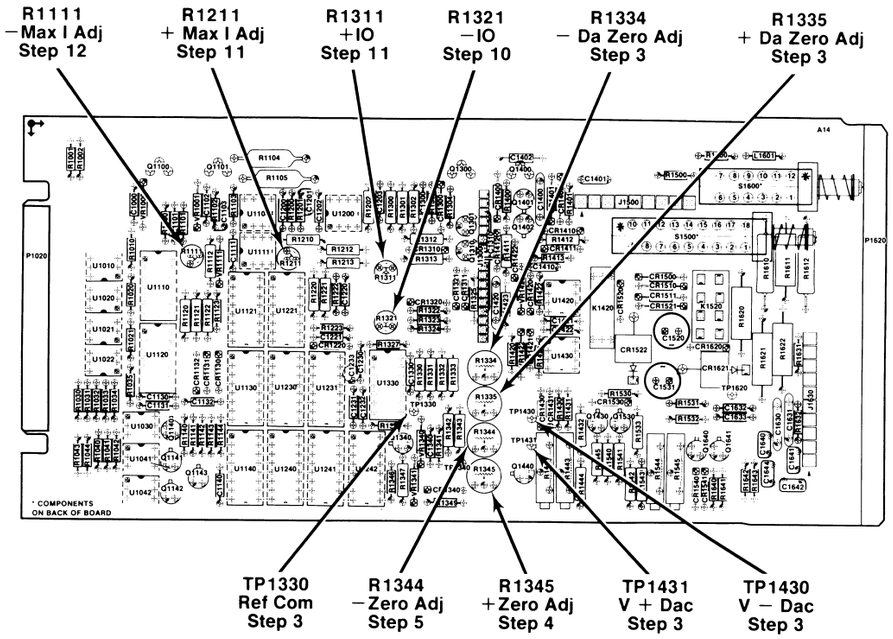


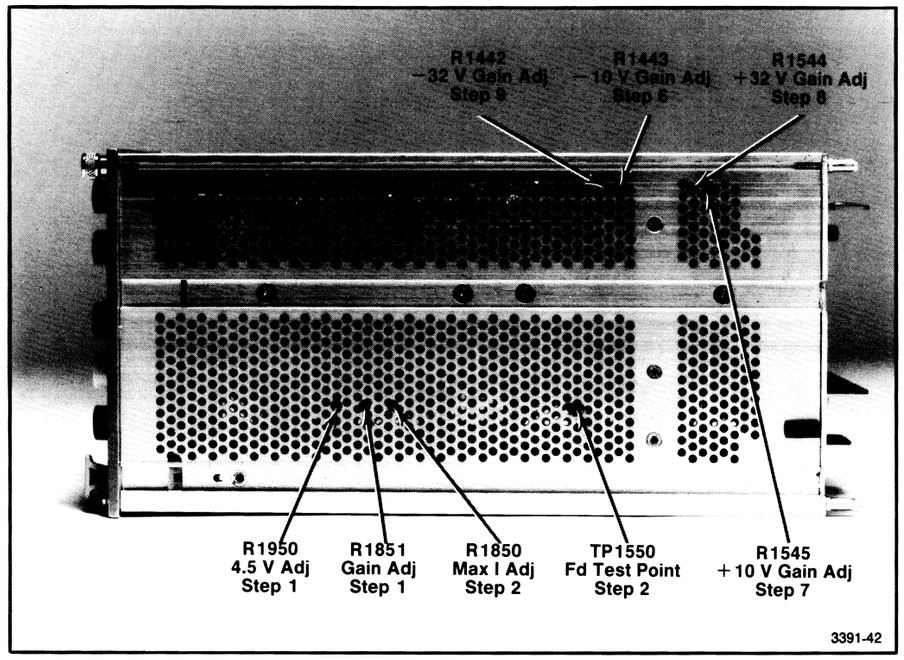
Fig. 9-8.

ADJUSTMENT LOCATIONS



3391-41

Fig. 9-9. **Floating supply board (A14) adjustments.**



3391-42

Fig. 9-10. **Adjustments accessed through bottom of instrument.**

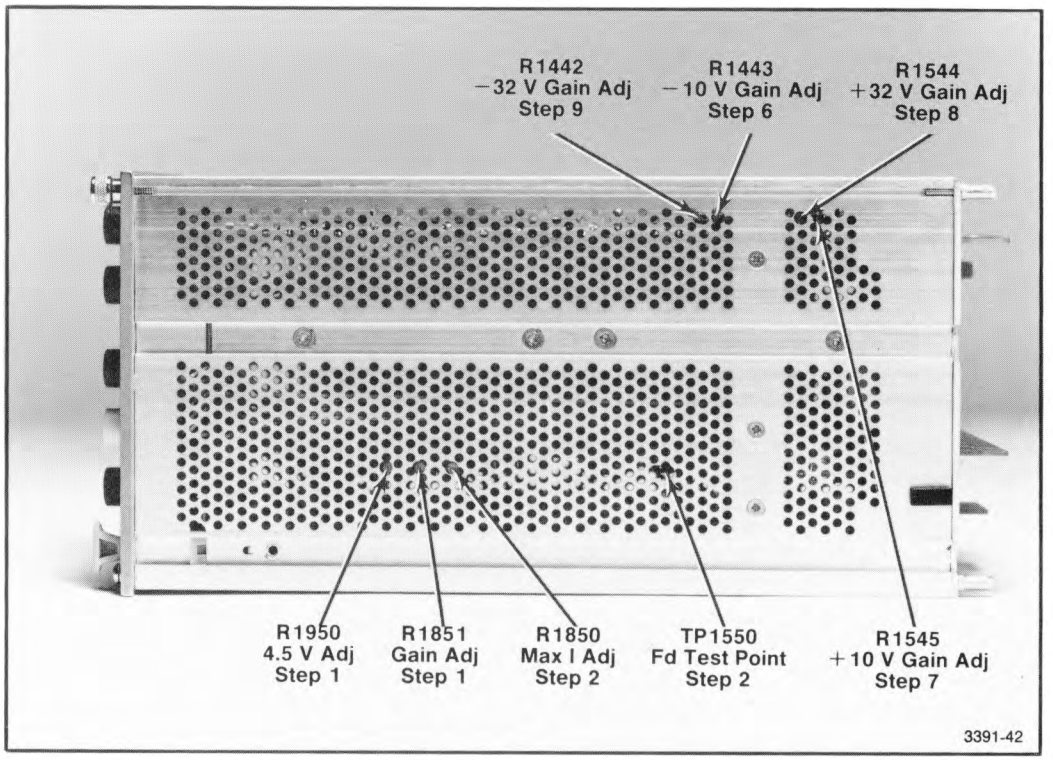
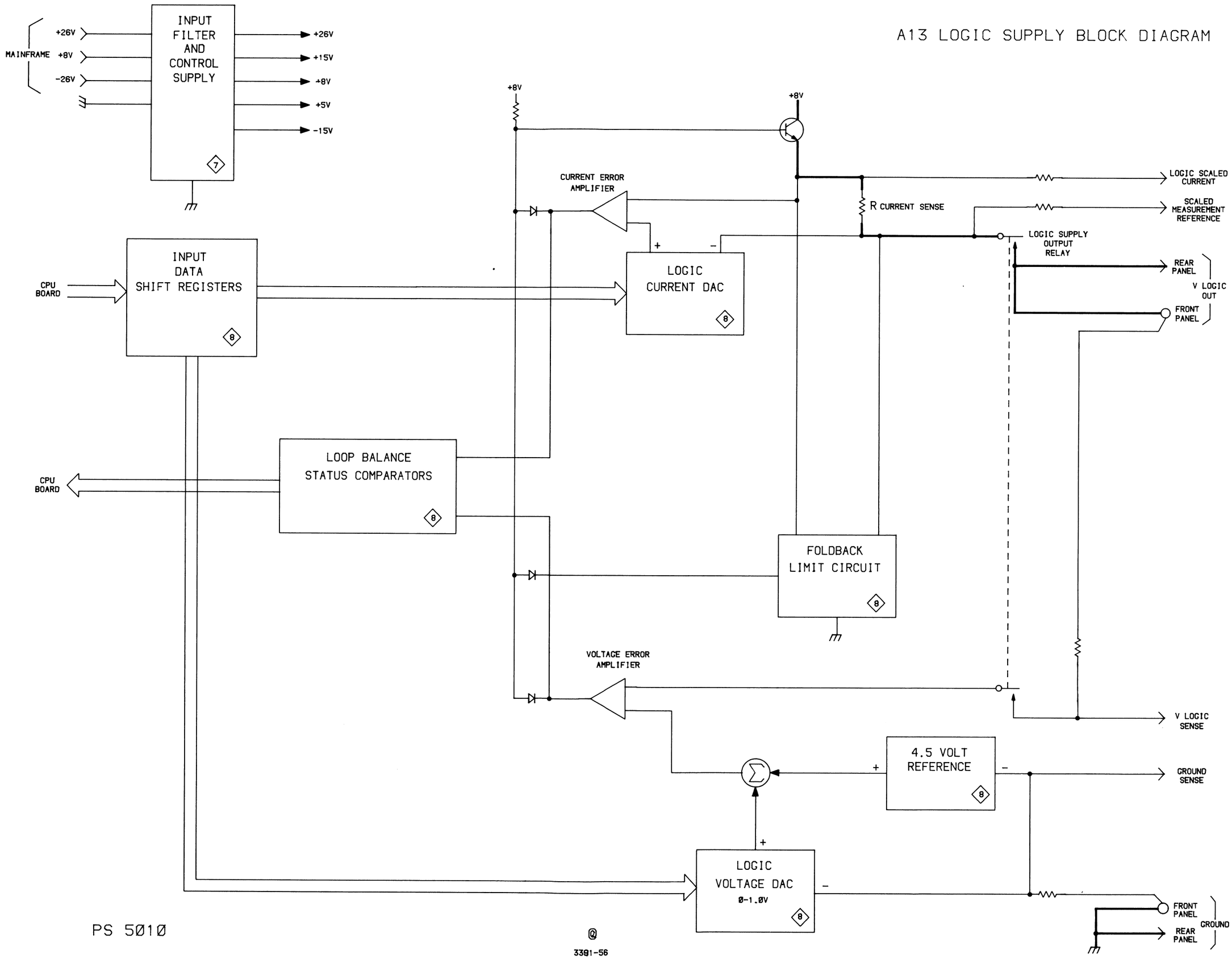


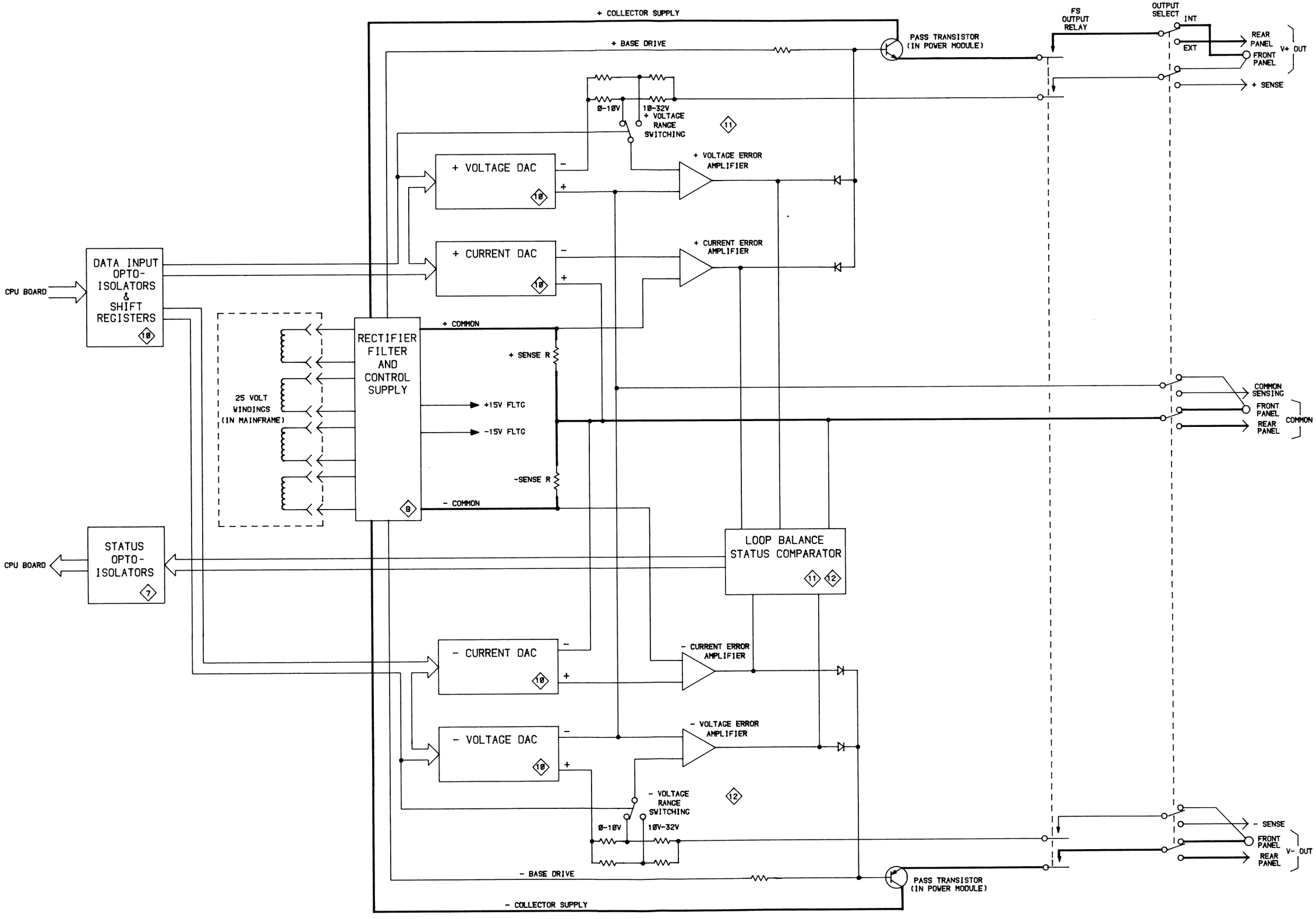
Fig. 9-10. Adjustments accessed through bottom of instrument.

A13 LOGIC SUPPLY BLOCK DIAGRAM



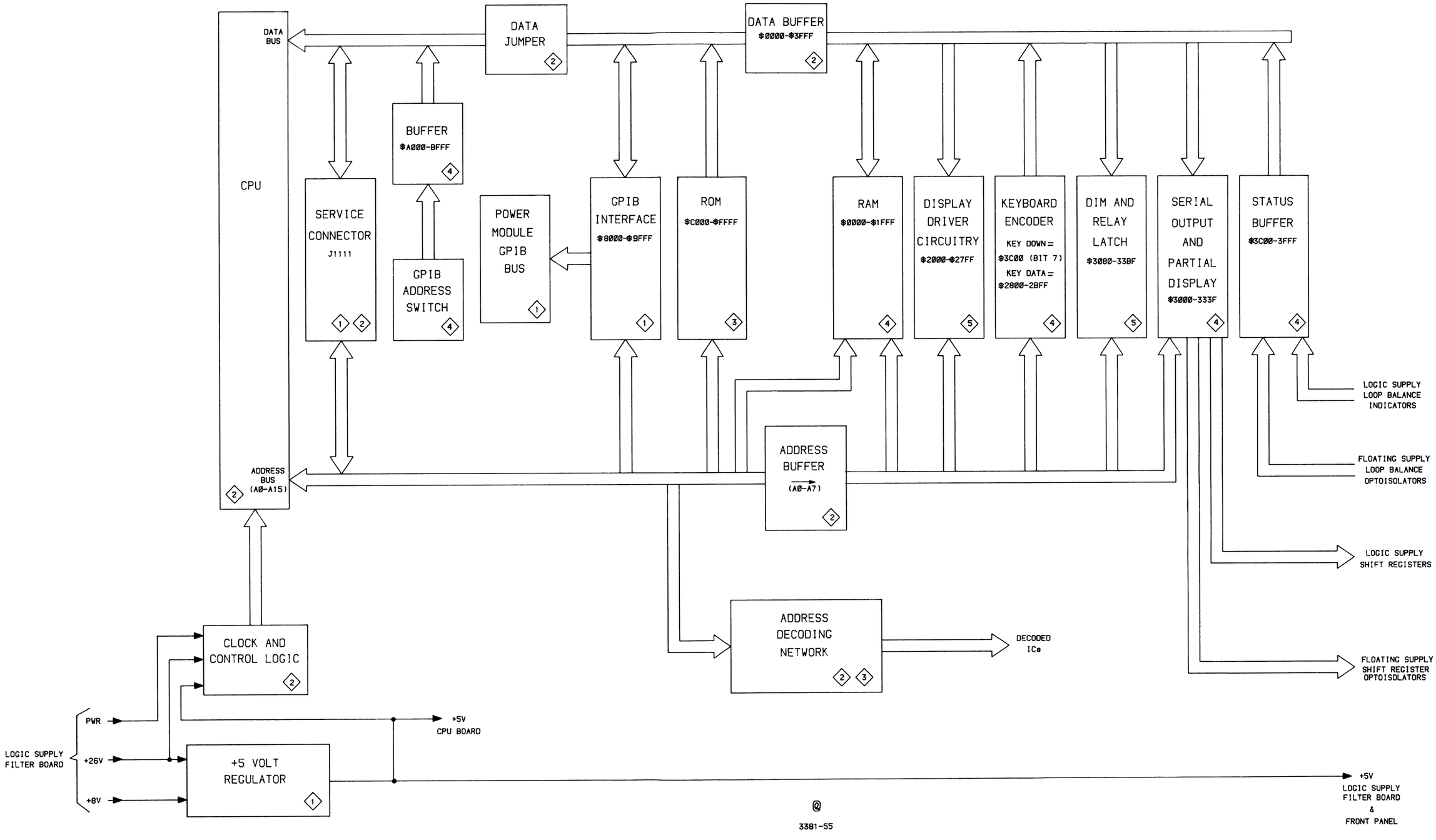
PS 5010

A14 FLOATING SUPPLY BLOCK DIAGRAM



PS 5Ø1Ø

A12 CPU BOARD BLOCK DIAGRAM



3381-55

PS 5010

PARTS LOCATION GRID

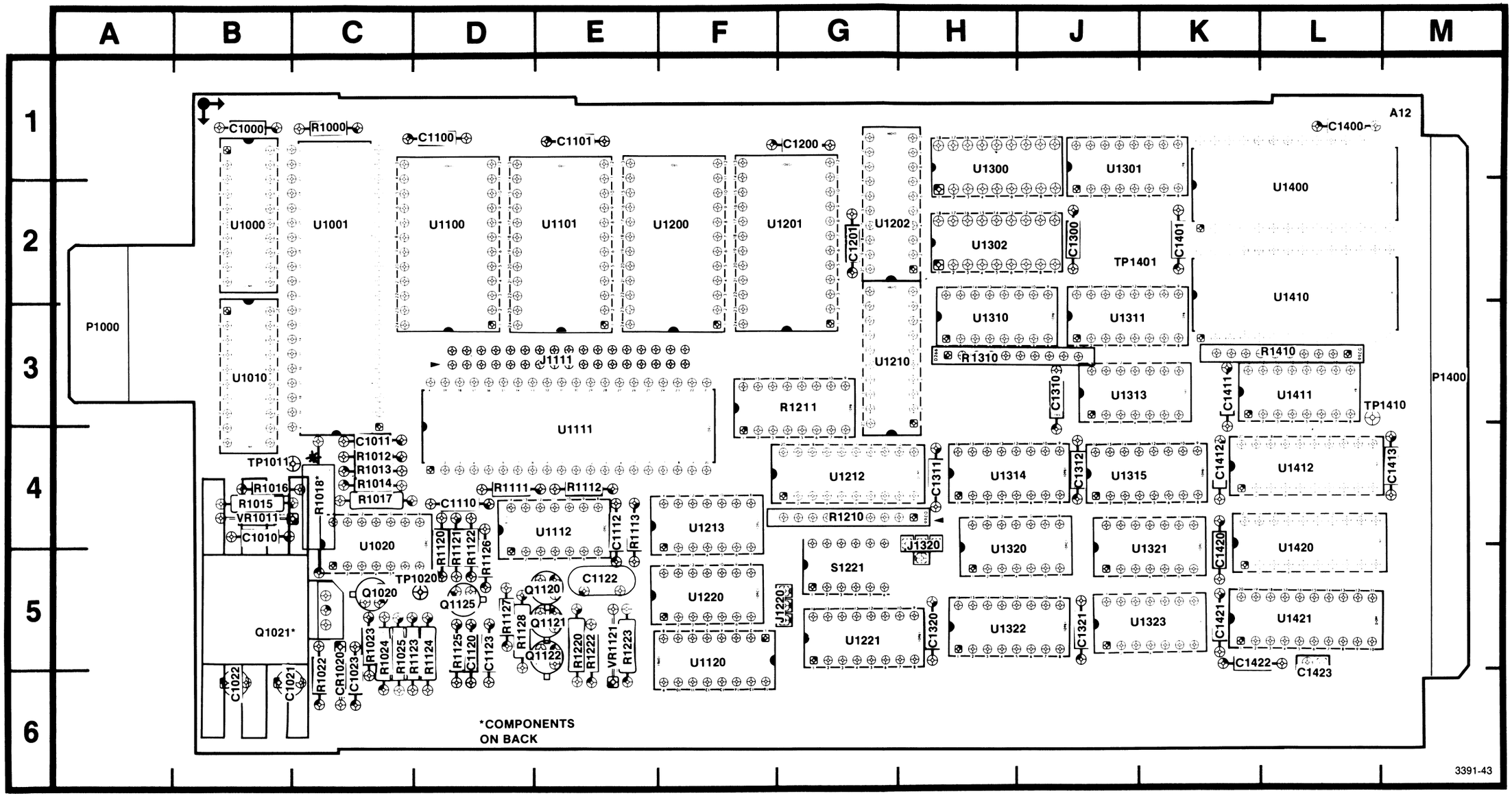
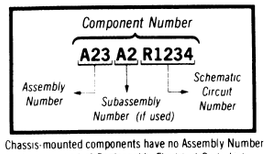


Fig. 9-11. CPU board (A12).

