

NOTE

This manual documents the Model 335D Voltage Standard Differential Voltmeter Null Detector and its assemblies at the revision levels shown in Appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in Appendix 7A for older assemblies.

335D

Voltage Standard Differential Voltmeter

Instruction Manual

P/N 353300
May 1972
Rev. 1 6/78



WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1 year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90 days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.
2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC., will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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FIRST AID FOR ELECTRIC SHOCK

RESCUE

**FREE VICTIM FROM CONTACT WITH LIVE CONDUCTOR QUICKLY.
AVOID CONTACT WITH EITHER LIVE CONDUCTOR OR VICTIM'S BODY.**

Shut off high voltage at once and ground circuit. If high voltage cannot be turned off quickly, ground circuit.

An ax with a dry wooden handle may be used to cut high voltage line. Use extreme caution to avoid resulting electric flash.

If circuit cannot be broken or grounded, use a dry board, dry clothing, or other nonconductor to free victim.

SYMPTOMS

NEVER ACCEPT ORDINARY AND GENERAL TESTS FOR DEATH.

Symptoms of electric shock may include unconsciousness, failure to breathe, absence of pulse, pallor, and stiffness, as well as severe burns. **WHENEVER VICTIM IS NOT BREATHING PROPERLY, GIVE ARTIFICIAL RESPIRATION.**

TREATMENT

START ARTIFICIAL RESPIRATION IMMEDIATELY.

Perform artificial respiration at scene of accident, unless victim's or operator's life is endangered. **IN THIS CASE ONLY**, remove victim to safe location nearby. If new location is more than a few feet away, give artificial respiration while victim is being moved.

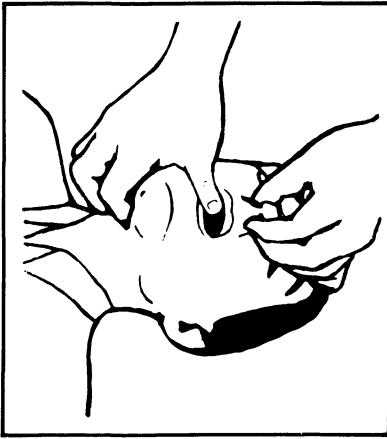
After starting artificial respiration, continue without loss of rhythm for at least **FOUR HOURS**, or until victim is breathing without help. If you have to change operators while giving artificial respiration, do so without losing rhythm of respiration.

AFTER VICTIM REVIVES

Be prepared to resume artificial respiration, as he may stop breathing again.

When victim is **COMPLETELY CONSCIOUS**, give him a stimulant (**NOT AN ALCOHOLIC DRINK**) such as a teaspoonful of aromatic spirits of ammonia in a small glass of water, hot coffee, or hot tea.

Keep victim warm and lying down until he has been conscious for at least fifteen minutes.



POSITION VICTIM

Place victim in face-upward position and kneel close to his ear.

CLEAR THROAT

Turn head to one side and quickly wipe out any fluid, mucus, or foreign body from mouth and throat with fingers.

OPEN AIR PASSAGE

Tilt head back and extend neck to open air passage.

LIFT JAW FORWARD

Place thumb in victim's mouth and grasp jaw firmly. Lift jaw forward to pull tongue out of air passage. Do not attempt to hold or depress tongue.



PINCH NOSTRILS CLOSED

With other hand pinch nostrils closed to prevent air leak.

FORM TIGHT SEAL WITH LIPS

Rescuer's wide-open mouth completely surrounds and seals open mouth of victim. This is not a kissing or puckered position -- mouth of rescuer must be wide-open.

BLOW

Exhale firmly into victim's mouth until chest is seen to lift. This can be seen by rescuer without difficulty.