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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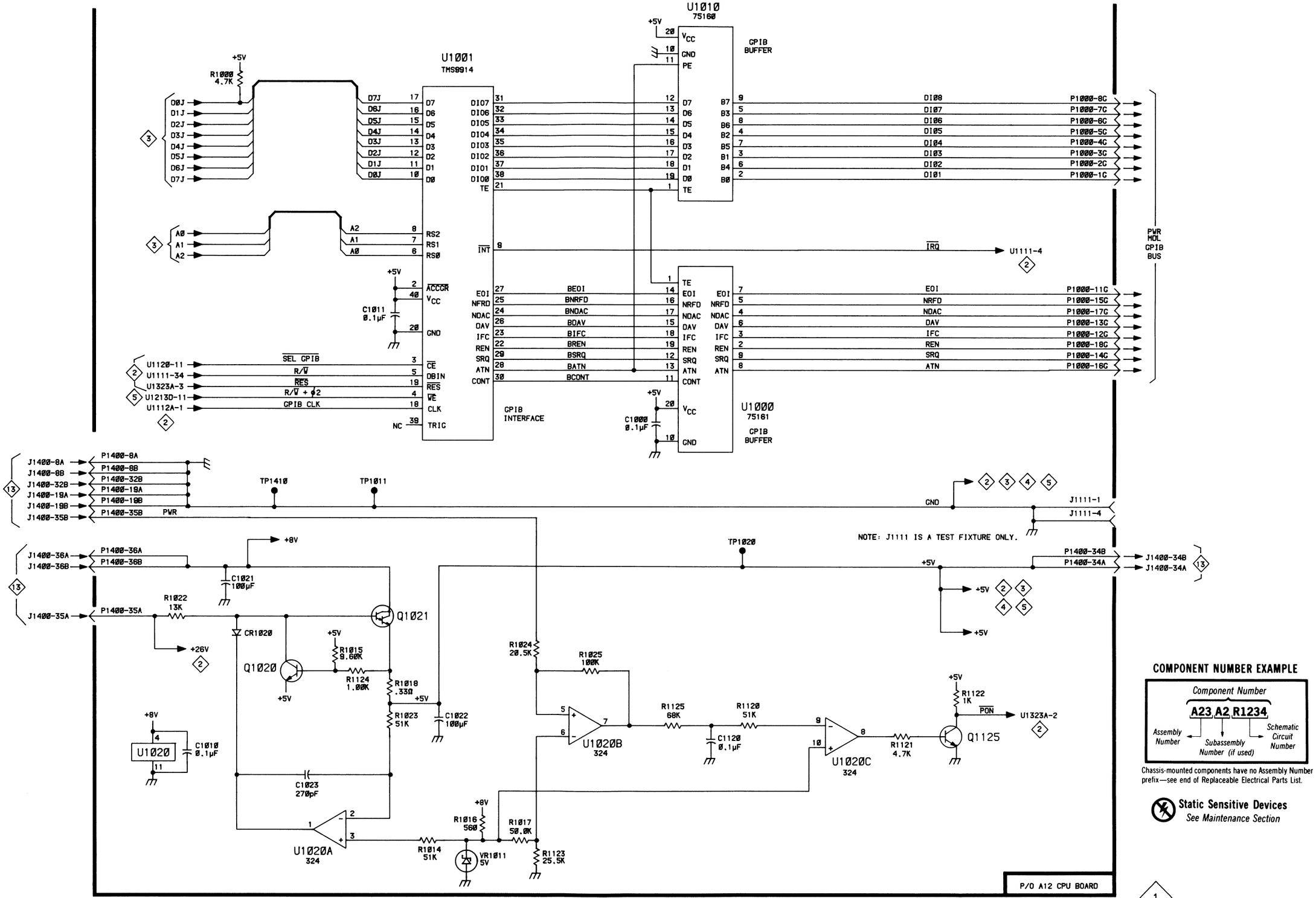
Table 9-1
COMPONENT REFERENCE CHART

P/O A12 ASSY — CPU Power Supply ◇1

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1000	G5	B1
C1010	C8	B4
C1011	D4	C4
C1021	C6	B6
C1022	E7	B6
C1023	D8	C6
C1120	H8	D5
CR1020	C7	C6
J1111	K5	E3
J1111	K6	E3
J1400	A5	M3
P1000	K2	A3
P1400	B5	M3
Q1020	C7	C5
Q1021	E6	B5
Q1125	J8	D5
R1000	C2	C1
R1014	E9	C4
R1015	D7	B4
R1016	E8	B4
R1017	F8	C4
R1018	E7	C4
R1022	C6	C6
R1023	E7	C5
R1024	F7	C5
R1025	F7	C5
R1120	H7	D4
R1121	I8	D4
R1122	J7	D4
R1123	F9	C5
R1124	D7	D5
R1125	G7	D5
TP1011	D5	B4
TP1020	H6	D5
TP1410	C5	L3
U1000	H5	B2
U1001	E1	C2
U1010	G1	B3
U1020A	D9	C4
U1020B	F8	C4
U1020C	I8	C4
VR1011	E9	B4

P/O A12 ASSY also shown on ◇2 ◇3 ◇4 ◇5



COMPONENT NUMBER EXAMPLE

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

PS 5010

CPU POWER SUPPLY

DJD

3391-58

PARTS LOCATION GRID

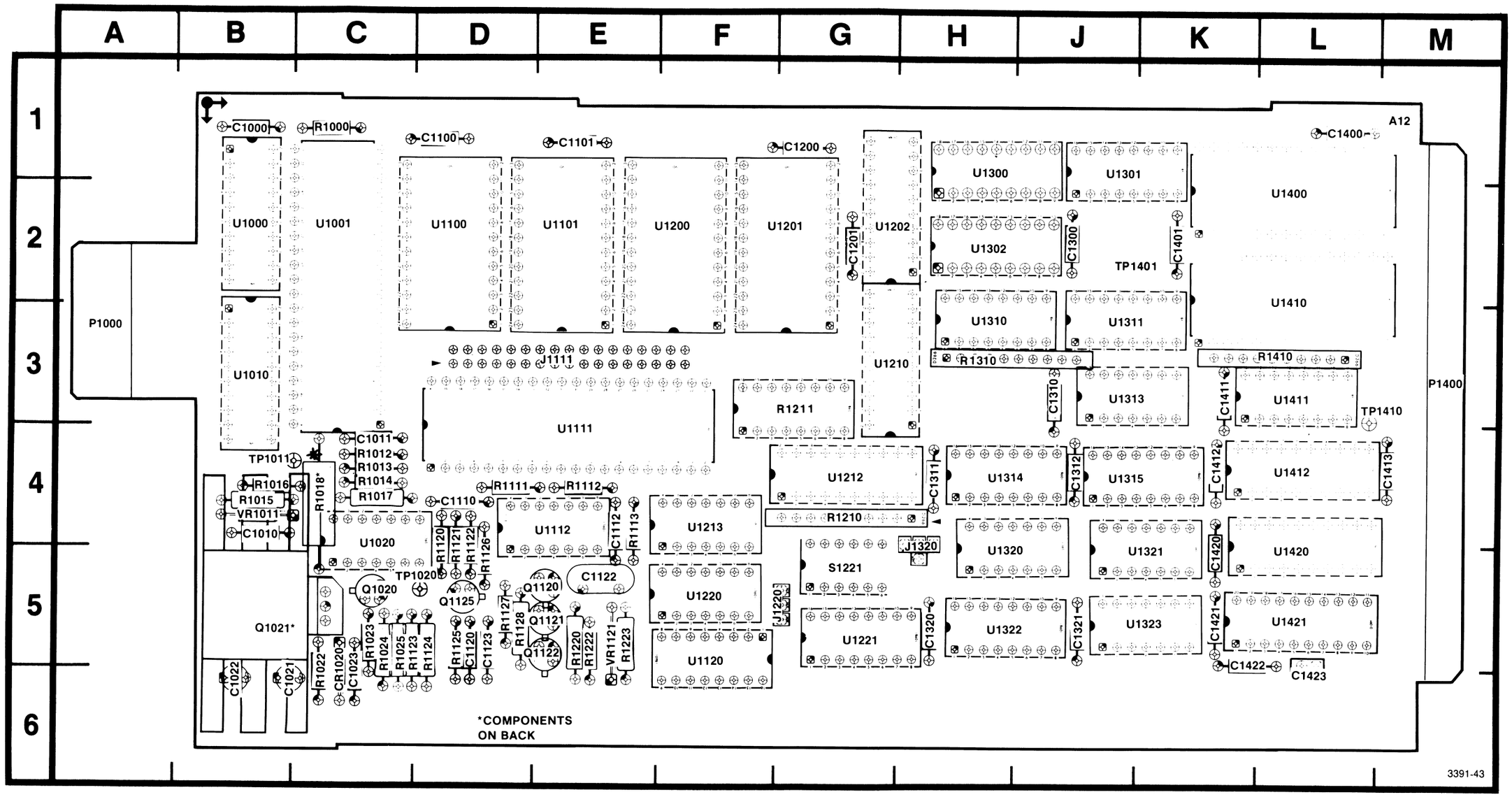
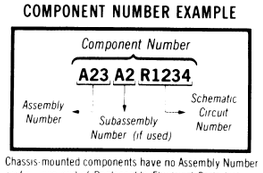


Fig. 9-12. CPU board (A12)

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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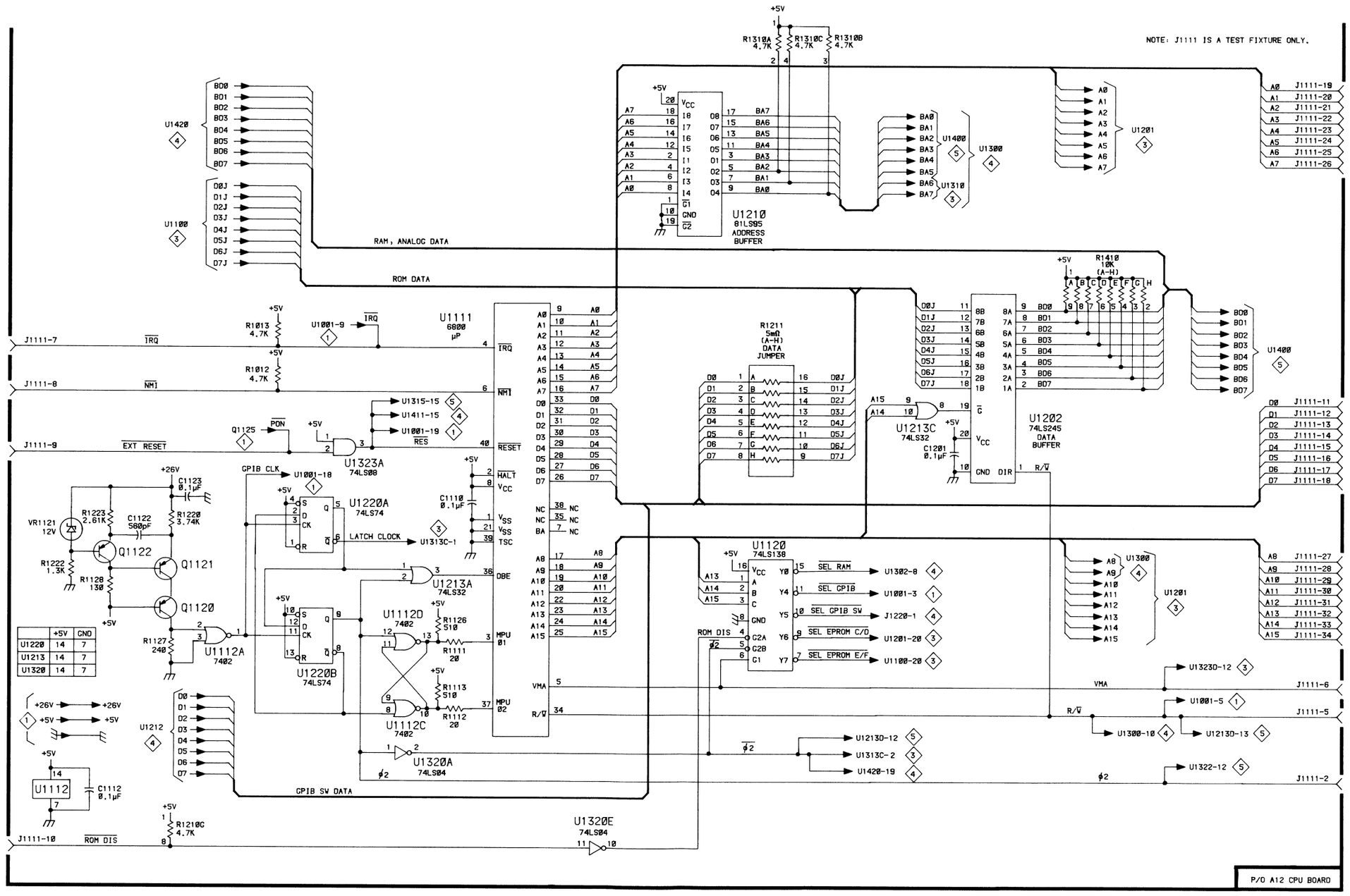
Table 9-2
COMPONENT REFERENCE CHART

P/O A12 ASSY

Microprocessor ◇2

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1110	E5	D4
C1112	B8	E4
C1122	C5	E5
C1123	C5	D5
C1201	J5	G2
J1111	M8	E3
J1111	M7	E3
J1111	M4	E3
J1111	B8	E3
J1111	M1	E3
J1111	M2	E3
J1111	B5	E3
J1111	B4	E3
J1111	M5	E3
J1111	M6	E3
Q1120	C6	E5
Q1121	C6	E5
Q1122	C6	E5
R1012	D4	C4
R1013	D4	C4
R1111	E7	D4
R1112	E7	E4
R1113	E7	E4
R1126	E6	D5
R1127	C6	D5
R1128	B6	D5
R1210G	C8	G4
R1211	H4	G3
R1220	C5	E5
R1222	B6	E5
R1223	B5	E5
R1310A	H1	H3
R1310B	I1	H3
R1310C	I1	H3
R1410	K3	L3
U1111	E4	E4
U1112A	C7	E4
U1112C	E7	E4
U1112D	E6	E4
U1120	H6	F5
U1202	K4	G2
U1210	H3	G3
U1213A	E6	F4
U1213C	J4	F4
U1220A	E5	F5
U1220B	D7	F5
U1320A	E8	H5
U1320E	G8	H5
U1323A	E5	K5
VR1121	B5	E5

P/O A12 ASSY also shown on ◇1 ◇3 ◇4 ◇5



PS 5010

MICROPROCESSOR 2

3391-59

DJD

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
(Assembly Number · Subassembly Number (if used) · Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices *See Maintenance Section*

PARTS LOCATION GRID

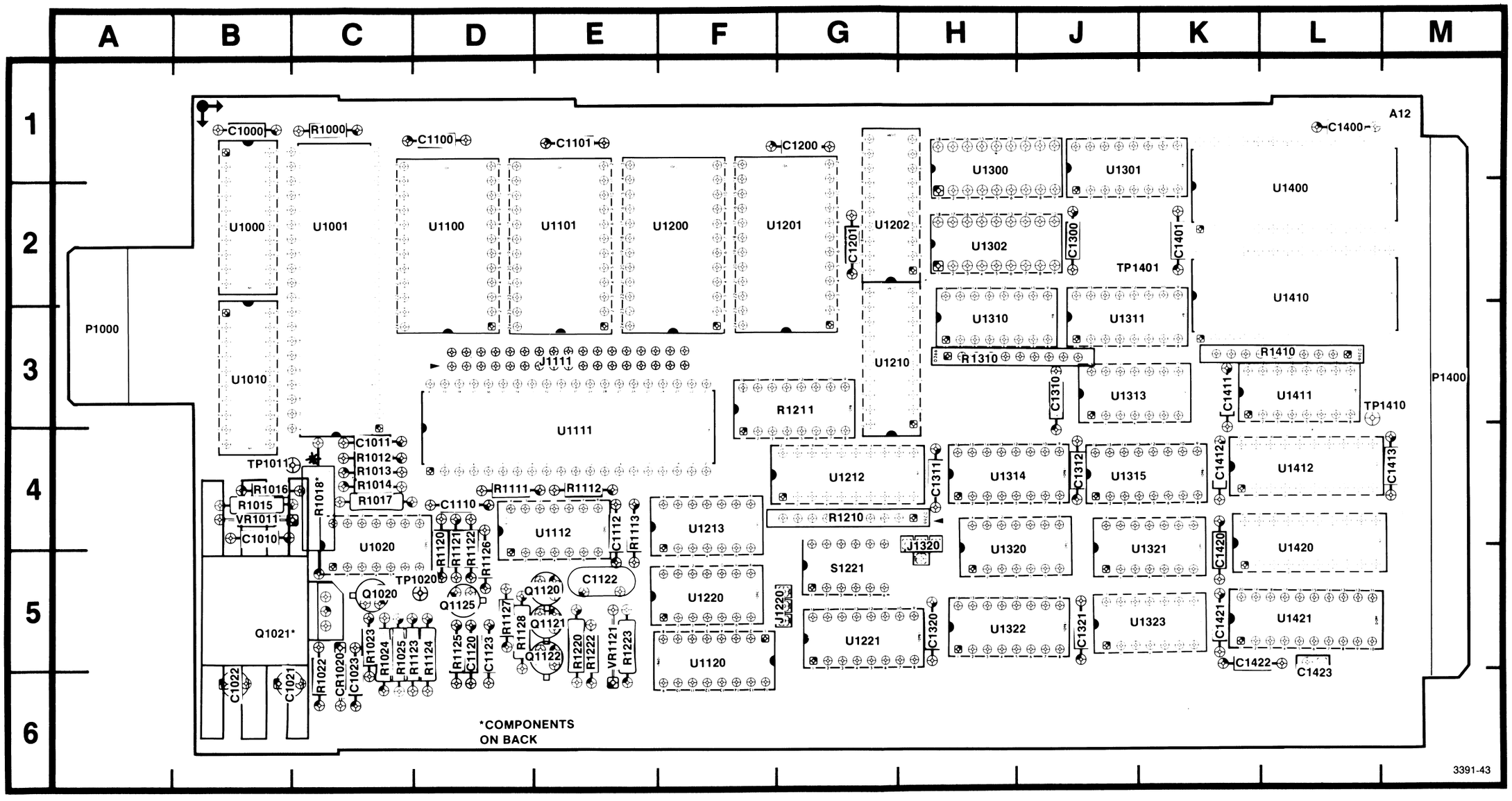
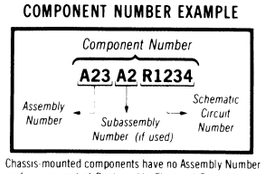


Fig. 9-13. CPU board (A12).