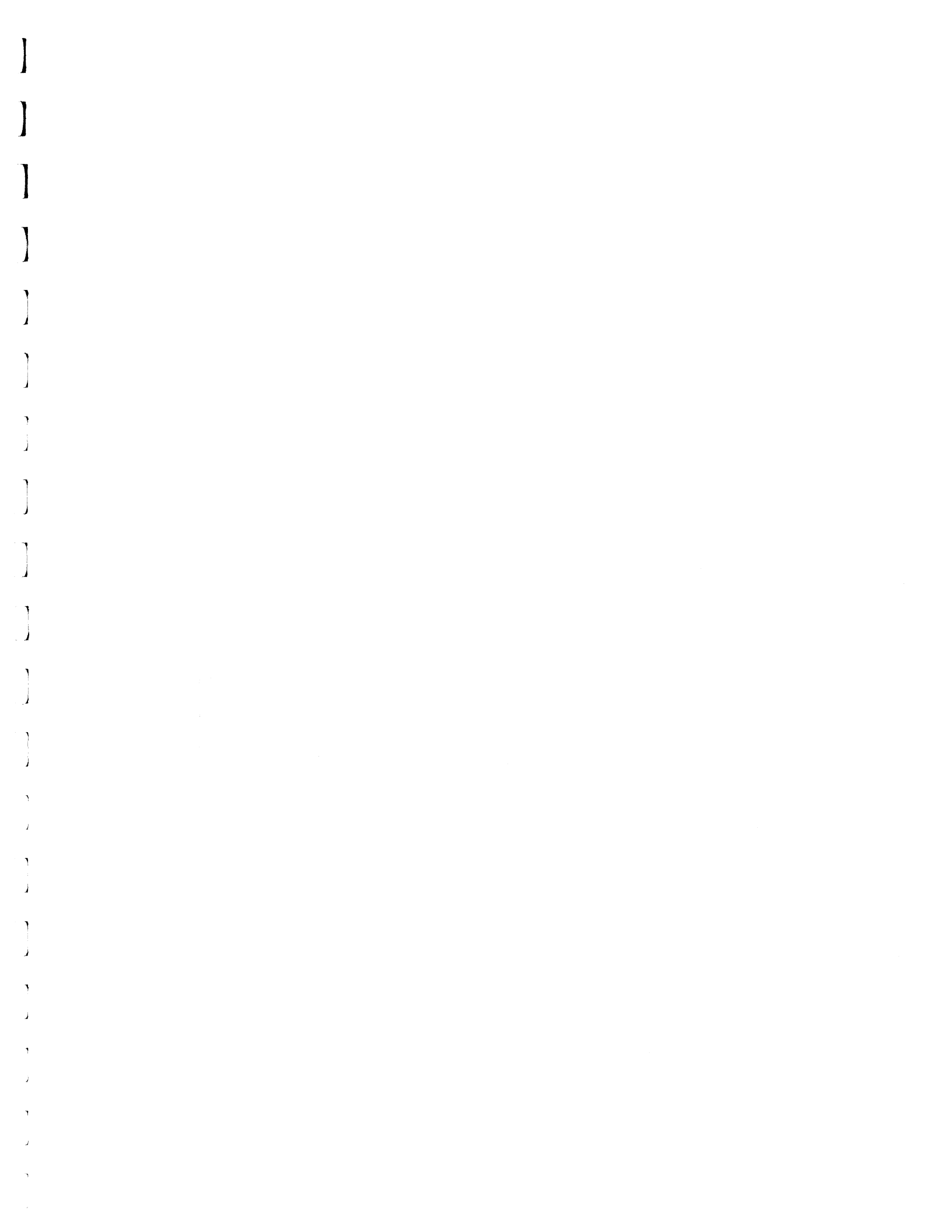


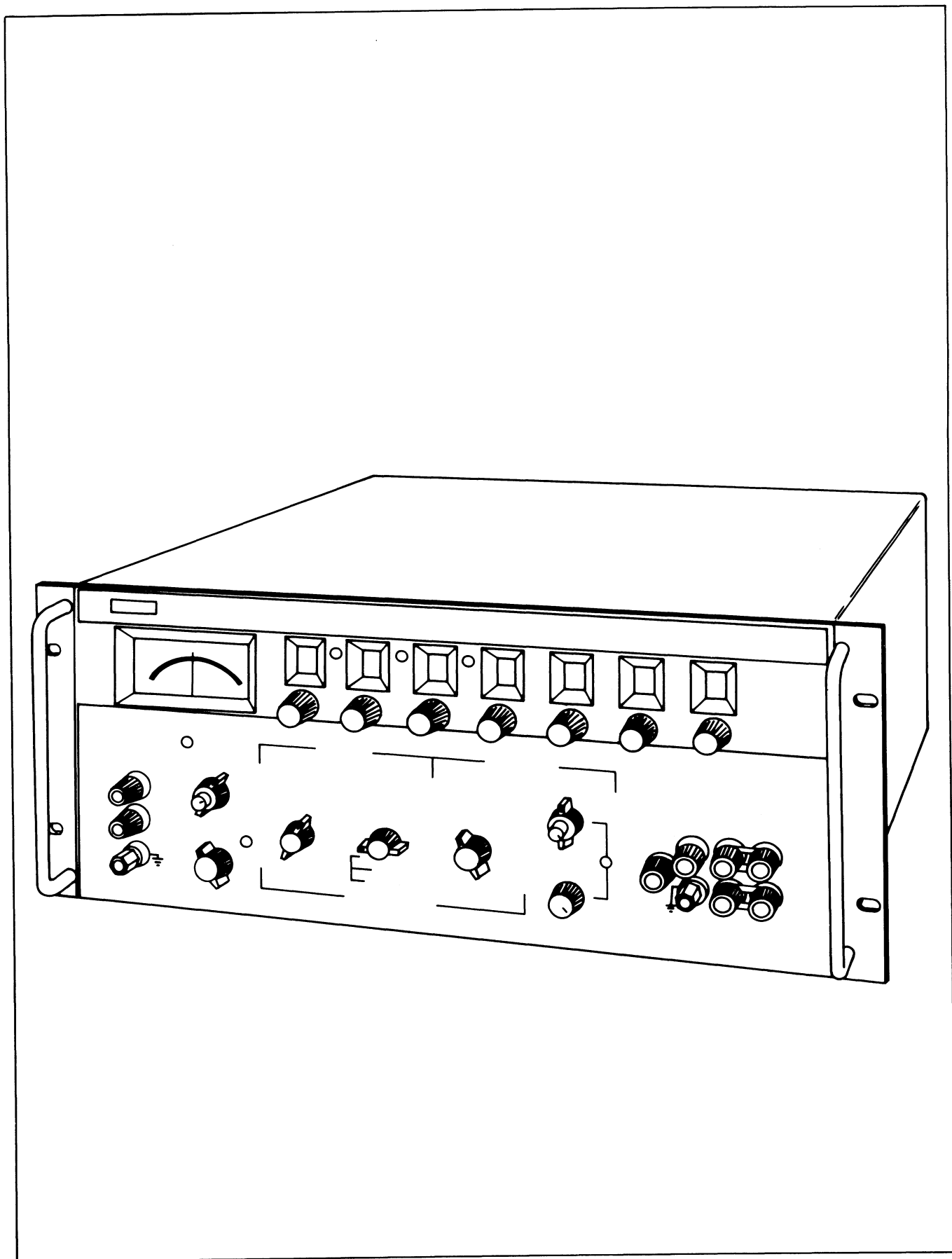
REMOVE MOUTH AND INHALE

During this time, rescuer can hear and feel escape for air from lungs. Readjust position if air does not flow freely in and out of victim's lungs.

Continue at a rate of 12 to 20 times per minute.

Breathing should be normal in rate with only moderate increase in volume, so that rescue breathing can be continued for long periods without fatigue. Do not breathe too forcibly or too large a volume if victim is an infant or small child.





Frontispiece

Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 335D Voltage Standard combines a dc voltage and a dc voltage measurement capability in one instrument. Precision dc voltages up to 1100 volts, variable by way of the front panel readout dials, are provided at the OUTPUT terminals of the instrument. Measurement capabilities from 10 microvolts to 1000 volts are provided by a precision dc differential voltmeter. This combination allows flexible use of the instrument as a voltage standard, a differential voltmeter, or as a null detector.

1-3. Protection against possible equipment failures or operator errors, which might otherwise damage expensive instruments, is incorporated. The VOLTAGE TRIP and VERNIER controls provide a means of limiting the output voltage within the range. Should the output voltage exceed a preset limit, the OUTPUT terminals are de-energized. A current limiting circuit limits the available current to a level determined by the setting of the CURRENT LIMIT control. Therefore, the

335D is able to provide currents up to, but not exceeding the level determined by the setting of the CURRENT LIMIT control.