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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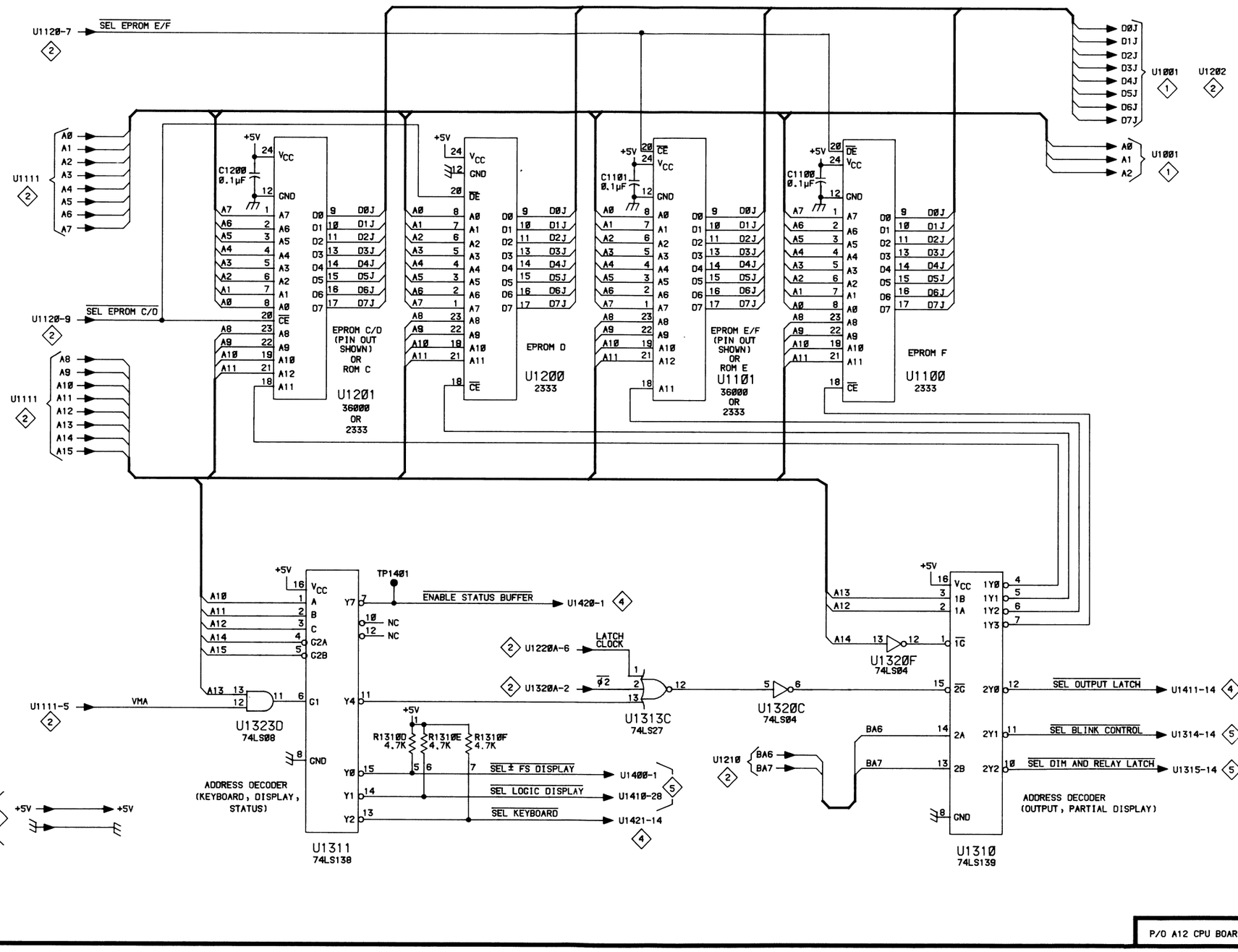
Table 9-3
COMPONENT REFERENCE CHART

P/O A12 ASSY — Memory ◇3

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1100	H3	D1	U1100	I4	D2
C1101	F3	E1	U1101	G4	E2
C1200	D3	G1	U1200	F4	F2
			U1201	D4	G2
R1310D	E7	H3	U1310	I8	H3
R1310E	E7	H3	U1311	D8	J3
R1310F	F7	H3	U1313C	G7	J3
			U1320C	H7	H5
TP1401	E6	K2	U1320F	I6	H5
			U1323D	D7	K5

P/O A12 ASSY also shown on ◇1 ◇2 ◇4 ◇5



COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
(Assembly Number · Subassembly Number (if used) · Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

PARTS LOCATION GRID

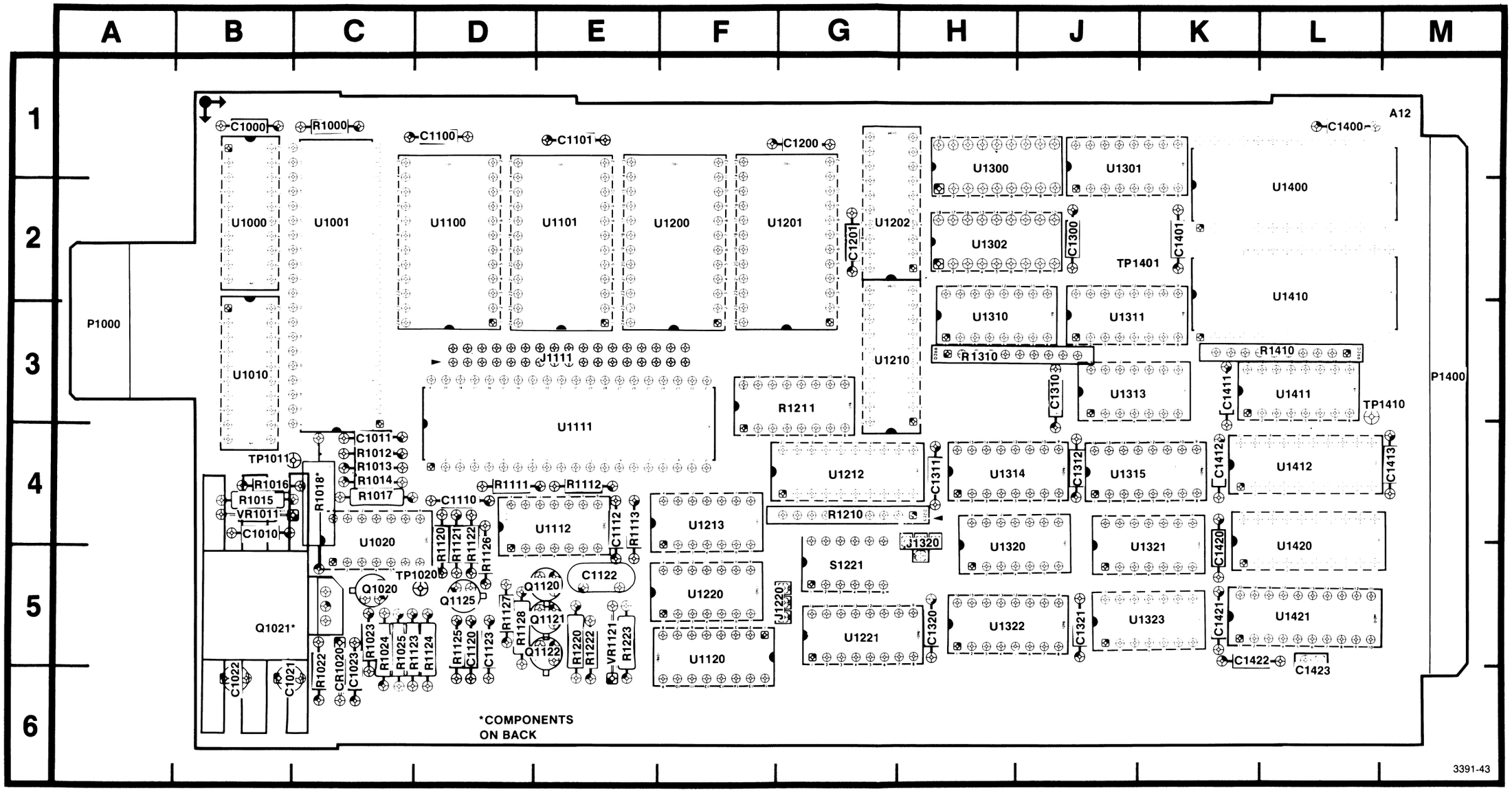
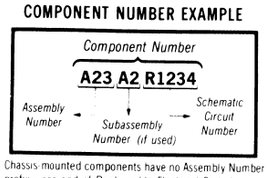


Fig. 9-14. CPU board (A12).

COMPONENT NUMBER EXAMPLE



Chassis mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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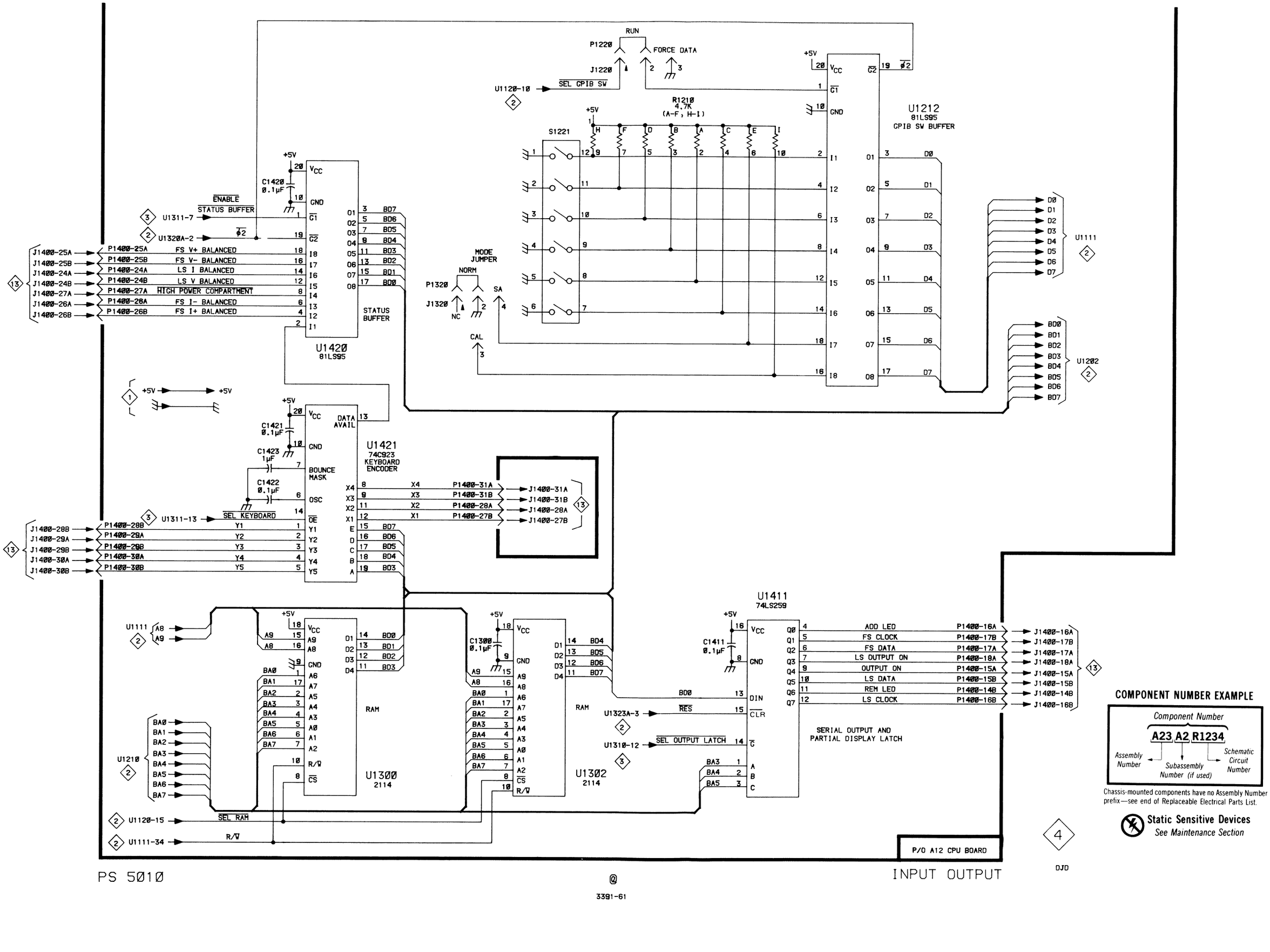
Table 9-4
COMPONENT REFERENCE CHART

P/O A12 ASSY

Input Output ◇4

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1300	E7	J2	R1210	G2	G4
C1411	H7	K3			
C1420	C2	K5	S1221	F2	G5
C1421	C5	K5			
C1422	C5	K5	U1212	J2	G4
C1423	C5	L5	U1300	E8	H1
			U1302	G8	H2
J1220	G1	G5	U1310	G8	H3
J1320	E4	H4	U1323A	G7	K5
			U1411	H6	L3
P1220	G1	G5	U1420	D4	L4
P1320	E3	H4	U1421	E5	L5
P1320	E4	H4			

P/O A12 ASSY also shown on ◇1 ◇2 ◇3 ◇5


RUN
P1220
FORCE DATA
J1220
SEL GPIB SW
U1120-10
R1210
4.7K
(A-F, H-I)
S1221
U1212
81LS95
GPIB SW BUFFER
MODE JUMPER
NORM
P1320
J1320
NC
SA
CAL
U1420
81LS95
STATUS BUFFER
ENABLE
STATUS BUFFER
U1311-7
U1320A-2
P1400-25A FS V+ BALANCED
P1400-25B FS V- BALANCED
P1400-24A LS I BALANCED
P1400-24B LS V BALANCED
P1400-27A HIGH POWER COMPARTMENT
P1400-26A FS I- BALANCED
P1400-26B FS I+ BALANCED
U1111
U1202
U1421
74C923
KEYBOARD ENCODER
SEL KEYBOARD
U1311-13
BOUNCE MASK
DATA AVAIL
P1400-28B
P1400-29A
P1400-29B
P1400-30A
P1400-30B
P1400-31A
P1400-31B
P1400-28A
P1400-27B
U1300
2114
RAM
U1302
2114
RAM
U1411
74LS259
SERIAL OUTPUT AND PARTIAL DISPLAY LATCH
U1323A-3
U1310-12
SEL OUTPUT LATCH
ADD LED
FS CLOCK
FS DATA
LS OUTPUT ON
OUTPUT ON
LS DATA
REM LED
LS CLOCK
P1400-16A
P1400-17B
P1400-17A
P1400-18A
P1400-15A
P1400-15B
P1400-14B
P1400-16B
U1210
U1120-15
SEL RAM
U1111-34
R/W
P/O A12 CPU BOARD
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
PS 5010
INPUT OUTPUT
DJD
3391-61

PARTS LOCATION GRID

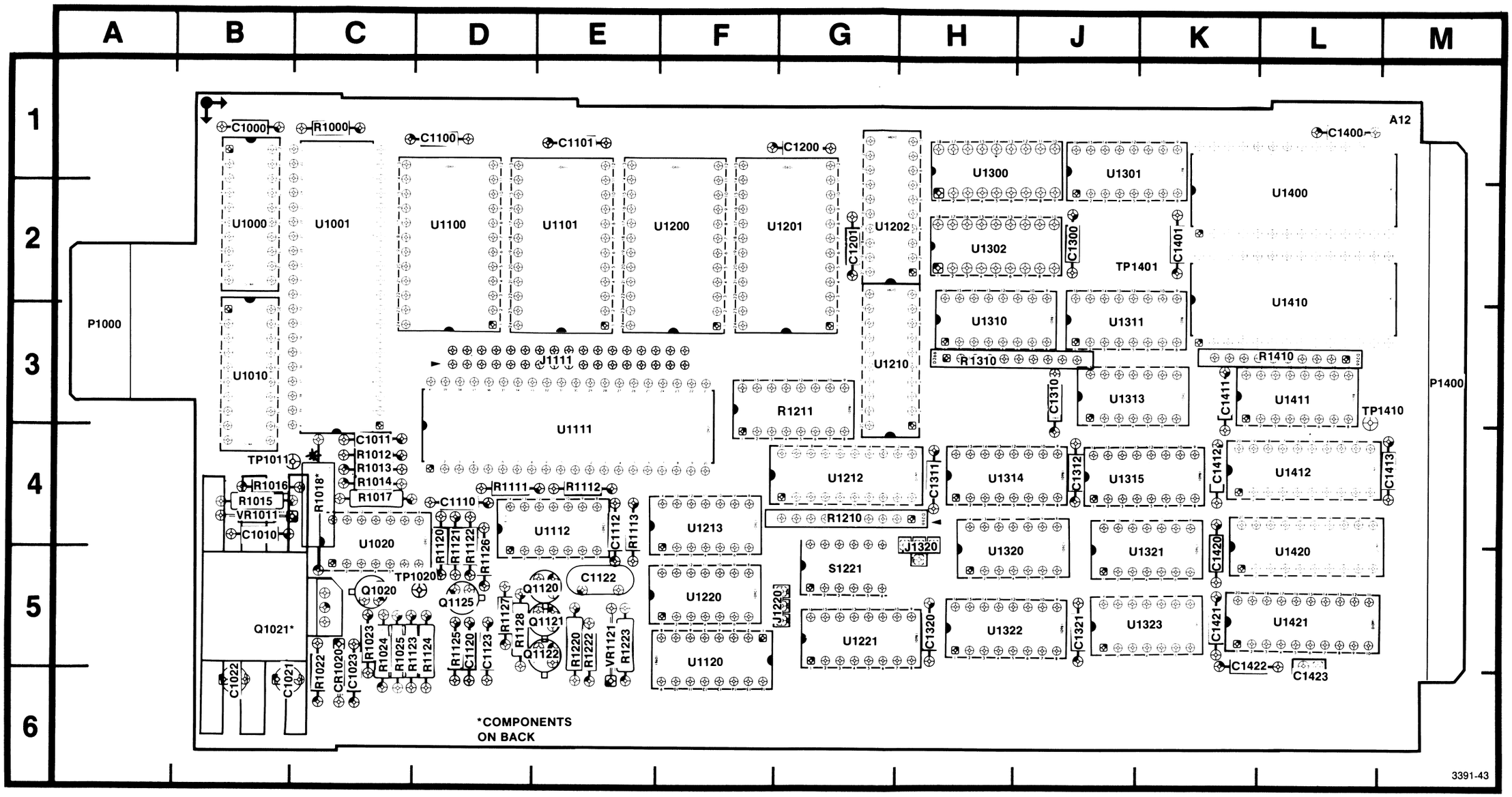
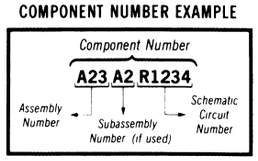


Fig. 9-15. CPU board (A12).

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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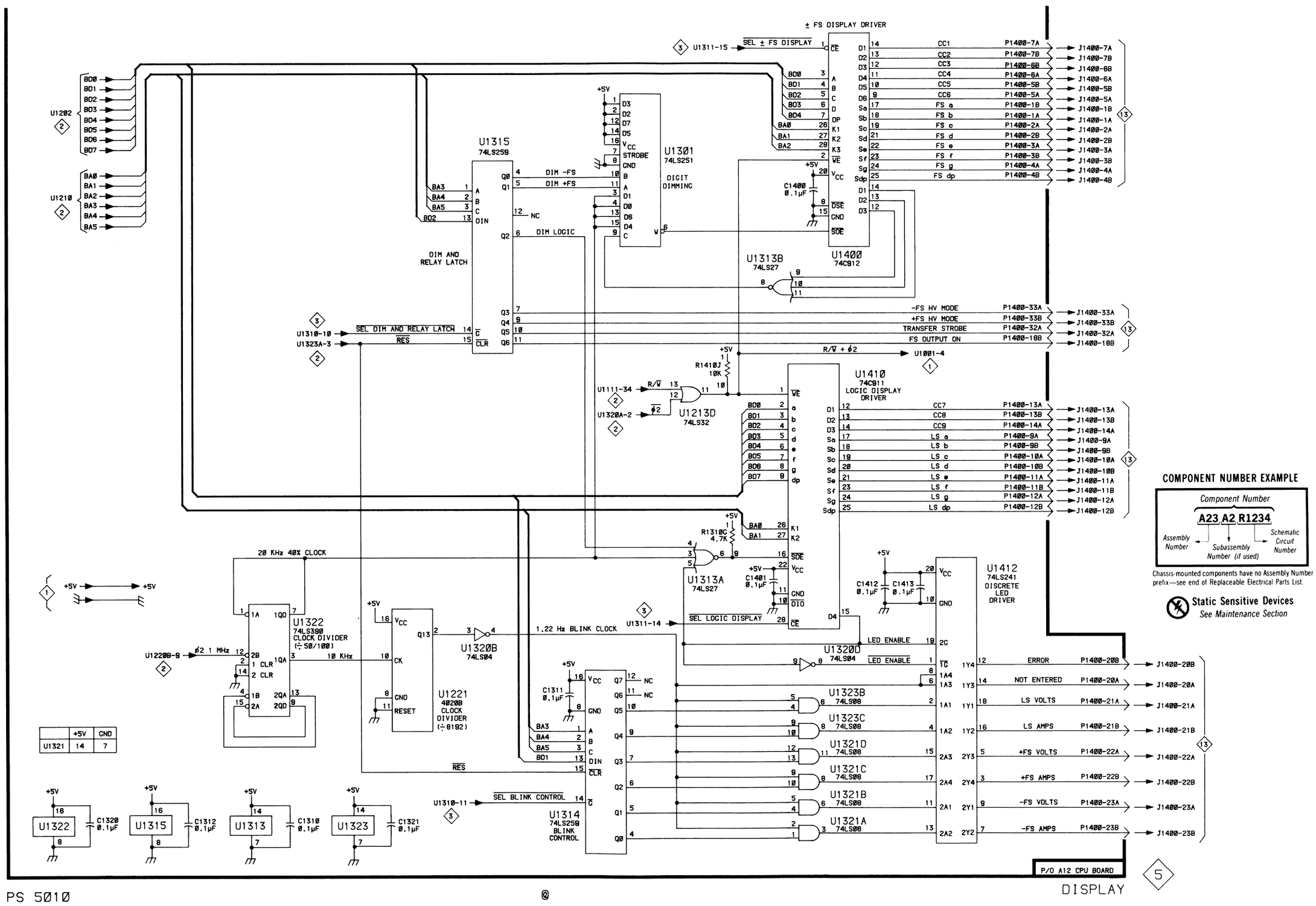
Table 9-5
COMPONENT REFERENCE CHART