1-4. The inner chassis and circuitry are surrounded by a guard which is isolated from the front panel and the outside cover. When properly connected, the guard bypasses any circulating ground currents which otherwise may cause error. Remote sensing of the output voltage is also used to reduce errors caused by voltage drop in external cables.

1-5. Most of the instrument circuitry is mounted on modular plug-in cards. An extender card is provided as an accessory to aid in the maintenance and adjustment of the instrument.

1-6. SPECIFICATIONS

1-7. Specifications for the Model 335D are listed in Table 1-1 and Figure 1-1.

Table 1-1. Specifications

VOLTAGE STANDARD	
PARAMETER	SPECIFICATIONS
OUTPUT VOLTAGE	0 to 1111.1110 VDC
OUTPUT CURRENT	0. to 50 milliamperes
VOLTAGE RANGES	10, 100, and 1000V with output as follows: 10V — 0 to 11. 111110 (1 μ V steps) 100V — 0. to 111. 11110 (10 μ V steps) 1000V — 0 to 1111. 1110 (100 μ V steps)

Table 1-1. Specifications (cont)

VOLTAGE STANDARD (cont)	
PARAMETER	SPECIFICATIONS
METER AND DIAL RESOLUTION	0.1 ppm of range (1 μ V maximum)
ACCURACY OF OUTPUT (for 60 days)	10V range $\pm (0.001 + 10 \mu\text{V})$ 100V range $\pm (0.001 + 20 \mu\text{V})$ 1000V range $\pm (0.0015 + 200 \mu\text{V})$
<p style="text-align: center;">NOTE</p> <p><i>The previous accuracies are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and up to 70% relative humidity.</i></p>	
TEMPERATURE COEFFICIENT OF OUTPUT	Less the $\pm(0.0002\%$ of setting + 1 $\mu\text{V})/^{\circ}\text{C}$ from 0°C to 50°C
STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT)	10V range $\pm(0.0005 + 7 \mu\text{V})$ per month 100V and 1000V ranges $\pm(0.0005 + 30 \mu\text{V})$ per month
OVERVOLTAGE PROTECTION	Automatically disconnects load if output voltage exceeds 1 to 1200V setting of front panel controls. Manual reset.
OVERCURRENT PROTECTION	Automatic current limiting continuously adjustable from 1 to 60 mA with front panel control and indicator. Normal operation restored upon removal of overload.
RIPPLE AND NOISE (DC to 100 kHz)	10V range — less than 20 μV rms 100V range — less than 30 μV rms 1000V range — less than 40 μV rms
SETTLING TIME	Typically, within 10 ppm of final output, less than 20 seconds after a range change
OUTPUT RESISTANCE	Less the 0.0005 ohms or $(0.0001E_0)$ ohms at dc
REGULATION	0.0002% of setting or 10 μV for either a 10% line voltage change or a full load change.
COMMON MODE REJECTION	Better than 125 dB from dc to 400 Hz, up to 700V rms or 1000 VDC
ISOLATION	Either output terminal may be floated up to 1000 VDC from chassis ground
REMOTE SENSING	Separate terminals are provided to sense the output voltage directly at the load, reducing errors caused by voltage drop in connecting wires between the output and the load.

Table 1-1. Specifications (cont)

DIFFERENTIAL VOLTMETER		
PARAMETER	SPECIFICATIONS	
ABSOLUTE ACCURACY, TEMP. COEFF. OF ACCURACY, INPUT RANGES, and STABILITY	Same as output characteristics under Voltage Standard	
NULL SENSITIVITIES	1000V to 10 μ V (full-scale) in 9 decade ranges. Any null sensitivity may be used on any voltage range.	
INPUT RESISTANCE	Infinite at null from 0 to 1111.1110 VDC	
METER AND DIAL RESOLUTION	0.1 ppm of range	
CONVENTIONAL VOLTMETER		
ACCURACY	$\pm 3\%$ of range.	
RANGES	Voltage Range	Input Resistance
	1000-0-1000	100 M Ω
	100-0-100	100 M Ω
	10-0-10	100 M Ω
	1-0-1	100 M Ω
	0.1-0-0.1	10 M Ω
	0.001-0-0.001	1 M Ω
	0.0001-0-0.0001	1 M Ω
0.00001-0-0.00001	1 M Ω	
GENERAL		
DESIGN	Solid-state	
STABILITY OF METER ZERO	On most sensitive range (10 μ V full-scale): 0.5 μ V peak-to-peak noise 0.5 μ V peak-to-peak stability for 10% line voltage variation	
RECORDER/ISOLATION AMPLIFIER OUTPUT	Adjustable from 0 to over 1.0V for end-scale meter deflection; source resistance 5 to 8 k Ω ; linearity better than $\pm 0.5\%$ of end-scale. Gain as an isolation amplifier is 1.0V/null range sensitivity. Recorder output may be grounded or floated up to 100 VDC.	
TEMPERATURE	0°C to +50°C, operating; -40°C to +65°C, non-operating.	
HUMIDITY	0 to 70% relative humidity.	
SHOCK AND VIBRATION	Meets all requirements of MIL-T-945A, rigidly mounted or rack mounted with slides.	
ALTITUDE	Operating, 10,000 ft. - 3.0 km Non-operating, 50, 000 ft - 15.2 km	

Table 1-1. Specifications (cont)

GENERAL (cont)	
PARAMETER	SPECIFICATIONS
FUNGUS NUTRIENTS MERCURIC COMPONENTS	None
FUSES	One power-line fuse; one high-voltage fuse.
INPUT POWER	115/230 VAC ±10%, 50–60 Hz, single phase, approximately 130 VA fully loaded.
SIZE	Height: 17.8 cm (7 in) Width: 4.83 cm (19 in) Depth: 45.7 cm (18 in)
WEIGHT	Approximately 23 kg (50 lbs)

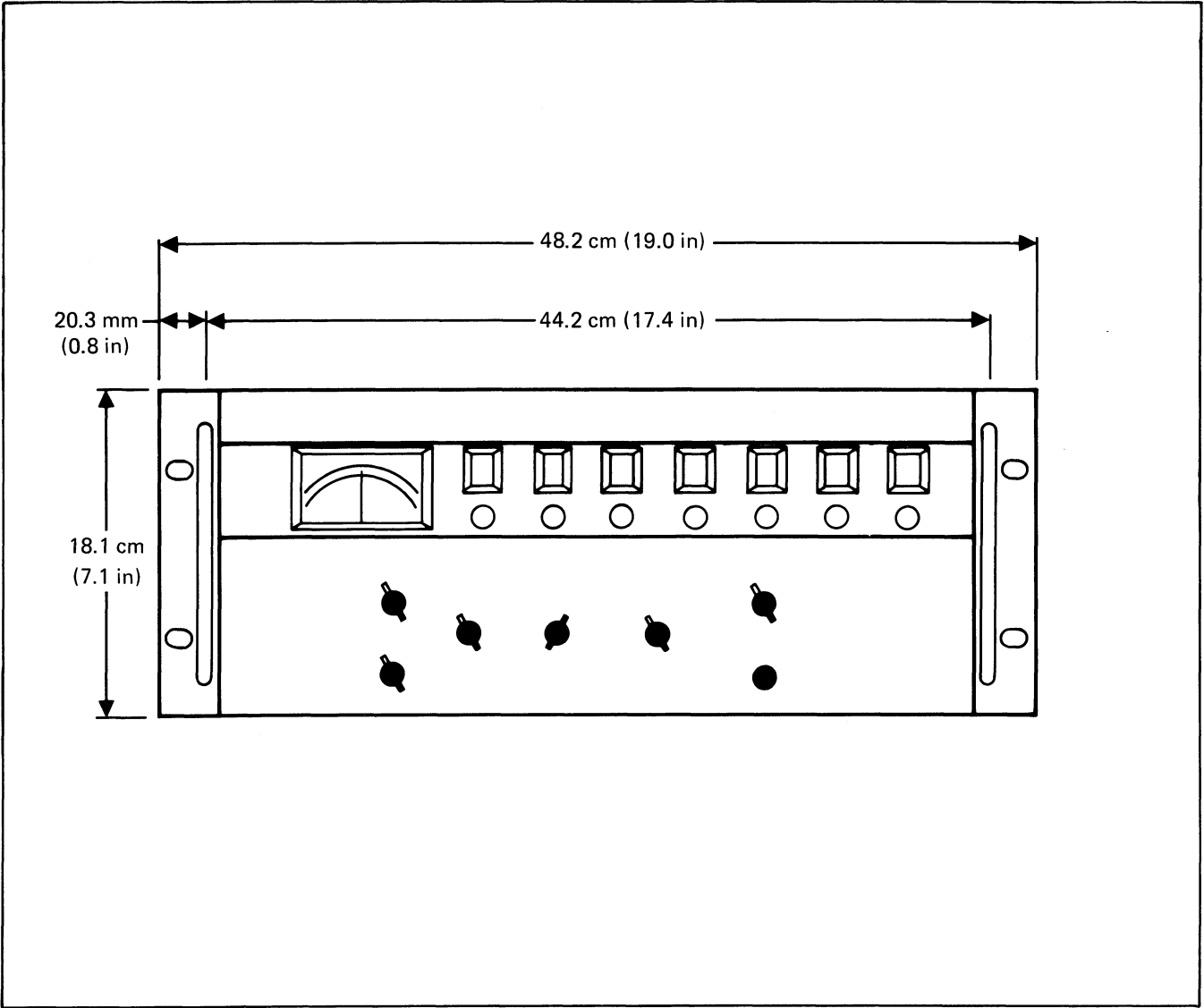


Figure 1-1. Outline Drawing

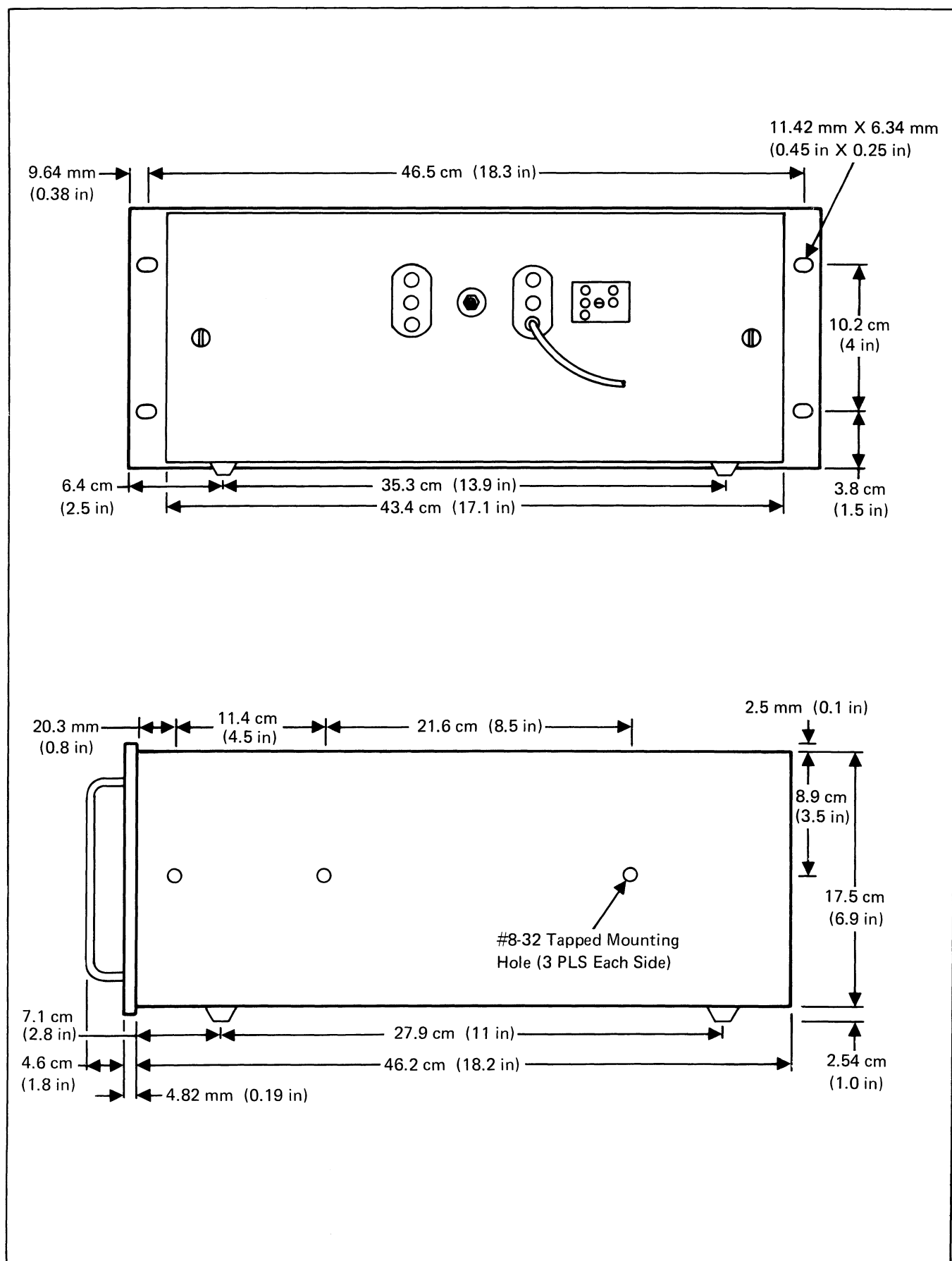


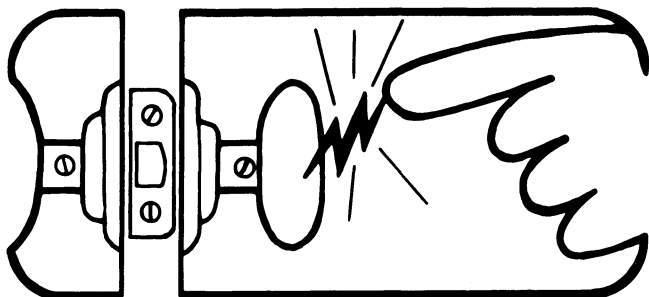
Figure 1-1. Outline Drawing (cont)



static awareness



A Message From
John Fluke Mfg. Co., Inc.



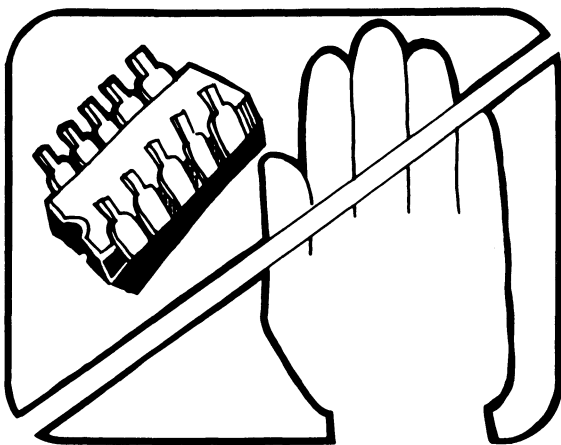
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

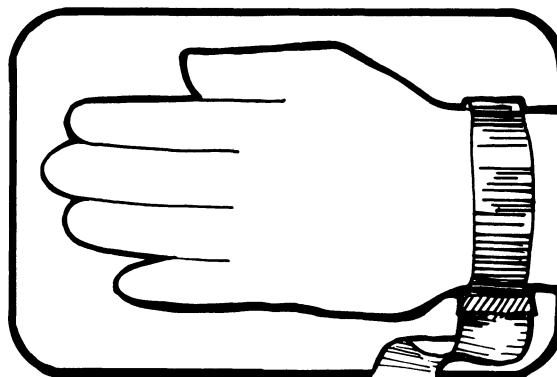