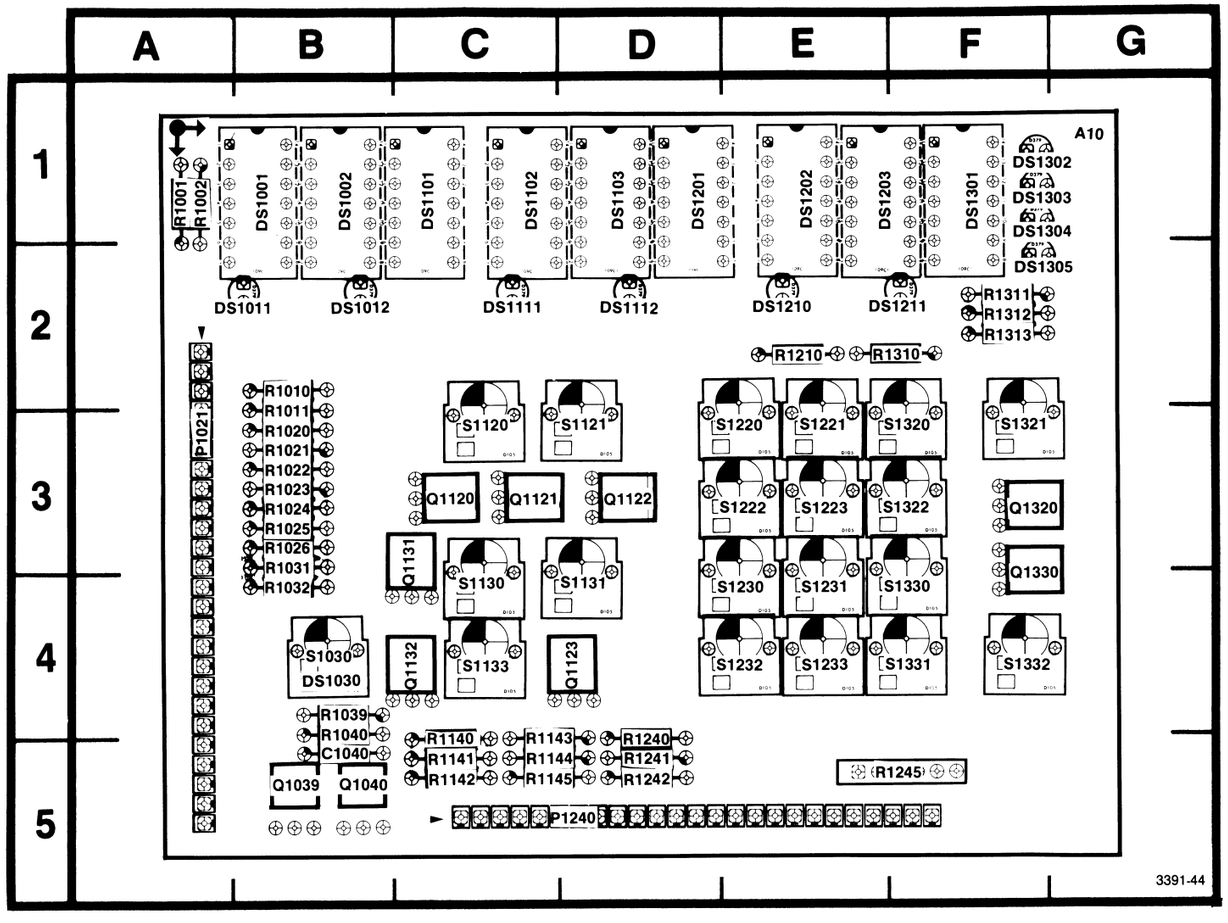
P/O A12 ASSY — Display ◇5

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1310	D9	J3	U1213D	H5	F4
C1311	F8	H4	U1221	E8	G5
C1312	C9	J4	U1301	H2	J1
C1320	B9	H5	U1313A	H7	J3
C1321	E9	J5	U1313B	I3	J3
C1400	I3	L1	U1314	G9	H4
C1401	H7	K2	U1315	F2	J4
C1412	J7	K4	U1320B	F7	H5
C1413	J7	M4	U1320D	I7	H5
			U1321A	I9	K5
P1400	K5	M3	U1321B	I9	K5
P1400	K1	M3	U1321C	I8	K5
P1400	K3	M3	U1321D	I8	K5
P1400	K2	M3	U1322	D7	H5
			U1323B	I8	K5
R1310G	H6	H3	U1323C	I8	K5
R1410J	H5	L3	U1400	I3	L2
			U1410	J5	L2
			U1412	K6	L4

P/O A12 ASSY also shown on ◇1 ◇2 ◇3 ◇4


± FS DISPLAY DRIVER
SEL ± FS DISPLAY
U1311-15
U1315
74LS259
DIM AND RELAY LATCH
DIM -FS
DIM +FS
DIM LOGIC
U1301
74LS251
DIGIT DIMMING
U1313B
74LS27
U1400
74C912
U1410
74C911
LOGIC DISPLAY DRIVER
U1213D
74LS32
U1313A
74LS27
U1412
74LS241
DISCRETE LED DRIVER
U1322
74LS390
CLOCK DIVIDER
U1320B
74LS04
U1221
4020B
CLOCK DIVIDER
U1314
74LS259
BLINK CONTROL
U1320D
74LS04
U1323B
74LS08
U1323C
74LS08
U1321D
74LS08
U1321C
74LS08
U1321B
74LS08
U1321A
74LS08
20 KHz 40% CLOCK
1.22 Hz BLINK CLOCK
SEL DIM AND RELAY LATCH
SEL BLINK CONTROL
SEL LOGIC DISPLAY
LED ENABLE
R/W + ϕ2
-FS HV MODE
+FS HV MODE
TRANSFER STROBE
FS OUTPUT ON
CC1
CC2
CC3
CC4
CC5
CC6
FS a
FS b
FS c
FS d
FS e
FS f
FS g
FS dp
CC7
CC8
CC9
LS a
LS b
LS c
LS d
LS e
LS f
LS g
LS dp
ERROR
NOT ENTERED
LS VOLTS
LS AMPS
+FS VOLTS
+FS AMPS
-FS VOLTS
-FS AMPS
P/O A12 CPU BOARD
DISPLAY
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
PS 5010
3391-62
DJD

PARTS LOCATION GRID



FRONT PANEL BOARD (A10)

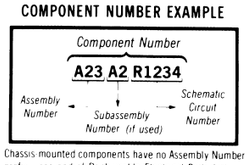
Fig. 9-16. **Front panel board (A10).**

Table 9-6
COMPONENT REFERENCE CHART

P/O A10 ASSY — Front Panel ◇6

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1040	L9	B5	R1001	B5	A1
			R1002	B4	A1
DS1001	C4	B1	R1010	B5	B2
DS1002	D4	B1	R1011	B5	B3
DS1011	I6	B2	R1020	B6	B3
DS1012	I6	B2	R1021	B6	B3
DS1030	K9	B4	R1022	B6	B3
DS1101	E4	C1	R1023	B6	B3
DS1102	F4	C1	R1024	H6	B3
DS1103	G4	D1	R1025	H6	B3
DS1111	I7	C2	R1026	H7	B3
DS1112	I8	D2	R1031	H7	B3
DS1201	H4	D1	R1032	H8	B4
DS1202	I4	E1	R1039	J10	B4
DS1203	J4	E1	R1040	K9	B4
DS1210	I8	E2	R1140	B3	C5
DS1211	I9	F2	R1141	B3	C5
DS1301	K4	F1	R1142	B3	C5
DS1302	L9	F1	R1143	B2	C5
DS1303	K9	F1	R1144	B2	C5
DS1304	I9	F1	R1145	B2	C5
DS1305	I10	F2	R1210	H9	E2
			R1240	B1	D5
P1021	H6	A3	R1241	B1	D5
P1021	B6	A3	R1242	B1	D5
P1021	H7	A3	R1245A	C7	F5
P1021	G10	A3	R1245B	D7	F5
P1021	B5	A3	R1245C	E7	F5
P1021	B4	A3	R1245D	E7	F5
P1021	H9	A3	R1245E	F7	F5
P1021	B7	A3	R1310	H8	F2
P1021	H8	A3	R1311	H9	F2
P1240	B4	D5	R1312	K9	F2
P1240	G10	D5	R1313	L9	F2
P1240	B9	D5			
P1240	B8	D5	S1030	E8	B4
P1240	B3	D5	S1120	F8	C3
P1240	B2	D5	S1121	F8	D3
P1240	B1	D5	S1130	F9	C4
P1240	B7	D5	S1131	E8	D4
			S1133	E7	C4
Q1039	K10	B5	S1220	D7	E3
Q1040	C3	B5	S1221	D9	E3
Q1120	G2	C3	S1222	C9	E3
Q1121	F2	C3	S1223	C8	E3
Q1122	H2	D3	S1230	C8	E4
Q1123	I1	D4	S1231	C8	E4
Q1131	E3	C3	S1232	C9	E4
Q1132	D3	C4	S1233	D8	E4
Q1320	J1	F3	S1320	D8	F3
Q1330	K1	F3	S1321	F7	F3
			S1322	C8	F3
			S1330	C7	F4
			S1331	D7	F4
			S1332	E9	F4

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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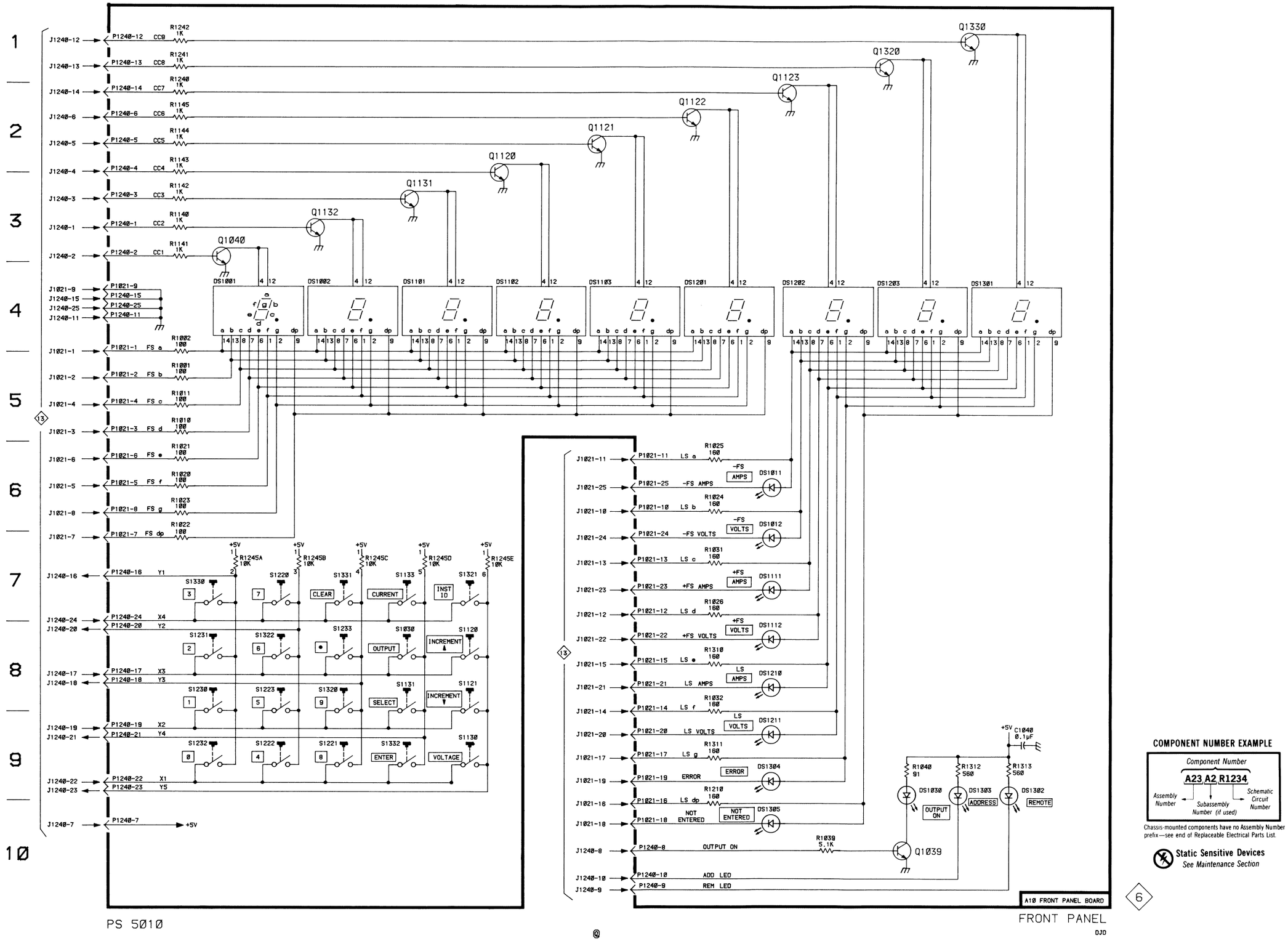


FRONT PANEL ◇6

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
(Assembly Number; Subassembly Number (if used); Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

◇6

Q
3391-63

PARTS LOCATION GRID

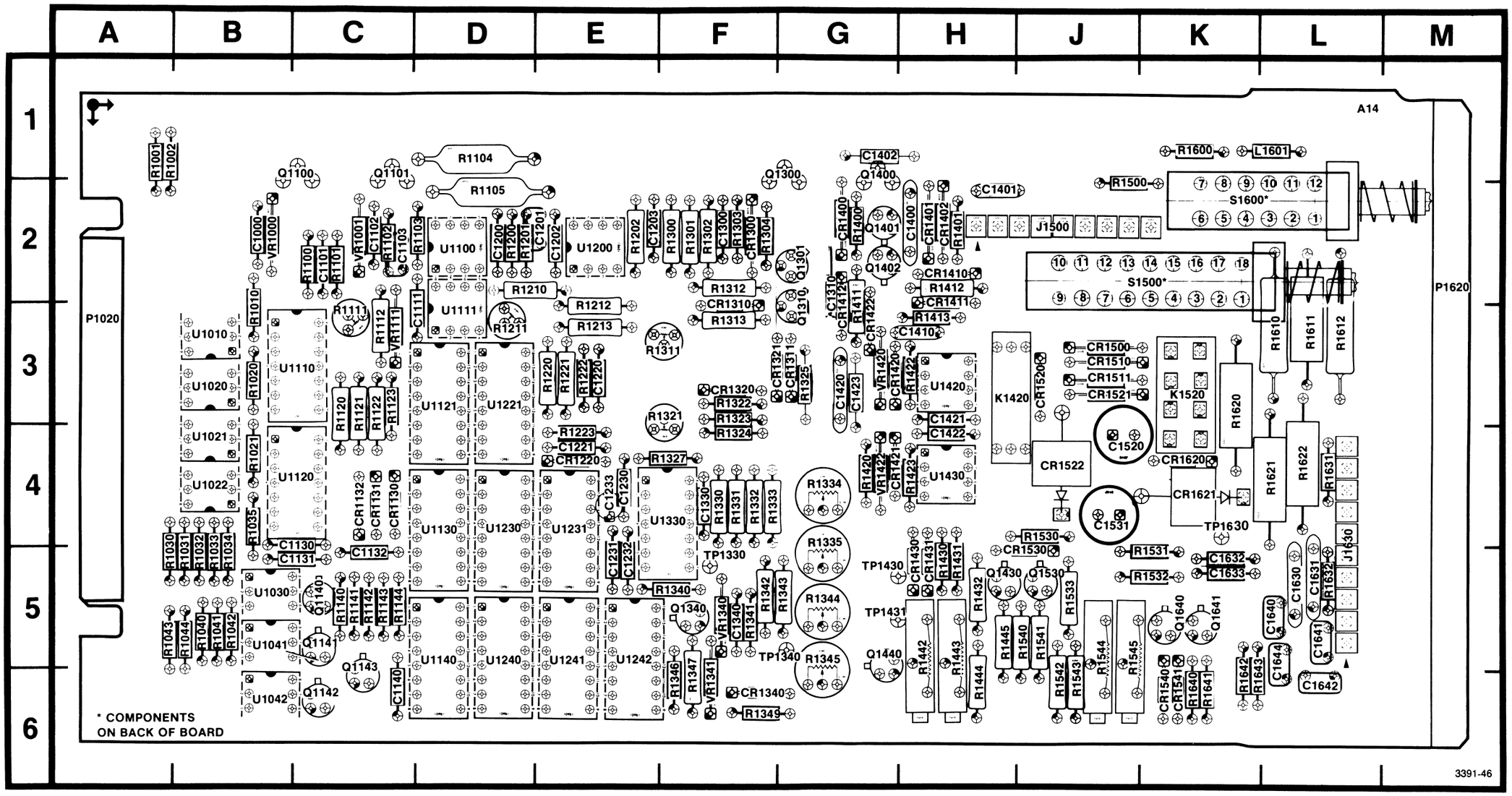
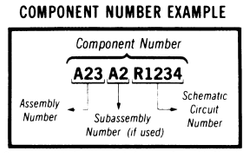


Fig. 9-17. **Floating supply board (A14).**

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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Table 9-7
COMPONENT REFERENCE CHART
Also see Fig. 9-18

P/O A13 ASSY — Ground Reference Circuit ◇7

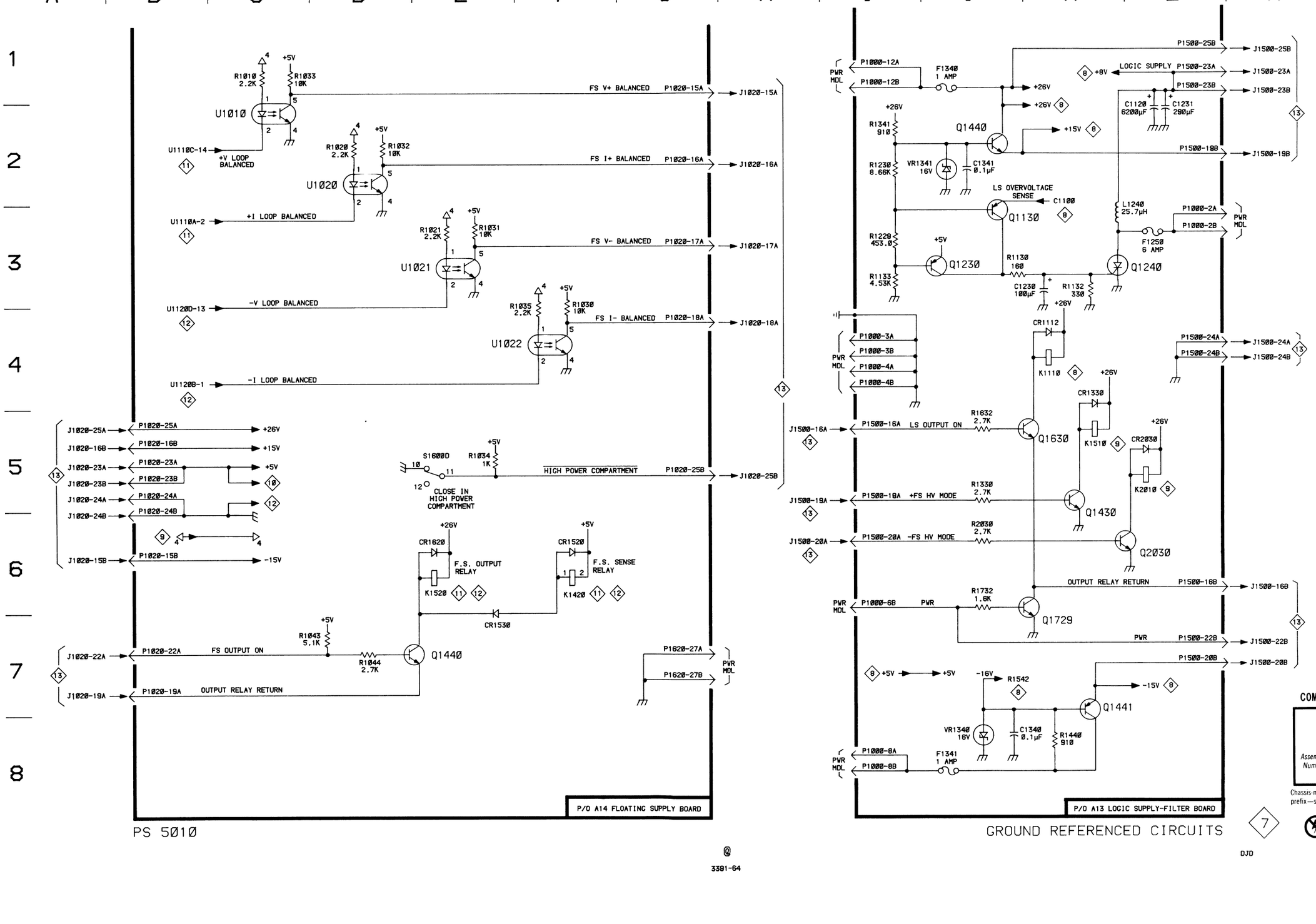
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1120	L2	C3	Q1130	K3	B4
C1230	K3	D4	Q1230	J3	C4
C1231	L2	C4	Q1240	L3	B5
C1340	K8	D5	Q1430	K6	E4
C1341	J2	D5	Q1440	J2	E5
			Q1441	K7	E5
CR1112	K4	C2	Q1630	K5	G4
CR1330	K4	D4	Q1729	K7	H4
CR2030	L5	L4	Q2030	L6	L4
F1250	L3	C6	R1130	J3	C4
F1340	J1	E5	R1132	K3	B4
F1341	J8	E5	R1133	I3	B4
			R1229	I3	C4
K1110	K4	C3	R1230	I2	C4
K1510	K5	F2	R1330	J5	D4
K2010	L5	L2	R1341	I2	D5
			R1440	K8	E5
L1240	L2	D4	R1632	J5	G4
			R1732	J6	H4
P1000	L3	A3	R2030	J6	L4
P1000	I6	A3			
P1000	I4	A3	VR1340	J8	D5
P1000	I8	A3	VR1341	J2	D5

P/O A13 ASSY also shown on ◇8 ◇9

P/O A14 ASSY — Ground Reference Circuit ◇7

CR1520	F6	J3	R1031	E3	B5
CR1530	E7	J5	R1032	D2	B5
CR1620	E6	K4	R1033	C1	B5
			R1034	E5	B5
K1420	F6	H3	R1035	F3	B4
K1520	E6	K3	R1043	C7	A5
			R1044	D7	B5
Q1440	E7	G5			
			S1600D	E5	K2
R1010	C1	B3			
R1020	D2	B3	U1010	C2	B3
R1021	E3	B4	U1020	D2	B3
R1030	F3	A5	U1021	E3	B4
			U1022	E4	B4