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol



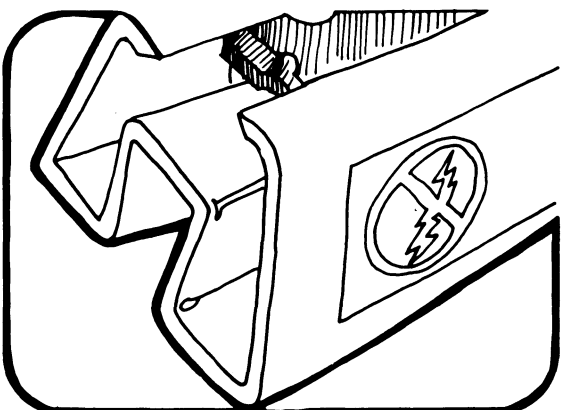
The following practices should be followed to minimize damage to S.S. devices.



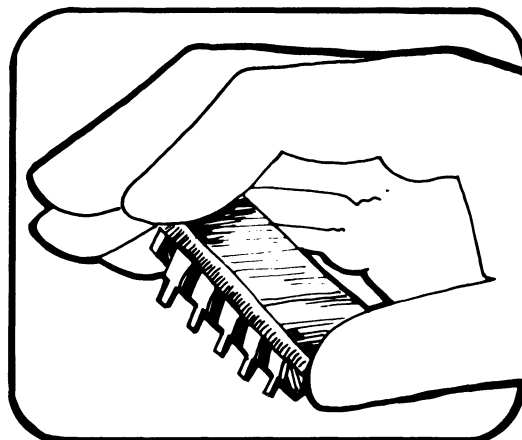
1. MINIMIZE HANDLING



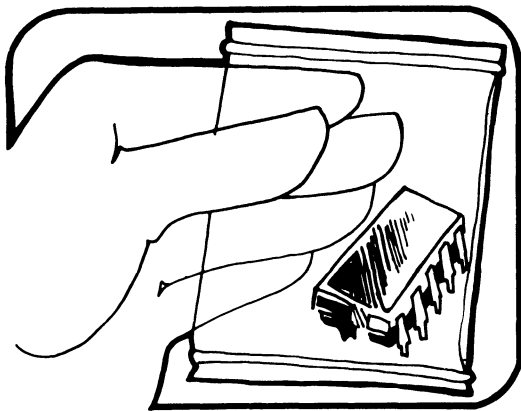
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



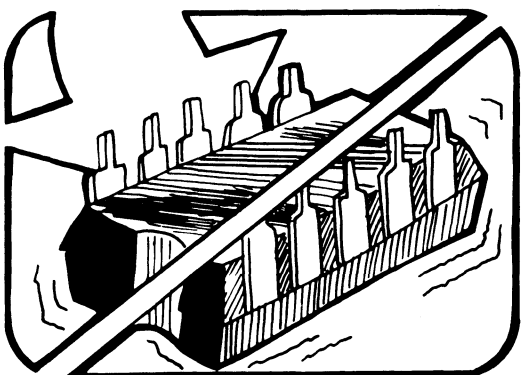
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