P/O A14 ASSY also shown on ◇9 ◇10 ◇11 ◇12


A
B
C
D
E
F
G
H
I
J
K
L
M
1
2
3
4
5
6
7
8
R1010 2.2K
R1033 10K
U1010
U1110C-14
+V LOOP BALANCED
FS V+ BALANCED P1020-15A
J1020-15A
R1020 2.2K
R1032 10K
U1020
U1110A-2
+I LOOP BALANCED
FS I+ BALANCED P1020-16A
J1020-16A
R1021 2.2K
R1031 10K
U1021
U1120D-13
-V LOOP BALANCED
FS V- BALANCED P1020-17A
J1020-17A
R1035 2.2K
R1030 10K
U1022
U1120B-1
-I LOOP BALANCED
FS I- BALANCED P1020-18A
J1020-18A
J1020-25A
J1020-16B
J1020-23A
J1020-23B
J1020-24A
J1020-24B
J1020-15B
P1020-25A
P1020-16B
P1020-23A
P1020-23B
P1020-24A
P1020-24B
P1020-15B
+26V
+15V
+5V
-15V
S1600D
CLOSE IN HIGH POWER COMPARTMENT
R1034 1K
HIGH POWER COMPARTMENT
P1020-25B
J1020-25B
CR1620
F.S. OUTPUT RELAY
K1520
CR1520
F.S. SENSE RELAY
K1420
CR1530
J1020-22A
J1020-19A
P1020-22A
P1020-19A
FS OUTPUT ON
OUTPUT RELAY RETURN
R1043 5.1K
R1044 2.7K
Q1440
P1620-27A
P1620-27B
PWR MDL
P/O A14 FLOATING SUPPLY BOARD
PS 5010
P1000-12A
P1000-12B
F1340 1 AMP
P1500-25B
J1500-25B
LOGIC SUPPLY P1500-23A
J1500-23A
P1500-23B
J1500-23B
C1120 6200µF
C1231 290µF
R1341 910
Q1440
VR1341 16V
C1341 0.1µF
R1230 8.66K
P1500-19B
J1500-19B
LS OVERVOLTAGE SENSE
C1100
Q1130
L1240 25.7µH
P1000-2A
P1000-2B
F1250 6 AMP
R1229 453.0
R1133 4.53K
Q1230
R1130 16Ω
Q1240
C1230 100µF
R1132 33Ω
CR1112
P1000-3A
P1000-3B
P1000-4A
P1000-4B
K1110
P1500-24A
P1500-24B
J1500-24A
J1500-24B
CR1330
R1632 2.7K
P1500-16A LS OUTPUT ON
Q1630
K1510
CR2030
K2010
J1500-16A
J1500-19A
J1500-20A
P1500-19A +FS HV MODE
P1500-20A -FS HV MODE
R1330 2.7K
R2030 2.7K
Q1430
Q2030
OUTPUT RELAY RETURN
P1500-16B
J1500-16B
P1000-6B PWR
R1732 1.6K
Q1729
PWR
P1500-22B
J1500-22B
P1500-20B
J1500-20B
+5V
-16V
R1542
-15V
Q1441
VR1340 16V
C1340 0.1µF
R1440 910
P1000-8A
P1000-8B
F1341 1 AMP
P/O A13 LOGIC SUPPLY-FILTER BOARD
GROUND REFERENCED CIRCUITS
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
DJD
3381-64

PARTS LOCATION GRID

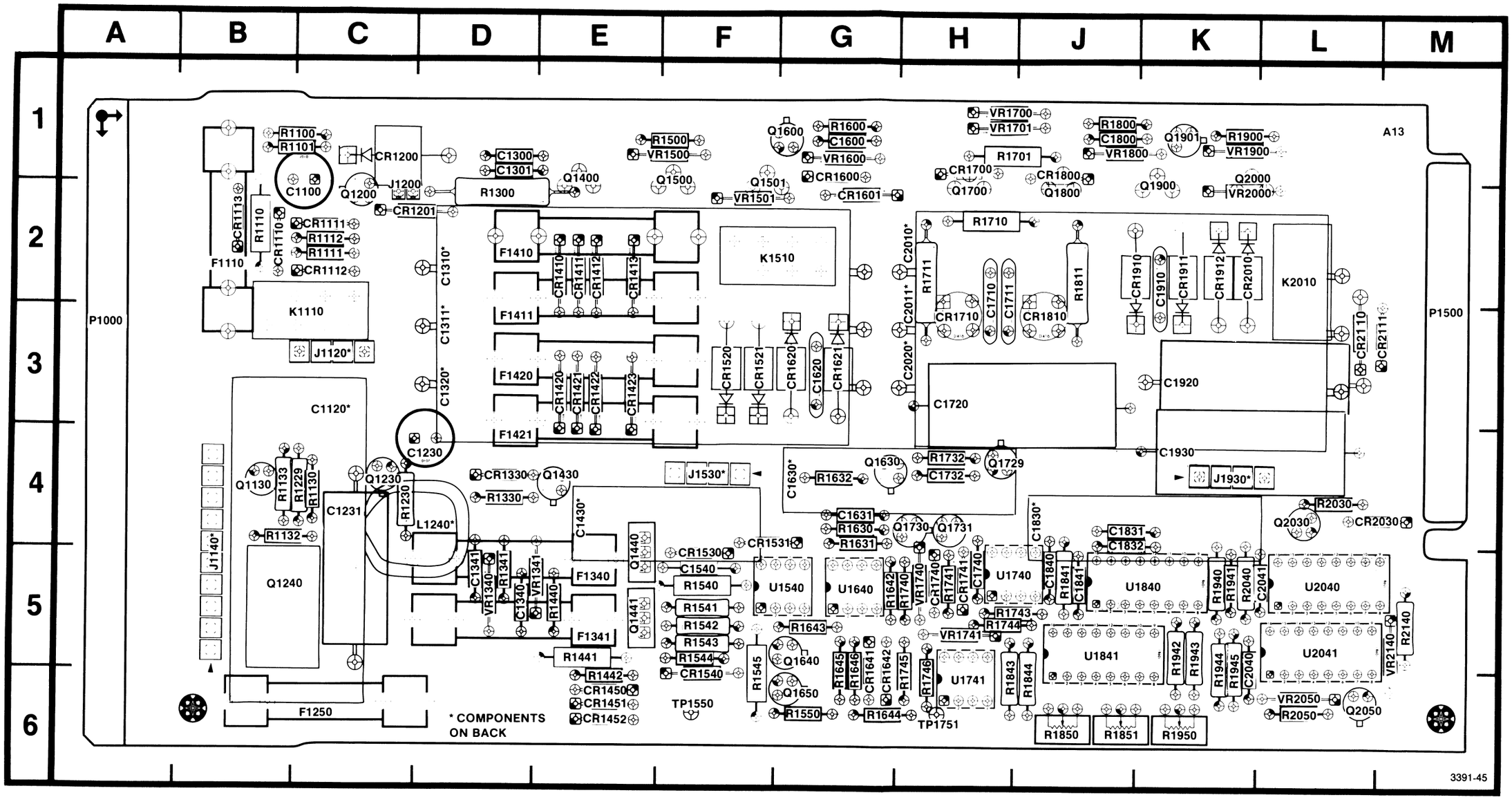
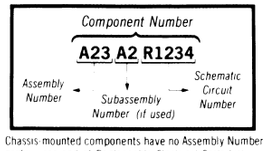


Fig. 9-18. Logic supply filter board (A13).

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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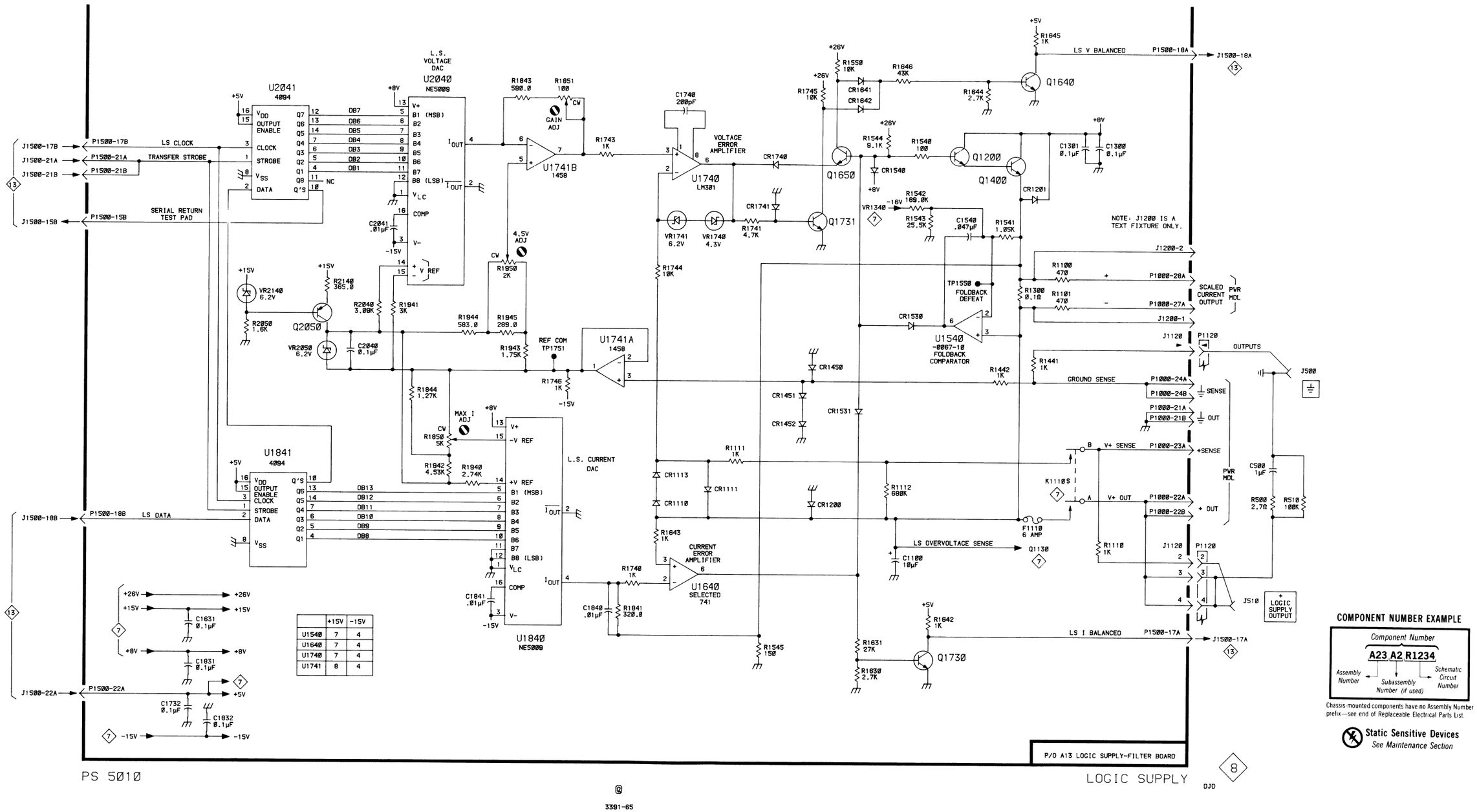
Table 9-8
COMPONENT REFERENCE CHART

P/O A13 ASSY — Logic Supply ◇8

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1100	K7	C1
C1300	M2	D1
C1301	L2	D1
C1540	K3	F5
C1631	C7	G4
C1732	C8	H4
C1740	H2	H5
C1831	C8	J4
C1832	D8	J4
C1840	G7	J5
C1841	F7	J5
C2040	E4	K5
C2041	E3	L5
C500	N6	Chassis
CR1110	H6	B2
CR1111	I6	C2
CR1113	H6	B2
CR1200	J6	C1
CR1201	L3	C2
CR1450	J5	E6
CR1451	I5	E6
CR1452	I5	E6
CR1530	K4	F5
CR1531	J5	F4
CR1540	K2	F6
CR1641	J2	G5
CR1642	J2	G5
CR1740	I2	H5
CR1741	I3	H5
F1110	L6	B2
J1120	N4	C3
J1120	N6	C3
J1200	N3	C2
J1200	N4	C2
J500	O5	Chassis
J510	N7	Chassis
K1110	L6	C3
P1120	N6	C3
P1120	N4	C3
Q1200	L2	C2
Q1400	L3	E1
Q1640	L1	G5
Q1650	J2	G6
Q1730	K8	H4
Q1731	J3	H4
Q2050	D4	L6
R1100	L3	C1
R1101	L4	C1
R1110	M6	B2
R1111	I5	C2
R1112	K6	C2
R1300	L4	D2
R1441	L4	E5
R1442	L5	E6
R1540	K2	F5
R1541	L3	F5
R1542	K3	F5
R1543	K3	F5
R1544	J2	F5
R1545	I8	F6
R1550	J1	G6
R1630	J8	G4
R1631	J7	G4
R1642	K7	G5
R1643	H6	G5
R1644	K2	G6
R1645	L1	G5
R1646	K1	G5
R1740	H7	H5
R1741	I3	H5
R1743	H2	H5
R1744	H3	H5
R1745	J2	H5
R1746	G5	H5
R1841	H7	J5
R1843	G2	H6
R1844	F5	J6
R1850	F5	J6
R1851	G2	J6
R1940	F6	K5
R1941	E4	K5
R1942	F6	K5
R1943	G4	K5
R1944	F4	K5
R1945	G4	K5
R1950	G4	K6
R2040	E4	K5
R2050	D4	L6
R2140	E4	M5
R500	O6	Chassis
R510	O6	Chassis
TP1550	K4	F6
TP1751	G4	H6
U1540	K4	G5
U1640	I7	G5
U1740	I3	H5
U1741A	H4	H6
U1741B	G2	H6
U1840	G7	K5
U1841	D5	J5
U2040	F1	L5
U2041	D2	L5
VR1740	I3	H5
VR1741	H3	H5
VR2050	D4	L6
VR2140	D4	M5

P/O A13 ASSY also shown on ◇7 ◇9



	+15V	-15V
U1540	7	4
U1640	7	4
U1740	7	4
U1741	8	4

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234

Assembly Number; Subassembly Number (if used); Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

PARTS LOCATION GRID

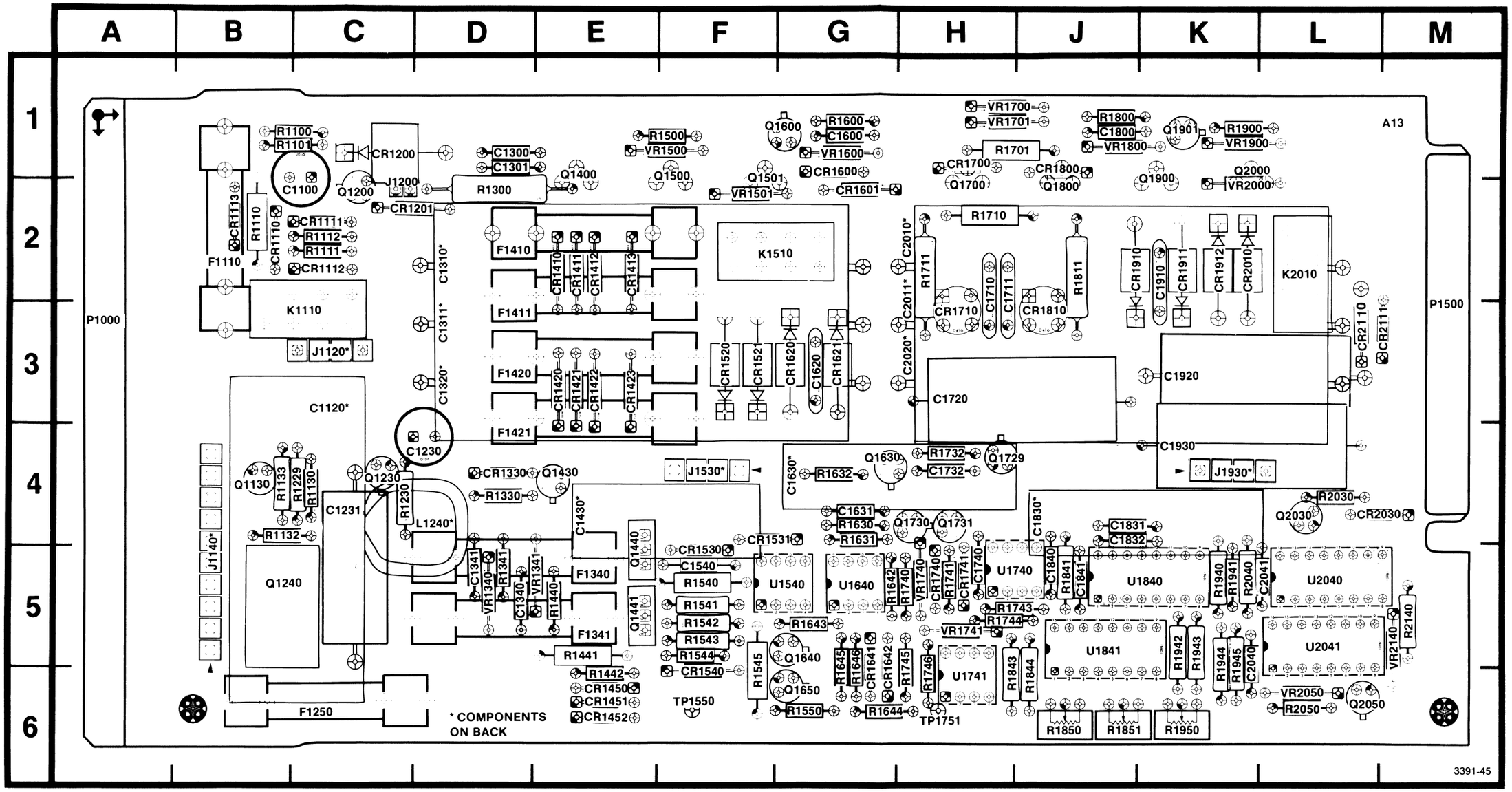
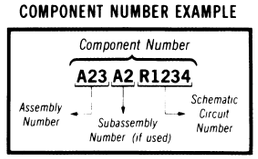


Fig. 9-19. Logic supply filter board (A13).

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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Table 9-9
COMPONENT REFERENCE CHART
Also see Fig. 9-18

P/O A13 ASSY — **Rectifier-Filter** ◇9

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1310	G2	D2
C1311	H5	D3
C1320	G5	D3
C1430	G4	E4
C1600	H3	G1
C1620	E5	G3
C1630	H1	G4
C1710	E3	H2
C1711	E8	H2
C1720	G1	H3
C1800	H8	J1
C1830	G9	J4
C1910	E5	K2
C1920	G7	K3
C1930	G9	K4
C2010	H8	H2
C2011	G6	H2
C2020	H6	H3
CR1410	E9	E2
CR1411	D9	E2
CR1412	E1	E2
CR1413	D1	E2
CR1420	E4	E3
CR1421	D4	E3
CR1422	E7	E3
CR1423	D7	E3
CR1520	E6	F3
CR1521	E6	F3
CR1600	J4	G1
CR1601	J3	G2
CR1620	E6	G3
CR1621	E6	G3
CR1700	K9	H1
CR1710	E2	H3
CR1800	K2	J1
CR1810	E9	J3
CR1910	E5	J2
CR1911	E5	K2
CR1912	E5	K2
CR2010	E4	K2
CR2110	J8	L3
CR2111	J7	M3
F1410	D9	D2
F1411	D2	D3
F1420	D5	D3
F1421	D6	D3
J1000	C2	A3
J1000	L5	A3
J1000	C3	A3
J1000	K4	A3
J1140	J4	B5
J1140	L6	B5
J1140	D4	B5
J1140	L5	B5
J1140	L4	B5
J1140	L5	B5
J1140	J5	B5
J1530	G2	F4
J1530	G4	F4
J1530	F4	F4
J1530	F2	F4
J1930	F8	K4
J1930	F6	K4
J1930	G6	K4
J1930	G8	K4
K1510	J3	F2
K2010	J8	L2
K2010S	J7	L2
L500A	F2	Chassis
L500B	F4	Chassis
L510A	F8	Chassis
L510B	F6	Chassis
P1000	D3	A3
P1000	D2	A3
P1000	K4	A3
P1000	L5	A3
P1140	J4	B5
P1140	L5	B5
P1140	L7	B5
P1140	J5	B5
P1140	L5	B5
P1140	L3	B5
P1140	C4	B5
P1500	K5	M2
P1500	K8	M2
P1500	K6	M2
P1500	K3	M2
P1500	K2	M2
P1500	K4	M2
P1500	K7	M2
P1500	K5	M2
P1530	G2	F4
P1530	F2	F4
P1530	F4	F4
P1530	G4	F4
P1930	G6	K4
P1930	F6	K4
P1930	F8	K4
P1930	G8	K4
Q1500	I3	F1
Q1501	I4	F1
Q1600	H2	G1
Q1700	J9	H2
Q1800	J2	J2
Q1900	I7	K1
Q1901	I9	K1
Q2000	I8	K1
R1500	H1	F1
R1600	H2	G1
R1701	I9	H1
R1710	I2	H2
R1711	J9	H2
R1800	H9	J1
R1811	J1	J2
R1900	I9	K1
VR1500	H1	F1
VR1501	I3	F2
VR1600	I4	G1
VR1700	I9	H1
VR1701	I1	H1
VR1800	I6	J1
VR1900	H9	K1
VR2000	I7	K2