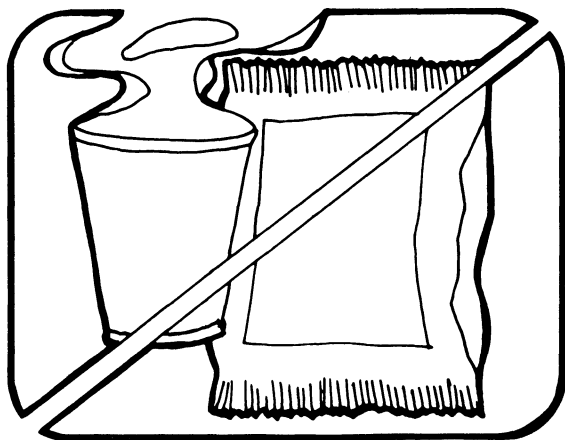
4. HANDLE S.S. DEVICES BY THE BODY



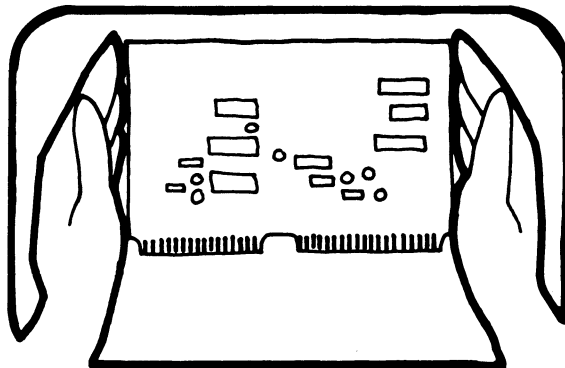
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



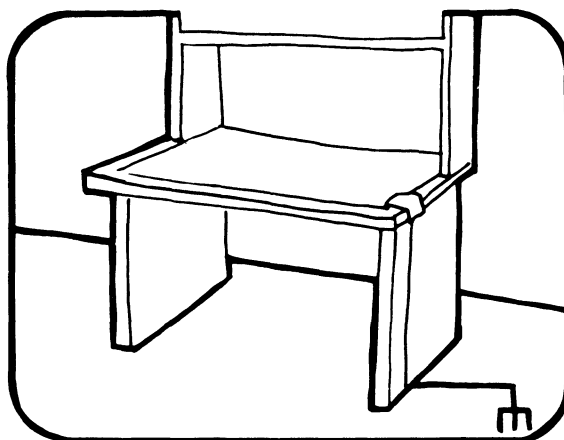
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

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Section 2

Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information concerning the installation and operation of the Model 335D Voltage Standard/Differential Voltmeter/Null Detector. It is recommended that the contents of this section be thoroughly read and understood before an attempt is made to operate the instrument.

2-3. If any problem is encountered in operation of the instrument, contact your nearest Fluke Sales Representative (list in Section 7), or the John Fluke Mfg. Co., Inc.; P.O. Box 43210; Mountlake Terrace, Washington 98043; Telephone: (206) 774-2211. Please include instrument model and serial number in such correspondence.

2-4. SHIPPING INFORMATION

2-5. The 335D is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a

thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-6. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument's model number when requesting a new shipping container.

2-7. INPUT POWER

2-8. The 335D can be operated from either 115 volts ac or 230 volts ac, 50 or 60 Hz line power. The instrument should arrive configured for the line power specified at the time of purchase. For verification that your instrument is properly connected for your input power requirements, refer to Figure 2-1.

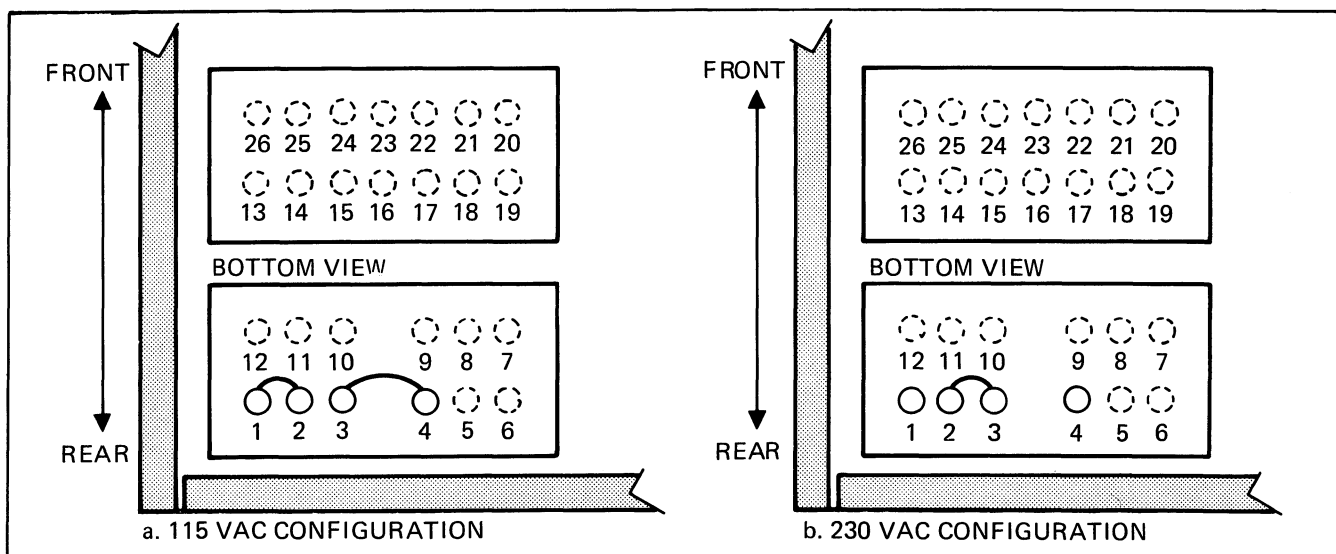


Figure 2-1. 115V/230V Conversion

2-9. To convert from one input power option to the other, refer to 115/230V Conversion, in Section, MAINTENANCE.

2-10. OPERATING FEATURES

2-11. Controls, terminals, and indicators locations are shown in Figure 2-2, Front and Rear Panel Controls,

Terminals and Indicators. The range and function are described in Table 2-1, Front and Rear Panel Controls, Terminals and Indicators. The numbers in the tails of the arrow callouts in Figure 2-1, correspond to the numerical sequence in Table 2-1.

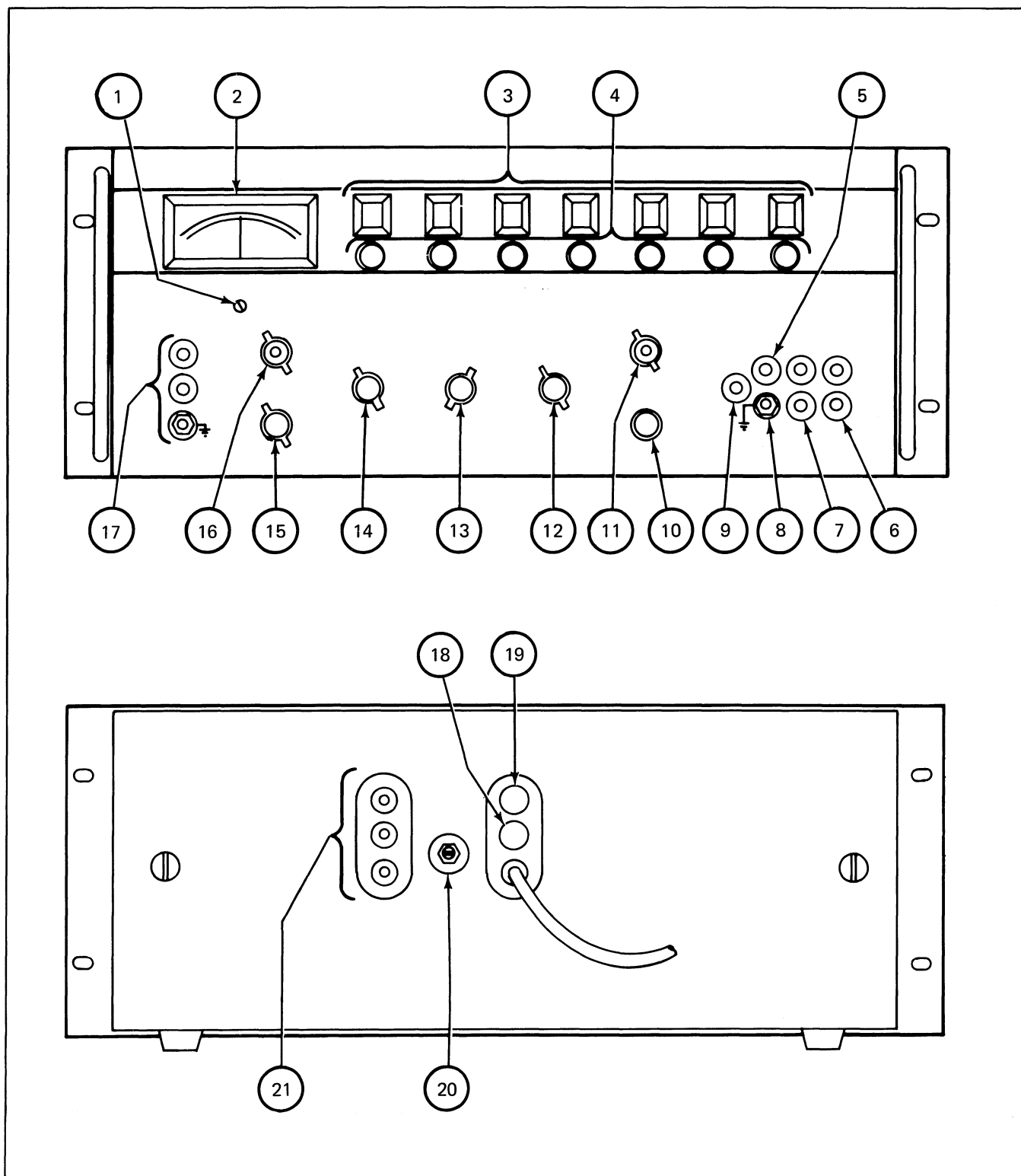


Figure 2-2. Front and Rear Panel Controls, Terminals, and Indicators

Table 2-1. Front and Rear Panel Controls, Terminals and Indicators

REF NO.	NAME	FUNCTION
1	Mechanical Zero Adjust	Provides a means of setting the meter mechanical zero. Adjustment should be made after the instrument has been completely de-energized for at least three minutes.
2	Meter	Indicates the full value of a voltage applied to the INPUT terminals when the INPUT MODE switch is in the TVM position. When the INPUT MODE switch is in the DIFF + or DIFF – positions, the meter indicates the difference between an unknown voltage at the INPUT terminals and the voltage indicated on the readout dials. The meter provides an indication of the output voltage when the SENSITIVITY switch is in the V position. An indication of the output current may be determined from the red meter scale when the SENSITIVITY switch is in the I position.
3	Decimal Point LEDs	These LEDs indicate the proper decimal point setting when illuminated and are controlled by the RANGE switch setting.
4	Readout Dials	Used to select the desired output voltage from the Voltage Standard portion of the instrument. Also, indicates the value of an unknown voltage when used in conjunction with the Differential Voltmeter portion of the instrument. When a dial is set to the X (10), it represents 0 with a 1 carry-over to the digit to the immediate left. For example: 10.XXXXXX represents 11.111110 volts.
5	GUARD Terminal	Provides a means of eliminating circulating ground currents through the load, when properly connected.
6	OUTPUT Terminal	Provides a convenient means of connecting the load to the output of the Model 335D.
7	SENSE Terminal	Allows the regulating circuitry within the Model 335D to be connected directly to the output terminals or to the load for optimum regulation.
8	Case Ground	Power line ground.
9	VM AC COMMON Terminal	Provides optimum common mode rejection when connected to the GUARD terminal for Voltage Standard operation. Provides minimum common mode voltage at the INPUT terminals, when connected to the ground terminal for voltmeter operation.
10	CURRENT LIMIT Control	Provides a means of setting a limit on the magnitude of the output current within a range of 0 to 60 milliamperes. An over-current condition is signified when the LED indicator, near the CURRENT LIMIT control, illuminates.