P/O A13 ASSY also shown on ◇7 ◇8

P/O A14 ASSY — **Rectifier-Filter** ◇9

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1000	N4	B2
C1102	N7	C2
C1640	B6	L5
C1641	B5	L5
C1642	C5	L6
C1644	C6	L5
CR1131	O7	C4
CR1132	O4	C4
J1620	B4	L4
J1620	B5	L4
J1630	C4	L4
P1020	M7	A3
P1020	M4	A3
P1020	M5	A3
P1020	M6	A3
P1620	B5	M2
P1620	B4	M2
P1630	C4	L4
Q1100	N4	C1
Q1101	N7	C1
R1001	N7	A1
R1002	N4	A1
R1104	N5	D1
R1105	N6	D2
VR1000	N4	B2
VR1001	N7	C2

P/O A14 ASSY also shown on ◇7 ◇10 ◇11 ◇12

POWER MODULE WINDING
J1000-1B
25V AC
J1000-1A
P1000-1B
P1000-1A
F1411 1.6 AMP
CR1413 CR1412
CR1710
C1710 .01µF
J1530 2
P1530 2 L500A P1530 3
J1530 3
C1720 330µF
C1630 100µF
VR1500 5.1V
R1500 470
R1600 30K
Q1600
C1310 2000µF
VR1701 8.2V
R1811 274
R1710 9.1K
Q1800
CR1800
-I SINK
25mA
P1500-13B
J1500-13B
K1510S 7 N.O. N.C. B
CR1601
+V COLLECTOR SUPPLY
P1500-1A
P1500-1B
J1500-1A
J1500-1B
Q1100 COLLECTOR P1500-8B
J1500-8B
Q1500
C1600 0.1µF
VR1501 16V
+40V
P1500-7A
J1500-7A
K1510S 7 N.O. N.C. A
V+ BASE DRIVE
P1500-10B
J1500-10B
CR1600
POWER MODULE WINDINGS
J1620-1B
25V AC
J1620-1A
P1620-1B
P1620-1A
C1641 0.47µF
C1642 0.47µF
J1630 2
P1630 2
P1140 2
J1140 2
F1420 2.5 AMP
CR1421 CR1420
CR2010
CR1912
CR1910
CR1911
C1910 .01µF
J1530
P1530 L500B P1530
J1530 4
C1430 330µF
C1320 2000µF
C1311 2000µF
Q1501
VR1600 24V
+24V
P1500-7B
J1500-7B
+ COMMON
P1500-3A
P1500-3B
J1500-3A
J1500-3B
COMMON RETURN
P1500-5A
P1500-5B
J1500-5A
J1500-5B
HIGH POWER COMPARTMENT
C1620 .01µF
CR1620
CR1621
CR1521
CR1520
J1620-13A
25V AC
J1620-13B
P1620-13A
P1620-13B
C1640 0.47µF
C1644 0.47µF
F1421 2.5 AMP
J1930
P1930 L510B P1930
J1930 4
C2011 2000µF
C2020 2000µF
C1920 330µF
CR1423 CR1422
P/O A14 FLOATING SUPPLY BOARD
- COMMON
P1500-4A
P1500-4B
J1500-4A
J1500-4B
VR1800 24V
Q1900
-24V
P1500-6B
J1500-6B
CR2111
K2010S 7 N.C. N.O. A
V- BASE DRIVE
P1500-11B
J1500-11B
VR2000 16V
C1800 0.1µF
Q2000
-40V
P1500-6A
J1500-6A
Q1101 COLLECTOR
P1500-9B
J1500-9B
POWER MODULE WINDING
J1000-13A
25V AC
J1000-13B
P1000-13A
P1000-13B
F1410 1.6 AMP
C1711 .01µF
CR1810
J1930
P1930 L510A P1930
J1930 3
C2010 2000µF
CR2110
K2010S 7 N.C. N.O. B
-V COLLECTOR SUPPLY
P1500-2A
P1500-2B
J1500-2A
J1500-2B
R1800 30K
Q1901
VR1900 5.1V
R1900 470
R1701 9.1K
Q1700
R1711 274
VR1700 8.2V
CR1700
+I SINK
25mA
P1500-12B
J1500-12B
CR1411 CR1410
C1930 330µF
C1830 100µF
P/O A13 LOGIC SUPPLY-FILTER BOARD
9
J1020-8A
P1020-8A
Q1100 COLLECTOR
J1020-7A
P1020-7A
R1002 1K
Q1100
CR1132
C1000 0.1µF
VR1000 16V
+15V
+24V
J1020-3A
P1020-3A
J1020-3B
P1020-3B
+ COMMON
R1104 0.1Ω
J1020-5A
P1020-5A
J1020-5B
P1020-5B
COMMON RETURN
R1105 0.1Ω
J1020-4A
P1020-4A
J1020-4B
P1020-4B
- COMMON
+I SENSE
R1102
R1200
-I SENSE
-24V
C1102 0.1µF
VR1001 16V
J1020-6A
P1020-6A
R1001 1K
Q1101
CR1131
-15V
J1020-9A
P1020-9A
Q1101 COLLECTOR
P/O A14 FLOATING SUPPLY BOARD

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
Assembly Number — Subassembly Number (if used) — Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

PS 5010 @ 3391-66 RECTIFIER FILTER 9 DJD

FLOATING SUPPLY BOARD (A14)

PARTS LOCATION GRID

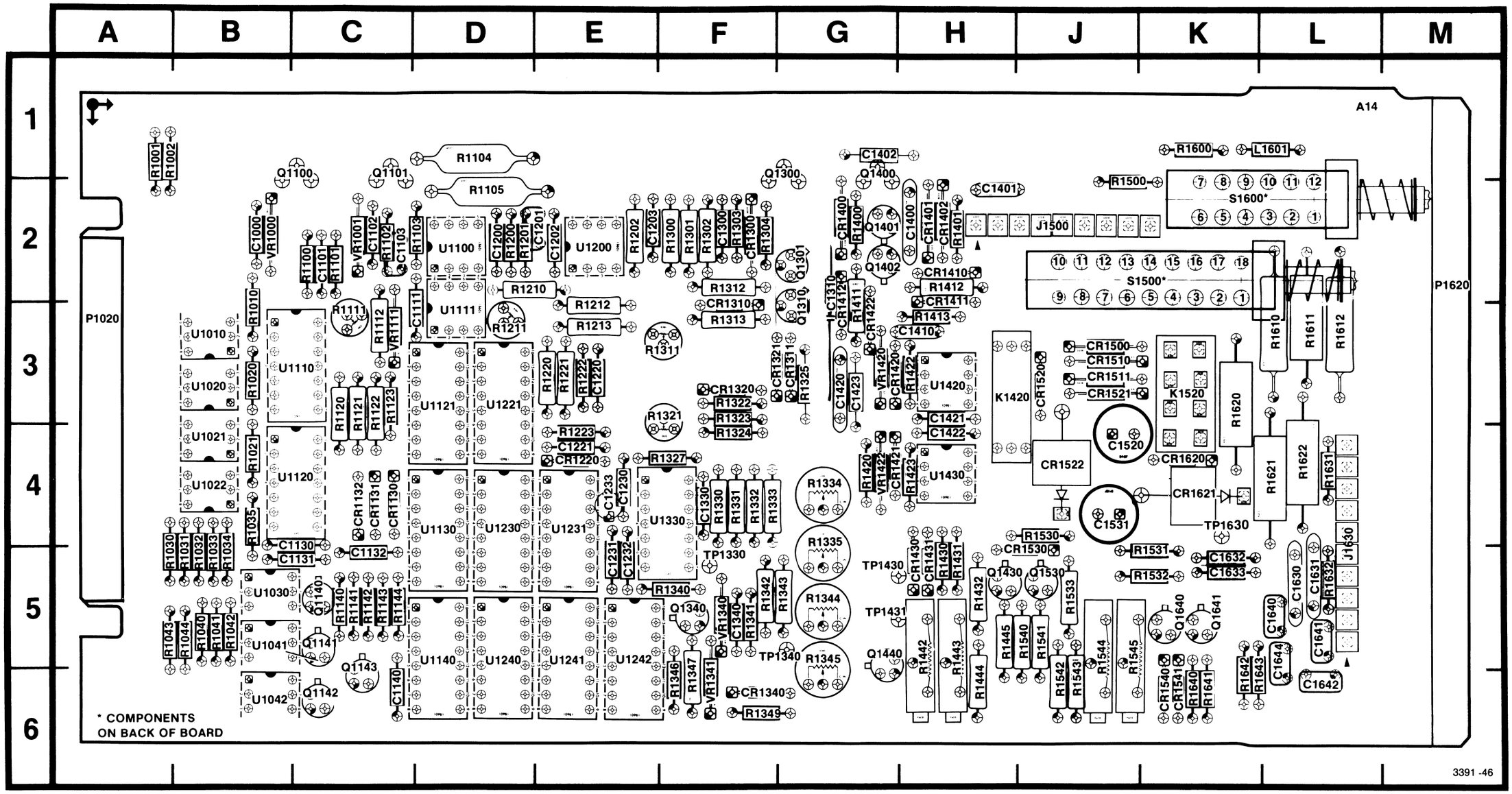
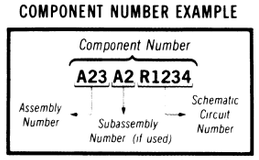


Fig. 9-20. Floating supply board (A14).

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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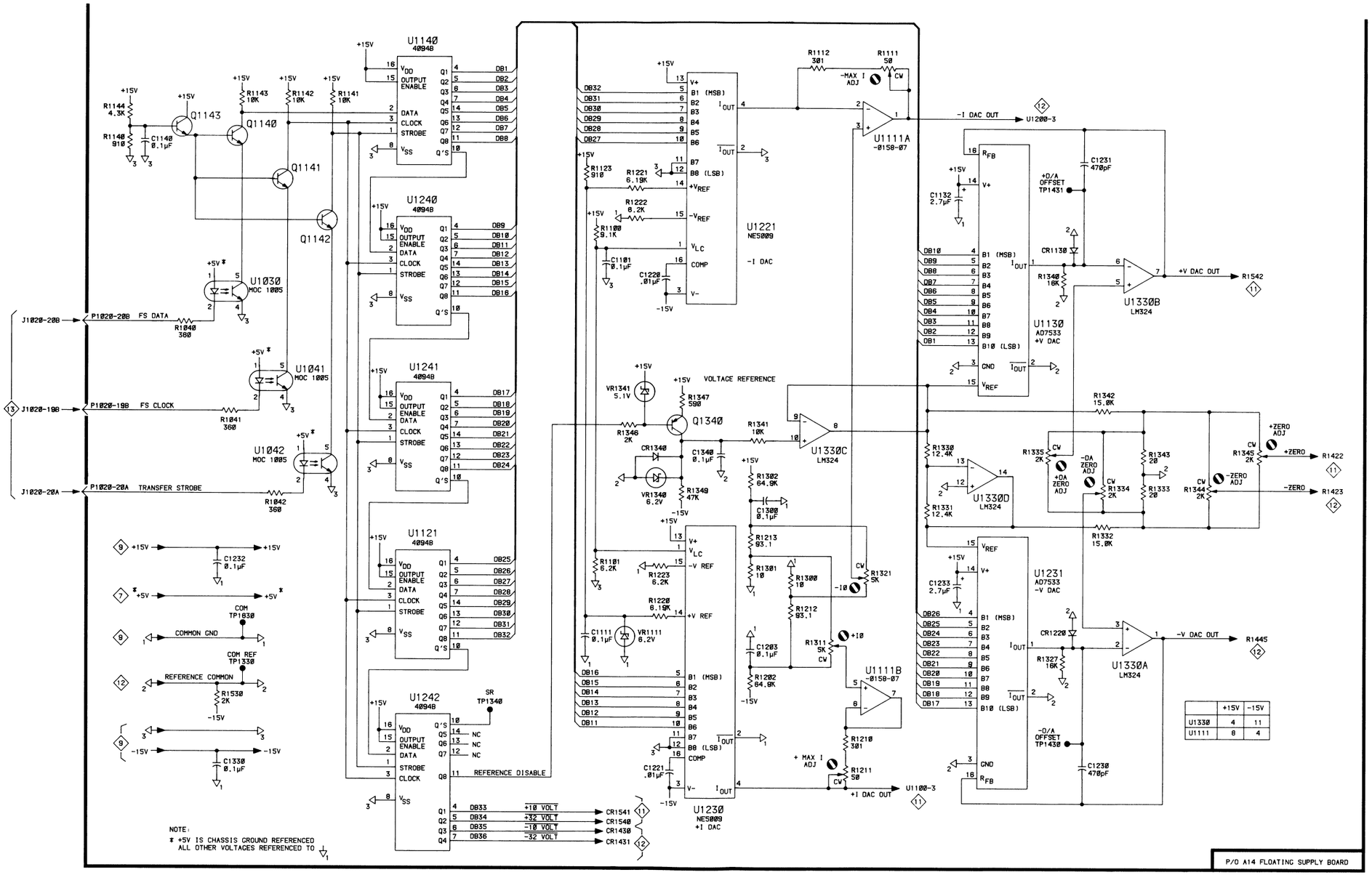
Table 9-10
COMPONENT REFERENCE CHART

P/O A14 ASSY — DAC Circuits ◇10◇

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1101	G3	C2
C1111	G7	D3
C1132	K3	C5
C1140	C2	C6
C1203	I7	E2
C1220	H3	E3
C1221	H8	E4
C1230	L8	E4
C1231	L2	E5
C1232	D6	E5
C1233	K6	E4
C1300	I6	F2
C1330	D8	F4
C1340	H5	F5
CR1130	L3	C4
CR1220	L7	E4
CR1340	H5	F6
Q1140	D2	C5
Q1141	D2	C5
Q1142	D3	C6
Q1143	C2	C6
Q1340	H5	F5
R1040	C2	B5
R1041	C5	B5
R1042	D6	B5
R1100	G3	C2
R1101	G6	C2
R1111	J1	C3
R1112	I1	C3
R1123	G2	C3
R1140	B2	C5
R1141	E2	C5
R1142	D2	C5
R1143	D2	C5
R1144	B2	C5
R1202	I7	E2
R1210	J8	D2
R1211	J8	D3
R1212	I7	E3
R1213	I6	E3
R1220	H7	E3
R1221	H2	E3
R1222	H3	E3
R1223	H6	E4
R1300	I6	F2
R1301	I6	F2
R1302	I5	F2
R1311	I7	F3
R1321	J6	F3
R1327	L7	F4
R1330	K5	F4
R1331	K6	F4
R1332	L6	F4
R1333	M5	F4
R1334	L5	G4
R1335	K5	G5
R1340	L3	F5
R1341	I5	F5
R1342	L5	F5
R1343	M5	G5
R1344	M5	G5
R1345	N5	G5
R1346	G5	F6
R1347	H5	F6
R1349	H6	F6
R1445	N7	H5
R1530	D8	J4
TP1330	D7	F5
TP1340	F8	G5
TP1430	L8	G5
TP1431	L3	G5
TP1630	D7	K4
U1030	D3	B5
U1041	D4	B5
U1042	D5	B6
U1111A	J2	D3
U1111B	J7	D3
U1121	E6	D3
U1130	L4	D4
U1140	E1	D5
U1221	I3	D3
U1230	H9	D4
U1231	L6	E4
U1240	E3	D5
U1241	E4	E5
U1242	E8	E5
U1330A	L7	F4
U1330B	M4	F4
U1330C	I5	F4
U1330D	K6	F4
VR1111	H7	C3
VR1340	H6	F5
VR1341	G4	F6

P/O A14 ASSY also shown on ◇7◇ ◇9◇ ◇11◇ ◇12◇



	+15V	-15V
U1330	4	11
U1111	8	4

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
(Assembly Number · Subassembly Number (if used) · Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices *See Maintenance Section*

PARTS LOCATION GRID

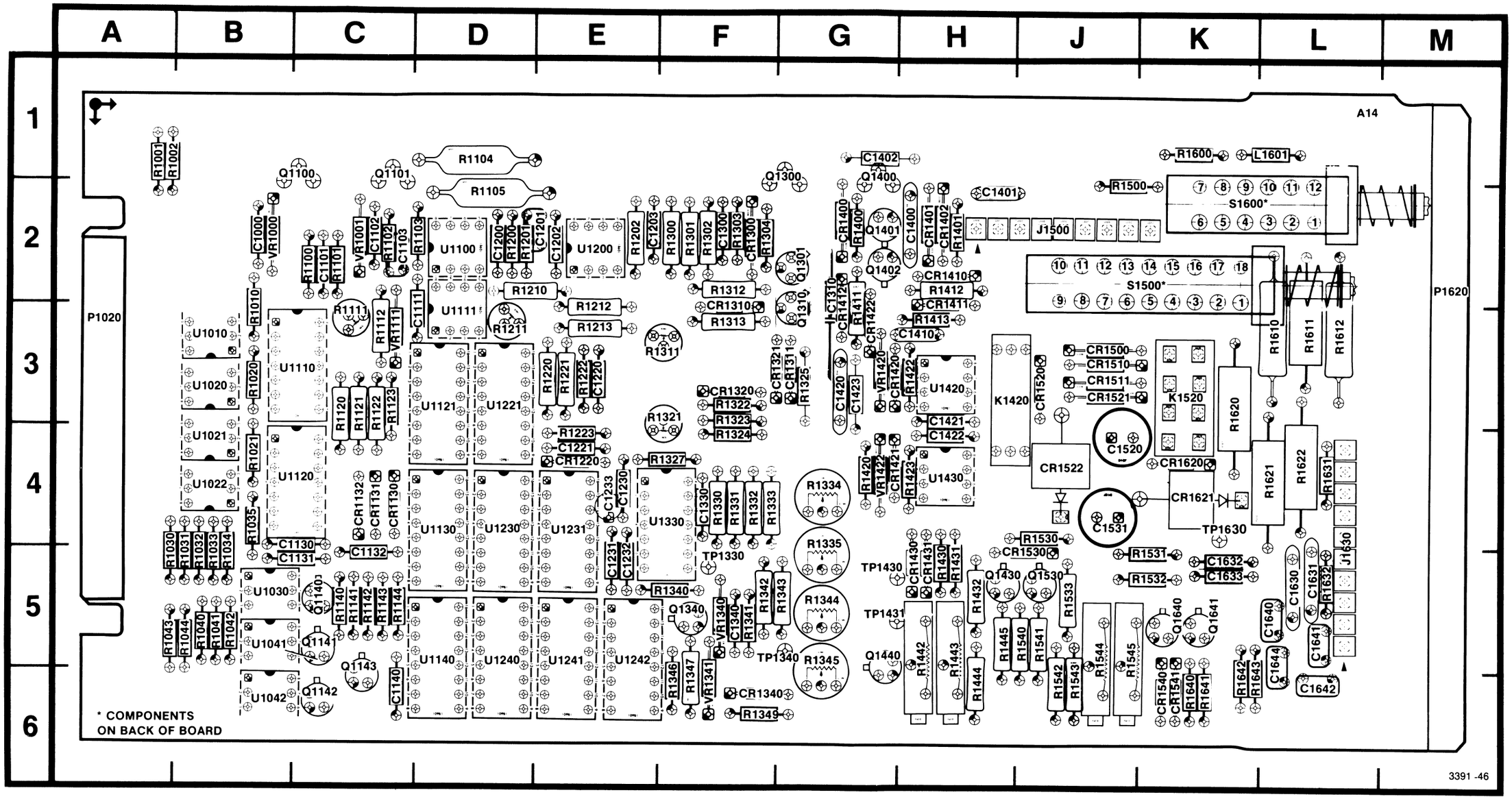
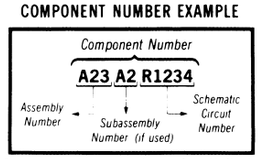


Fig. 9-21. **Floating supply board (A14).**

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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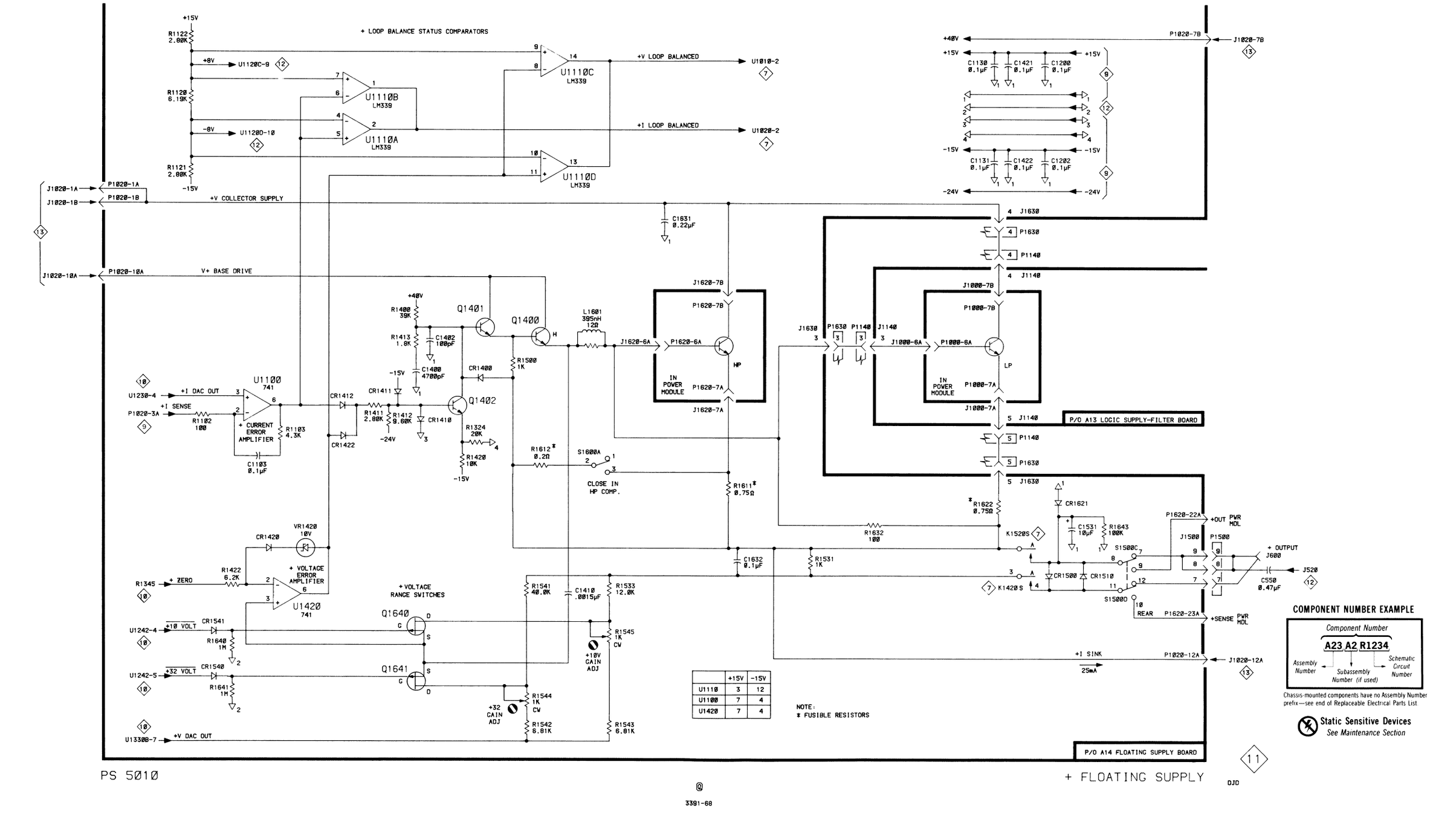
Table 9-11
COMPONENT REFERENCE CHART

P/O A14 ASSY

+ Floating Supply (11)

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1103	D6	C2
C1130	K1	C5
C1131	K2	C5
C1200	L1	D2
C1202	L2	E2
C1400	F5	H2
C1402	F4	G1
C1410	G7	H3
C1421	L1	H3
C1422	L2	H4
C1531	M6	J4
C1631	H3	L5
C1632	I7	K5
C550	O7	Chassis
CR1400	F5	G2
CR1410	F5	H2
CR1411	E5	H2
CR1412	E5	G3
CR1420	D7	G3
CR1422	E6	G3
CR1500	L7	J3
CR1510	M7	J3
CR1540	C8	K6
CR1541	C7	K6
CR1621	M6	K4
J1500	N6	J2
J1620	I4	L4
J1620	H4	L4
J1620	I5	L4
J1630	L6	L4
J1630	J4	L4
J1630	L3	L4
J600	O7	Chassis
K1420	L7	H3
K1520S	L6	K3
L1601	G4	L1
P1020	N1	A3
P1020	B3	A3
P1500	N6	J2
P1620	I5	M2
P1620	H4	M2
P1620	I4	M2
P1630	J4	L4
P1630	L3	L4
P1630	L6	L4
Q1400	G4	G1
Q1401	F4	G2
Q1402	F5	G2
Q1640	E7	K5
Q1641	E8	K5
R1102	C5	C2
R1103	D5	D2
R1120	C2	C3
R1121	C3	C3
R1122	C1	C3
R1324	F5	F4
R1400	E4	G2
R1411	E5	G3
R1412	E5	H2
R1413	E4	H3
R1420	F6	G4
R1422	C7	H3
R1500	G5	J2
R1531	J7	K5
R1533	H7	J5
R1541	G7	J5
R1542	G9	J6
R1543	H9	J6
R1544	G8	J5
R1545	H8	J5
R1611	I6	L3
R1612	G6	L3
R1622	L6	L4
R1632	J6	L5
R1640	C8	K6
R1641	C8	K6
R1643	M6	K6
S1500C	M7	K2
S1500D	M7	K2
S1600A	G6	K2
U1100	D5	D2
U1110A	E2	C3
U1110B	E2	C3
U1110C	G1	C3
U1110D	G3	C3
U1420	D7	H3
VR1420	D6	G3

P/O A14 ASSY also shown on (7) (9) (10) (12)



	+15V	-15V
U1110	3	12
U1100	7	4
U1420	7	4

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PARTS LOCATION GRID

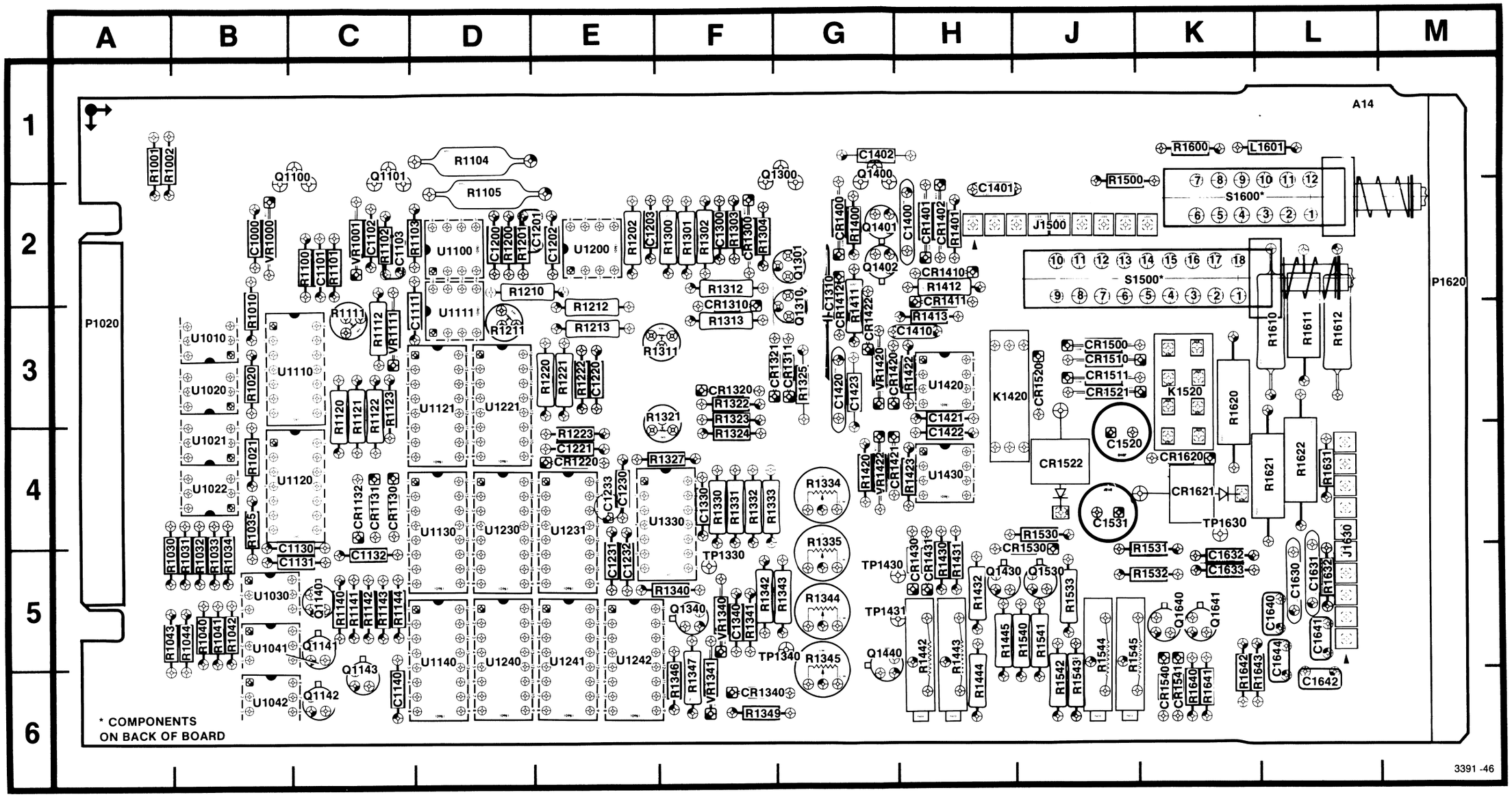

Fig. 9-22. Floating supply board (A14).

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234

- A23 — Assembly Number
- A2 — Subassembly Number (if used)
- R1234 — Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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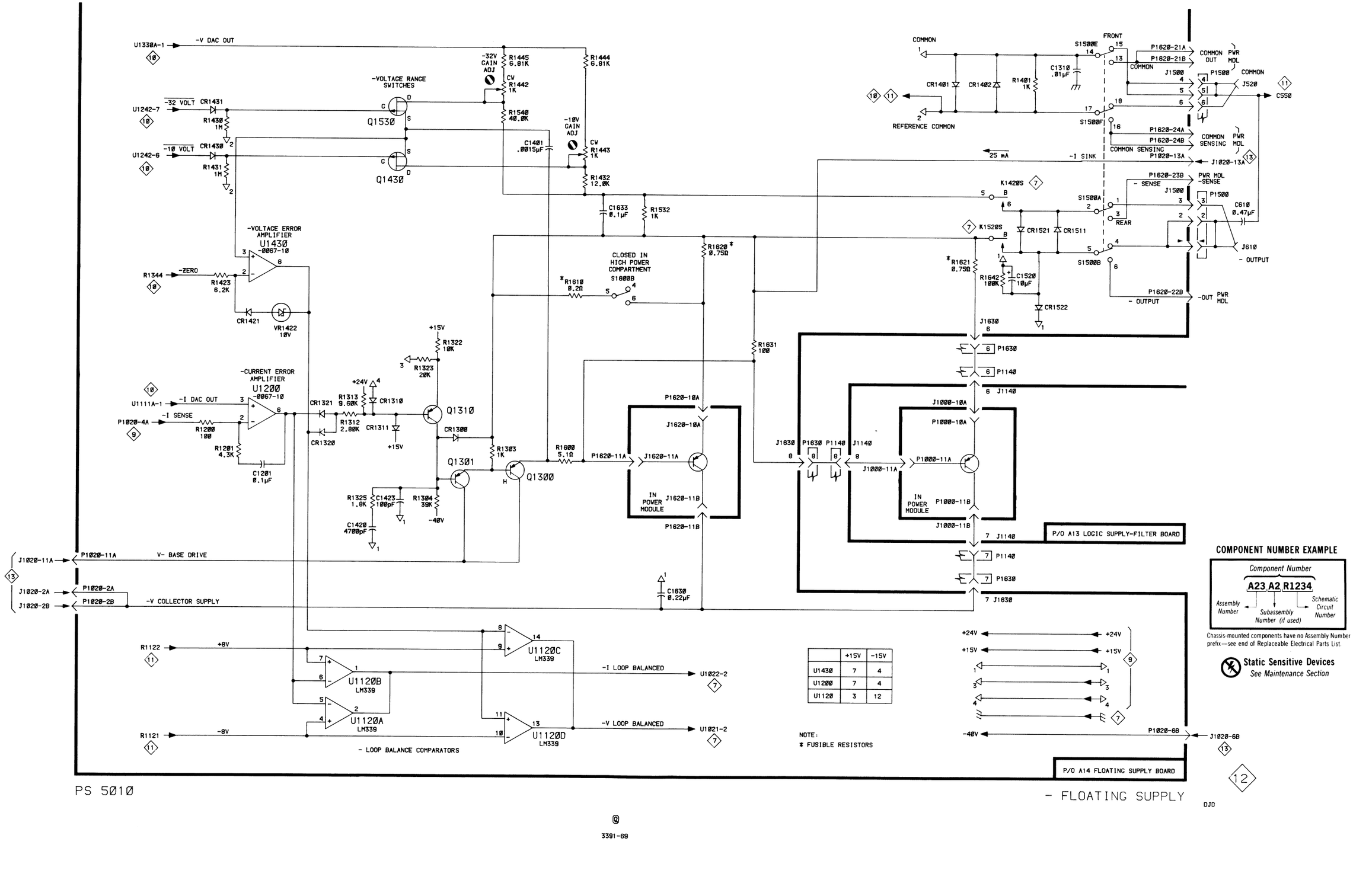
Table 9-12
COMPONENT REFERENCE CHART

P/O A14 ASSY — Floating Supply ◇12◇

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1201	D6	E2
C1310	L1	G2
C1401	G2	H2
C1420	E6	G3
C1423	E6	G3
C1520	L4	J4
C1630	H7	L5
C1633	H3	K5
C610	N3	Chassis
CR1300	F5	F2
CR1310	E5	F3
CR1311	E5	G3
CR1320	D5	F3
CR1321	D5	F3
CR1401	K2	H2
CR1402	L2	H2
CR1421	D4	G4
CR1430	C2	H5
CR1431	C2	H5
CR1511	M3	J3
CR1521	L3	J3
CR1522	L4	J4
J1500	N1	J2
J1500	N3	J2
J1630	L7	L4
J1630	L4	L4
J1630	I5	L4
J520	O2	Chassis
J610	O3	Chassis
K1420	L3	H3
K1520	L3	K3
P1020	B7	A3
P1020	N8	A3
P1500	N1	J2
P1500	N3	J2
P1630	J5	L4
P1630	L4	L4
P1630	L7	L4
Q1300	G6	G1
Q1301	F6	G2
Q1310	F5	G3
Q1430	E3	H5
Q1530	E2	J5
R1200	C5	D2
R1201	C6	D2
R1303	F6	F2
R1304	F6	F2
R1312	E5	F2
R1313	E5	F3
R1322	F4	F3
R1323	F5	F3
R1325	E6	G3
R1401	L1	H2
R1423	C4	H4
R1430	C2	H5
R1431	C2	H5
R1432	G3	H5
R1442	G2	H5
R1443	G2	H5
R1444	G1	H6
R1445	G1	H5
R1532	H3	K5
R1540	G2	J5
R1600	G6	K1
R1610	G4	L3
R1620	I3	K3
R1621	K3	L4
R1631	I4	L4
R1642	L4	K6
S1500A	M3	K2
S1500B	M3	K2
S1500E	M1	K2
S1500F	M2	K2
S1600B	H4	K2
U1120A	E8	C4
U1120B	E8	C4
U1120C	G8	C4
U1120D	G9	C4
U1200	D5	E2
U1430	D3	H4
VR1422	D4	G4

P/O A14 ASSY also shown on ◇7◇ ◇9◇ ◇10◇ ◇11◇ ◇12◇



	+15V	-15V
U1430	7	4
U1200	7	4
U1120	3	12

PARTS LOCATION GRID

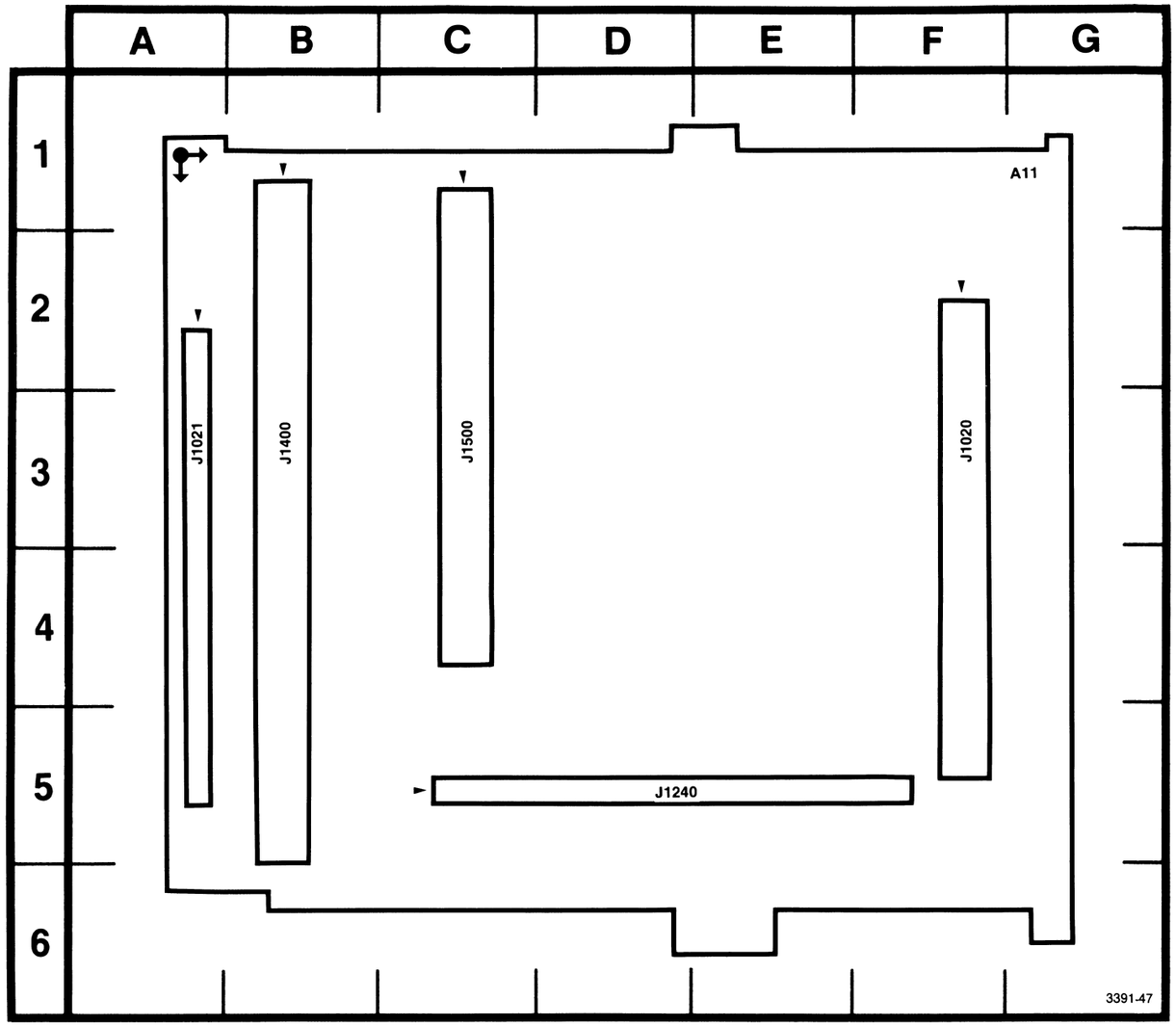


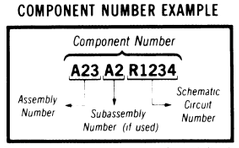
Fig. 9-23. Interconnect board (A11).

Table 9-13
COMPONENT REFERENCE CHART

P/O A11 ASSY — Interconnect Board 13

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
J1020	N1	F3	J1400	F1	B3
J1021	B1	A3	J1500	J1	C3
J1240	B12	D5			

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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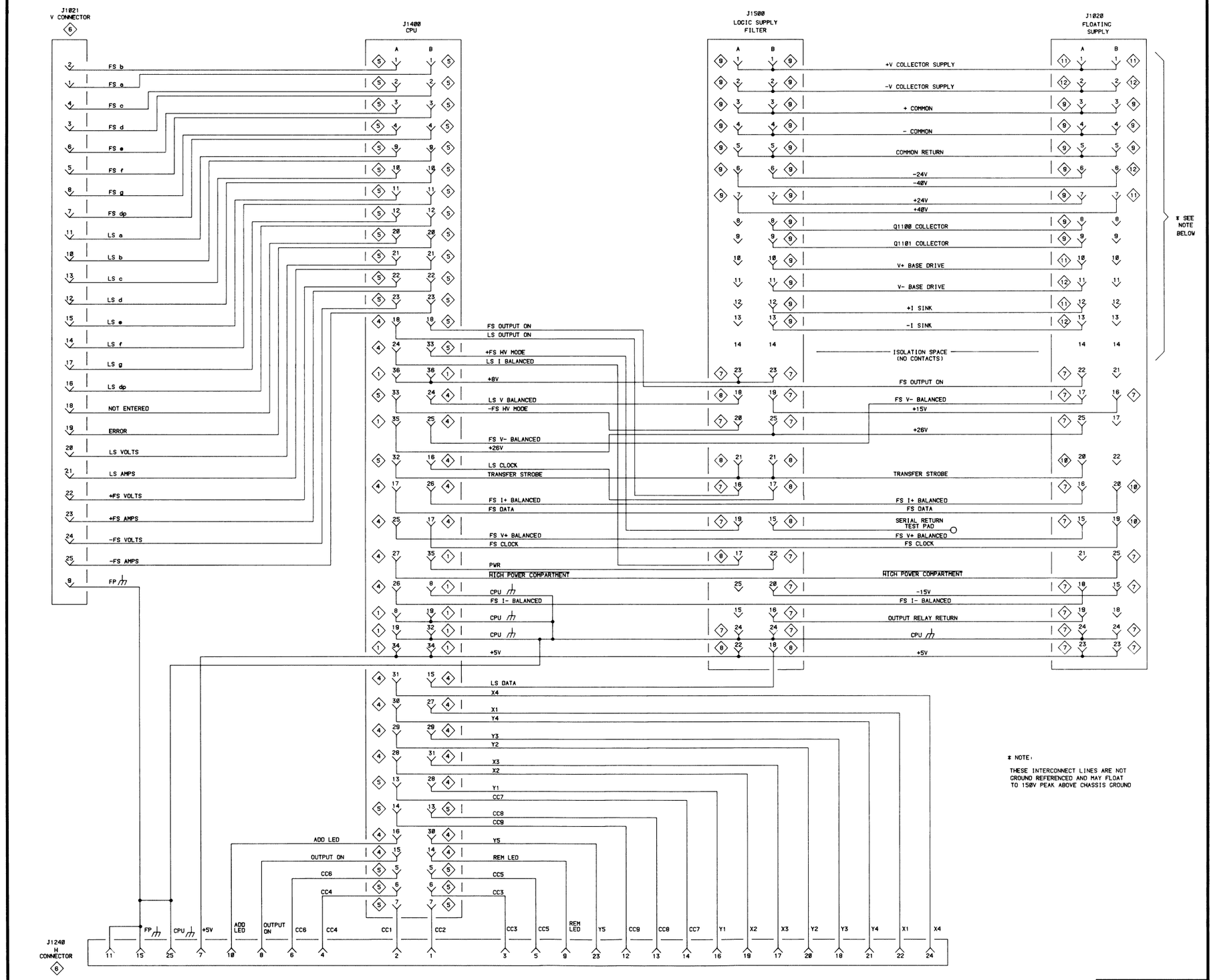
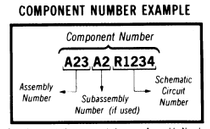


INTERCONNECT BOARD <13>

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 *Name & Description*

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
06915	RICHCO PLASTIC CO.	5825 N. TRIPP AVE.	CHICAGO, IL 60646
18565	CHOMERICS INC.	77 DRAGON COURT	WOBURN, MA 01801
49671	RCA CORPORATION	30 ROCKEFELLER PLAZA	NEW YORK, NY 10020
59730	THOMAS AND BETTS COMPANY	36 BUTLER ST.	ELIZABETH, NJ 07207
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 6000
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
85471	BOYD, A. B., CO.	2527 GRANT AVENUE	SAN LEANDRO, CA 94579
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101
98159	RUBBER TECK, INC.	19115 HAMILTON AVE., P O BOX 389	GARDENA, CA 90247

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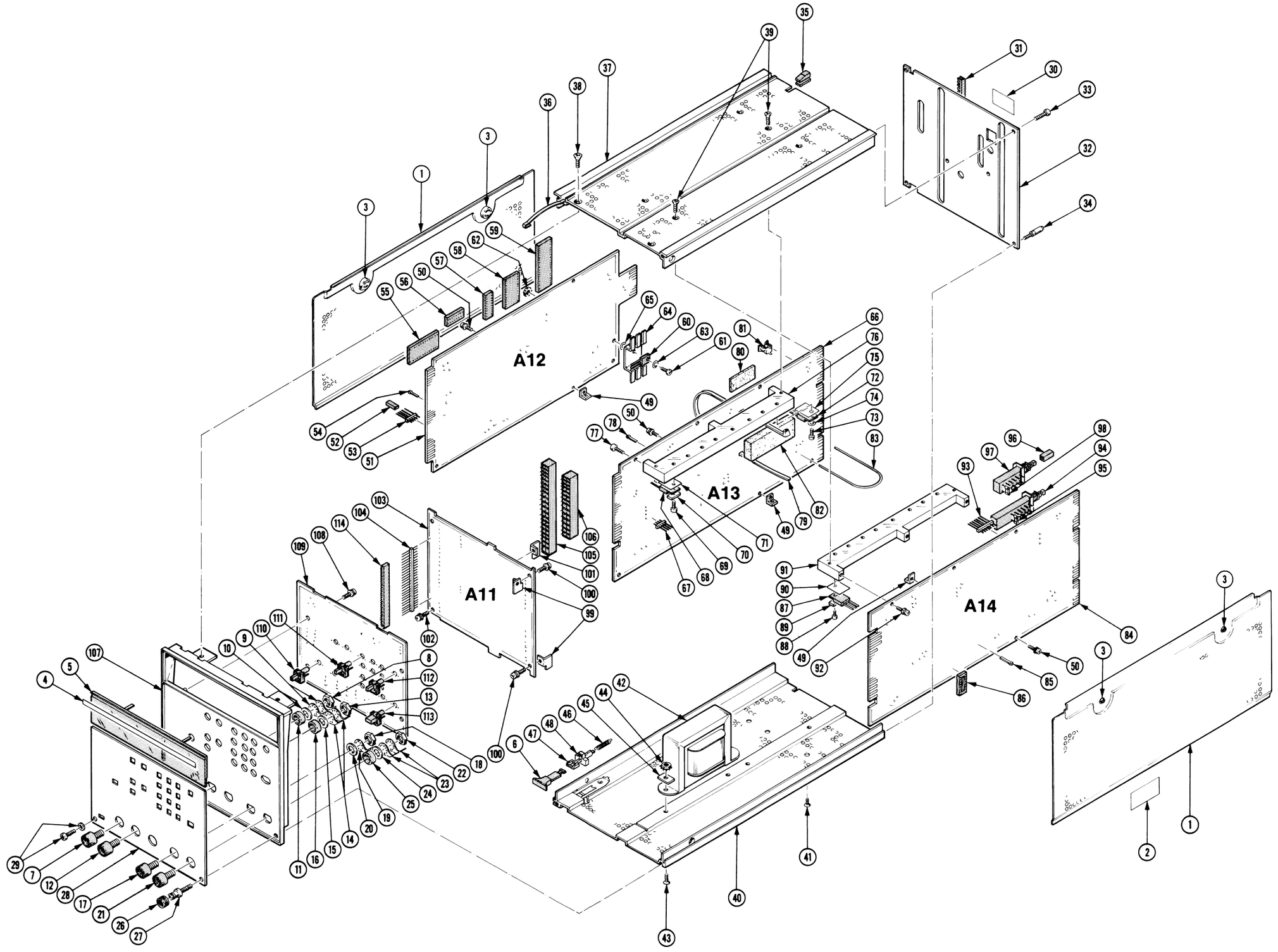
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-2807-02			2		SHIELD,ELEC:SIDE,PLUG-IN UNIT	80009	337-2807-02
-2	334-4225-00			2		MARKER,IDENT:MKD GPIB INSTRUCTION	80009	334-4225-00
-3	105-0869-00			4		LATCH,PANEL:SIDE,1/4 TURN,PLASTIC	80009	105-0869-00
-4	334-3847-00			1		MARKER,IDENT:MKD PS510P PRGM PWR SUPPLY	80009	334-3847-00
-5	378-0159-01			1		LENS,LED DSPL:RED W/MARKINGS	80009	378-0159-01
-6	366-1851-01			1		KNOB,LATCH:IVORY GY,0.625 X 0.25 X 1.09	80009	366-1851-01
-7	----- -----			1		JACK,TIP:(SEE J610 REPL)		
						(ATTACHING PARTS)		
-8	210-0465-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-9	210-0223-00			2		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
-10	210-0905-00			1		WASHER,FLAT:0.256 ID X 0.438 INCH OD,BRS	83385	OBD
-11	342-0137-00			1		WASHER,NONMETAL:0.266 ID X0.50 OD	80009	342-0137-00
						- - - * - - -		
-12	----- -----			1		JACK,TIP:(SEE J520 REPL)		
						(ATTACHING PARTS)		
-13	210-0465-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-14	210-0223-00			2		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
-15	210-0905-00			1		WASHER,FLAT:0.256 ID X 0.438 INCH OD,BRS	83385	OBD
-16	342-0137-00			1		WASHER,NONMETAL:0.266 ID X0.50 OD	80009	342-0137-00
						- - - * - - -		
-17	----- -----			1		JACK,TIP:(SEE J500 REPL)		
						(ATTACHING PARTS)		
-18	210-0465-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-19	210-0223-00			1		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
-20	210-0905-00			1		WASHER,FLAT:0.256 ID X 0.438 INCH OD,BRS	83385	OBD
						- - - * - - -		
-21	----- -----			2		JACK,TIP:(SEE J510,J600 REPL)		
						(ATTACHING PARTS)		
-22	210-0465-00			2		NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-23	210-0223-00			4		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
-24	210-0905-00			2		WASHER,FLAT:0.256 ID X 0.438 INCH OD,BRS	83385	OBD
-25	342-0137-00			2		WASHER,NONMETAL:0.266 ID X0.50 OD	80009	342-0137-00
						- - - * - - -		
-26	220-0633-00			1		NUT,PLAIN,KNURL:0.25-28 X 0.25 INCH L,BRS	80009	220-0633-00
-27	355-0170-00			1		STUD,SHOULDERED:6-32 X 0.40 INCH LONG	80009	355-0170-00
-28	333-2671-00			1		PANEL,FRONT:	80009	333-2671-00
						(ATTACHING PARTS)		
-29	213-0875-00			1		SCR ASSEM WSHR:6-32 X 0.5,TAPTITE,PNH	93907	OBD
	210-1365-00			1		WASHER,FLAT:0.141 ID X 0.5 THK,AL	80009	210-1365-00
						- - - * - - -		
-30	334-4224-00			1		MARKER,IDENT:GPIB INSTRUCTION	80009	334-4224-00
-31	255-0581-00			AR		PLASTIC CHANNEL:0.156 X 0.156,POLYETHYLENE	06915	PGS-2
-32	333-2670-01			1		PANEL,REAR:	80009	333-2670-01
						(ATTACHING PARTS)		
-33	213-0868-00			2		SCREW,TPG,TF:6-32 X 0.375 L,FILM,STEEL	93907	OBD
-34	386-3657-01			2		SUPPORT,PLUG IN:	93907	OBD
						- - - * - - -		
-35	214-3089-00			2		LOCKOUT,PLUG-IN:PLASTIC	80009	214-3089-00
-36	214-1061-00			1		SPRING,GROUND:FLAT	80009	214-1061-00
-37	426-1757-00			1		FR SECT,PLUG-IN:TOP	80009	426-1757-00
						(ATTACHING PARTS)		
-38	211-0541-00			2		SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
-39	211-0101-00			7		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-40	426-1756-01			1		FR SECT,PLUG-IN:BOTTOM	80009	426-1756-01
						(ATTACHING PARTS)		
-41	211-0101-00			5		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-42	----- -----			2		COIL ASSY,AF:(SEE L500,L510 REPL)		
						(ATTACHING PARTS)		
-43	211-0538-00			4		SCREW,MACHINE:6-32 X 0.312"100 DEG,FLH STL	83385	OBD
-44	210-0457-00			4		NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
-45	210-1102-00			4		WASHER,FLAT:0.375 ID X 0.062 THK,SST	80009	210-1102-00
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-46	214-3143-00			1		SPRING,HLEXT:0.125 OD X 0.545 L, X LOOP	80009	214-3143-00
-47	105-0865-00			1		BAR,LATCH RLSE:	80009	105-0865-00
-48	105-0866-00			1		LATCH,RETAINING:SAFETY	80009	105-0866-00
-49	407-2556-00			4		BRACKET,ANGLE:CIRCUIT BOARD,AL	80009	407-2556-00
						(ATTACHING PARTS)		
-50	211-0292-00			4		SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
						- - - * - - -		
-51	----- -----			1		CKT BOARD ASSY:CPU(SEE A12 REPL)		
-52	131-0993-00			2		. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-53	----- -----			1		. TERM SET,PIN:(SEE A12J1111,J1220,J1320 REPL)		
-54	----- -----			4		. TERM,TEST POINT:(SEE A12TP1011,TP1020,TP1401,		
	----- -----			-		. TP1410 REPL)		
-55	136-0694-00			2		. SKT,PL-IN ELEK:MICROCIRCUIT,28 CONTACT	73803	CS9002-28
-56	136-0260-02			1		. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-57	136-0634-00			3		. SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-58	136-0578-00			4		. SKT,PL-IN ELEK:MICROCKT,24 PIN,LOW PROFILE	73803	C S9002-24
-59	136-0623-00			2		. SOCKET,PLUG-IN:40 DIP,LOW PROFILE	73803	CS9002-40
-60	----- -----			1		. TRANSISTOR:(SEE A12Q1021 REPL)		
						(ATTACHING PARTS)		
-61	211-0198-00			1		. SCREW,MACHINE:4-40 X 0.438 PNH,STL,POZ	77250	OBD
-62	210-0586-00			1		. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
-63	210-1122-00			1		. WASHER,LOCK:0.12 ID,DISHED,0.025 THK	86928	B52200F006
-64	214-2955-00			1		. HEAT SINK,XSTR:TO-220,AL	80009	214-2955-00
						- - - * - - -		
-65	210-0906-00			1		. WASHER,NONMETAL:FIBER,0.125 ID X 0.203"OD	86928	OBD
-66	----- -----			1		CKT BOARD ASSY:LOGIC SUPPLY(SEE A13 REPL)		
-67	----- -----			2		. TERM SET,PIN:(SEE A13J1120,J1140,J1530,		
	----- -----			-		. J1930 REPL)		
-68	----- -----			6		. TRANSISTOR:(SEE A13Q1500,Q1501,Q1700,Q1800,		
	----- -----			-		. Q1900,Q2000 REPL)		
						(ATTACHING PARTS)		
-69	211-0012-00			6		. SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	OBD
-70	342-0536-00			6		. INSULATOR,XSTR:TO-220	80009	342-0536-00
-71	342-0563-00			6		. INSULATOR,PLATE:TRANSISTOR,FIBERGLAS	18565	OBD
						- - - * - - -		
-72	----- -----			1		. TRANSISTOR:(SEE A13Q1400 REPL)		
						(ATTACHING PARTS)		
-73	211-0012-00			1		. SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	OBD
-74	210-1178-00			1		. WSHR,SHOULDERED:FOR MTG TO-220 TRANSISTOR	49671	DF 137A
-75	342-0328-00			1		. INSULATOR,PLATE:XSTR,ALUMINUM	80009	342-0328-00
						- - - * - - -		
-76	214-3086-00			1		. HEAT SINK,ELEC:CIRCUIT BOARD,AL	80009	214-3086-00
						(ATTACHING PARTS)		
-77	211-0292-00			3		. SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
						- - - * - - -		
-78	----- -----			2		. TERM,TEST POINT:(SEE A13TP1550,TP1751 REPL)		
-79	346-0143-00			2		. STRAP,TIEDOWN:14.5 X 0.14 INCH,PLASTIC	59730	TY-244-M
-80	348-0314-00			3		. PAD,CUSHIONING:1.8 X 0.5 X 0.094 SIL	80009	348-0314-00
-81	344-0326-00			16		. CLIP,ELECTRICAL:FUSE,BRASS	75915	102071
-82	348-0090-00			5		. PAD,CUSHIONING:2.03 X 0.69 X0.312	85471	OBD
-83	346-0032-00			1		. STRAP,RETAINING:0.075 DIA X 4.0 L,MLD RBR	98159	2859-75-4
-84	----- -----			1		CKT BOARD ASSY:FLOATING SUPPLY(SEE A14 REPL)		
-85	----- -----			5		. TERM,TEST POINT:(SEE A14TP1330,TP1340,TP1430,		
	----- -----			-		. TP1431,TP1630 REPL)		
-86	136-0260-02			2		. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-87	----- -----			4		. TRANSISTOR:(SEE A14Q1100,Q1101,Q1300,		
	----- -----			-		. Q1400 REPL)		
						(ATTACHING PARTS)		
-88	211-0012-00			4		. SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	OBD
-89	342-0536-00			4		. INSULATOR,XSTR:TO-220	80009	342-0536-00
-90	342-0563-00			4		. INSULATOR,PLATE:TRANSISTOR,FIBERGLAS	18565	OBD
						- - - * - - -		
-91	214-3086-00			1		. HEAT SINK,ELEC:CIRCUIT BOARD,AL	80009	214-3086-00
						(ATTACHING PARTS)		
-92	211-0292-00			3		. SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-93	----- -----			2		. TERM SET,PIN:(SEE A14J1500,J1630 REPL)		
-94	----- -----			1		. SWITCH,PUSH:(SEE A14S1500 REPL)		
-95	361-0382-00			2		. SPACER,PB SW:BROWN,0.275 INCH LONG	80009	361-0382-00
-96	366-1768-00			1		. PUSH BUTTON:WHITE,0.198 SQ X 0.28 H	80009	366-1768-00
-97	----- -----			1		. SWITCH,PUSH:(SEE A14S1600 REPL)		
-98	361-0382-00			2		. SPACER,PB SW:BROWN,0.275 INCH LONG	80009	361-0382-00
-99	407-2555-00			3		BRACKET,ANGLE:CIRCUIT BOARD,AL	80009	407-2555-00
						(ATTACHING PARTS)		
-100	211-0292-00			3		SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
						- - - * - - -		
-101	407-2559-00			1		BRACKET,ANGLE:INTERFACE CKTBD,AL	80009	407-2559-00
						(ATTACHING PARTS)		
-102	211-0292-00			1		SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
						- - - * - - -		
-103	----- -----			1		CKT BOARD ASSY:INTERCONNECT(SEE A11 REPL)		
-104	----- -----			2		. TERM SET,PIN:(SEE A11J1021,J1240 REPL)		
-105	----- -----			2		. CONN,RCPT,ELEC;(SEE A11J1020,J1500 REPL)		
-106	----- -----			1		. CONN,RCPT,ELEC:(SEE A11J1400 REPL)		
-107	386-4451-00			1		SUBPANEL,FRONT:	80009	386-4451-00
						(ATTACHING PARTS)		
-108	211-0292-00			4		SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
						- - - * - - -		
-109	----- -----			1		CKT BOARD ASSY:FRONT PANEL(SEE A10 REPL)		
-110	----- -----			1		. SWITCH,PB ASSY:(SEE A10S1030 REPL)		
-111	----- -----			17		. SWITCH,PB ASSY:(SEE A10S1120,S1130,S1131,		
	----- -----			-		. S1131,S1133,S1220,S1221,S1222,S1223,S1230,		
	----- -----			-		. S1231,1232,S1233,S1320,S1322,S1330,		
	----- -----			-		. S1331 REPL)		
-112	----- -----			1		. SWITCH,PB ASSY:(SEE A10S1321 REPL)		
-113	----- -----			1		. SWITCH,PB ASSY:(SEE A10S1332 REPL)		
-114	----- -----			2		. CONN,RCPT,ELEC:(SEE A10P1021,P1240 REPL)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						WIRE ASSEMBLIES		
	175-3333-00			1		CA ASSY,SP,ELEC:10,22 AWG,3.0 L,RIBBON	80009	175-3333-00
	----- -----			-		(FROM A13J1140 TO A14J1630)		
	352-0206-00			2		HLDR,TERM CONN:10 WIRE BLACK	80009	352-0206-00
	175-3334-00			1		CA ASSY,SP,ELEC:9,22 AWG,14.0 L,RIBBON	80009	175-3334-00
	----- -----			-		(FROM J520,J600,J610 TO A14J1500)		
	352-0205-00			1		CONN BODY,PL,EL:9 WIRE BLACK	80009	352-0205-00
	175-3745-00			1		CA ASSY,SP,ELEC:4,22 AWG,12.0 L,RIBBON	80009	175-3745-00
	----- -----			-		(FROM J500,J510 TO A13J1120)		
	352-0200-00			1		HLDR,TERM CONN:4 WIRE BLACK	80009	352-0200-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						ACCESSORIES		
	070-3391-00			1		MANUAL,TECH:INSTRUCTION	80009	070-3391-00
	070-2402-00			1		MANUAL,TECH:PROGRAMMERS REFERENCE	80009	070-2402-00


A12
A13
A11
A14

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime	108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

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MANUAL CHANGE INFORMATION

Date: 7-8-81 Change Reference: C1/781

Product: PS5010 Manual Part No.: 070-3391-00

DESCRIPTION

All references to the SA 501 in this manual now apply to the 067-1090-00 Signature Analyzer.

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MANUAL CHANGE INFORMATION

Date: 7-29-81 Change Reference: C2/781

Product: PS 5010 PROGRAMMABLE POWER SUPPLY Manual Part No.: 070-3391-00

DESCRIPTION

EFF FOR ALL SN EXCEPT AS NOTED

REPLACEABLE ELECTRICAL PARTS AND SCHEMATIC CHANGES

		SN		REF
REMOVE:				
A12CR1020	152-0141-02		SEMICOND DEVICE:SILICON,30V,150MA	PC 23
ADD:				
A12R1020	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	PC 23

R1020 replaces CR1020 shown on diagram 1 CPU POWER SUPPLY.

CHANGE TO:				
A13R1500	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	PC 17
A13R1900	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	PC 17
A13VR1500	152-0195-00		SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	PC 17
A13VR1900	152-0195-00		SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	PC 17
A14C1520	290-0779-00	B010155	CAP.,FXD,ELCTLT:10UF,+50-10%,50V	PC 22
A14C1531	290-0779-00	B010155	CAP.,FXD,ELCTLT:10UF,+50-10%,50V	PC 22
A14R1610	308-0832-00		RES.,FXD,WW:0.2 OHM,5%,1W,FUSIBLE	PC 16
A14R1611	308-0841-00		RES.,FXD,WW:0.75 OHM,5%,2W,FUSIBLE	PC 16
A14R1612	308-0832-00		RES.,FXD,WW:0.2 OHM,5%,1W,FUSIBLE	PC 16
A14R1620	308-0841-00		RES.,FXD,WW:0.75 OHM,5%,2W,FUSIBLE	PC 16
A14R1621	308-0841-00		RES.,FXD,WW:0.75 OHM,5%,2W,FUSIBLE	PC 16
A14R1622	308-0841-00		RES.,FXD,WW:0.75 OHM,5%,2W,FUSIBLE	PC 16

MECHANICAL PARTS LIST CHANGES

CHANGE TO:				
Fig. 1-3	105-0932-00	4	LATCH,PANEL:SIDE	PC 21
	214-3364-00	4	LATCH,FASTENER	PC 21

ACCESSORIES

REMOVE:				
	070-2402-00	1	MANUAL,TECH:PROGRAMMERS REFERENCE	PC 21
ADD:				
	070-3402-00	1	MANUAL,TECH:PROGRAMMERS REFERENCE	PC 21