Table 2-1. Front and Rear Panel Controls, Terminals and Indicators (cont)

REF NO	NAME	FUNCTION
11	TRIP Switch and VERNIER Control	The TRIP switch provides a means of limiting the output voltage in three ranges (10, 100, and 1000 volts) independent of the RANGE switch. The VERNIER control varies the amount of limiting within the ranges of the TRIP switch. When an overvoltage condition exists, the red indicator lamp near the TRIP switch will illuminate and the red lamp near the POWER switch will be extinguished.
12	RANGE Switch	Allows selection of one of three ranges (10, 100, or 1000 volts) for use in either Voltage Standard or Differential Voltmeter operation of the instrument.
13	SENSITIVITY Switch	Provides selection of 10 microvolts through 1 kilovolt full-scale input ranges for Null Detector operation. Also, selects 10 microvolts through 1 kilovolt null sensitivity ranges for Differential Voltmeter operation. The I and V positions allow monitoring of the current and voltage output of the Voltage Standard portion of the instrument.
14	INPUT MODE Switch	Allows selection of either Differential Voltmeter operation, in DIFF- or DIFF+, or Null Detector operation, in the TVM (Transistor Volt Meter).
15	POWER Switch	Applies line power to the auxiliary power supplies within the instrument, when set to STDBY/RESET. The instrument is completely energized when the POWER switch is in the OPR position and the red LED indicator near the switch is illuminated.
16	NULL ZERO Switch and ADJUST Control	Placing the NULL ZERO switch in the ZERO position, the ADJUST control may be varied to electrically zero the meter. Optimum electrical zero is accomplished in the 10 microvolt position of the SENSITIVITY switch. After adjustment of the electrical zero, the NULL ZERO switch should be returned to OPR.
17	INPUT Terminals	The HI, LO and case ground (power line ground) terminals provide a convenient means of connecting a dc voltage source to the voltmeter input.
18	Fuse, line	A 3 ampere slow-blow fuse for 115 volt power line operation. Use a 1½ ampere slow-blow fuse for instruments configured for 230 volt operation.
19	Fuse, High Voltage	A ¼ ampere slow-blow fuse electrically located at the output of the high voltage rectifier circuit.
20	RECORDER OUTPUT ADJUST	Allows adjustment of the Model 335D recorder output level from 0 to 1 volt, for an end scale deflection of the front panel meter.
21	RECORDER OUTPUT Terminals	Terminals provided for the connection of a recording instrument. The (black) terminal is connected to case ground.

2-12. Operating Notes

2-13. The following paragraphs describe various conditions which should be considered before operating the 335D as a voltage source, voltmeter, or null detector. Whether to use the settings and conditions or not, depends upon the degree of the equipment safety and accuracy required.

2-14. Warm-Up Time

2-15. For optimum accuracy, the unit should be warmed up as long as possible prior to operation. A two hour warm-up should be used as a minimum with the unit in the "100 Volt/RANGE" operating mode.

2-16. Trip Setting

2-17. The TRIP switch and VERNIER control provide protection for external equipment by limiting the output voltage to the external load. The range of voltage limiting is selected with the TRIP switch. Refinement of the value of the voltage to be limited is accomplished with the VERNIER control. If no degree of limiting is required within the ranges of the instrument, set the TRIP switch to 1000 and the VERNIER fully clockwise. Should some degree of limiting be desirable, proceed as follows:

WARNING

OPERATOR INJURY OR DEATH MAY RESULT FROM CONTACT WITH THE OUTPUT TERMINALS WHEN LETHAL VOLTAGES ARE SELECTED FOR INSTRUMENT OUTPUT AND THE OPERATE SWITCH IS IN THE ON POSITION. WHEN THE OPERATE SWITCH IS IN THE STDBY/RESET POSITION, INSTRUMENT OUTPUT IS NOT ENABLED SO NO ELECTRICAL HAZARD FROM THE MODEL 335D EXISTS ON THE OUTPUT TERMINALS.

1. With the load disconnected from the OUTPUT terminals and the POWER switch set to STDBY/RESET, set the remaining front panel controls as follows:

RANGE	As desired
TRIP	To the lowest range that overlaps the desired trip voltage.
VERNIER	Fully cw
CURRENT LIMIT	As desired
INPUT MODE	TVM
SENSITIVITY	V
Readout Dials	Desired trip voltage

2. Set the POWER switch from STDBY/RESET to OPR.

3. Slowly rotate the VERNIER control counter-clockwise until the indicator lamp near the TRIP switch illuminates and the red lamp near the POWER switch is extinguished. The voltage trip is not set to the value indicated on the readout dials and the instrument is tripped to the STDBY mode.

4. To reset the instrument, set the readout dials to a value less than the trip voltage and set the POWER switch to STDBY/RESET, then to OPR.

2-18. Current Limit Setting

2-19. The CURRENT LIMIT control provides a means of limiting the amount of output current. If limiting within the current range of the instrument is not desired, set the CURRENT LIMIT control fully clockwise (60). Should some degree of current limiting be desired, proceed as follows:

1. With the POWER switch in the STDBY/RESET position, set the front panel controls as follows:

RANGE	As desired
TRIP and VERNIER	As desired
CURRENT LIMIT	Fully clockwise
INPUT MODE	TVM
SENSITIVITY	I
Readout Dials	1 volt

2. Place a short across the OUTPUT terminals.
3. Set the POWER switch to OPR.
4. Adjust the CURRENT LIMIT control until the current indicated on the meter is the value of the desired limiting current.
5. Set the POWER switch to STDBY/RESET. Remove the short. Current limiting is now set to the desired value for any output voltage.

2-20. VM AC Common Connections

2-21. For optimum common mode rejection, connect the VM AC COMMON terminal to either the GUARD or ground terminal with the shorting link provided. The decal on the rear of the instrument case shown in Figure 2-1 illustrates the proper connection depending upon whether the instrument is operated as a voltage source or as a voltmeter.

2-22. Sense Connections

2-23. When a load is connected, there may be an appreciable voltage drop between the instrument and load due to the length and gauge of the connecting wire leads. The nomograph, in Figure 2-3, can be used to determine the approximate voltage across the connecting wire leads.

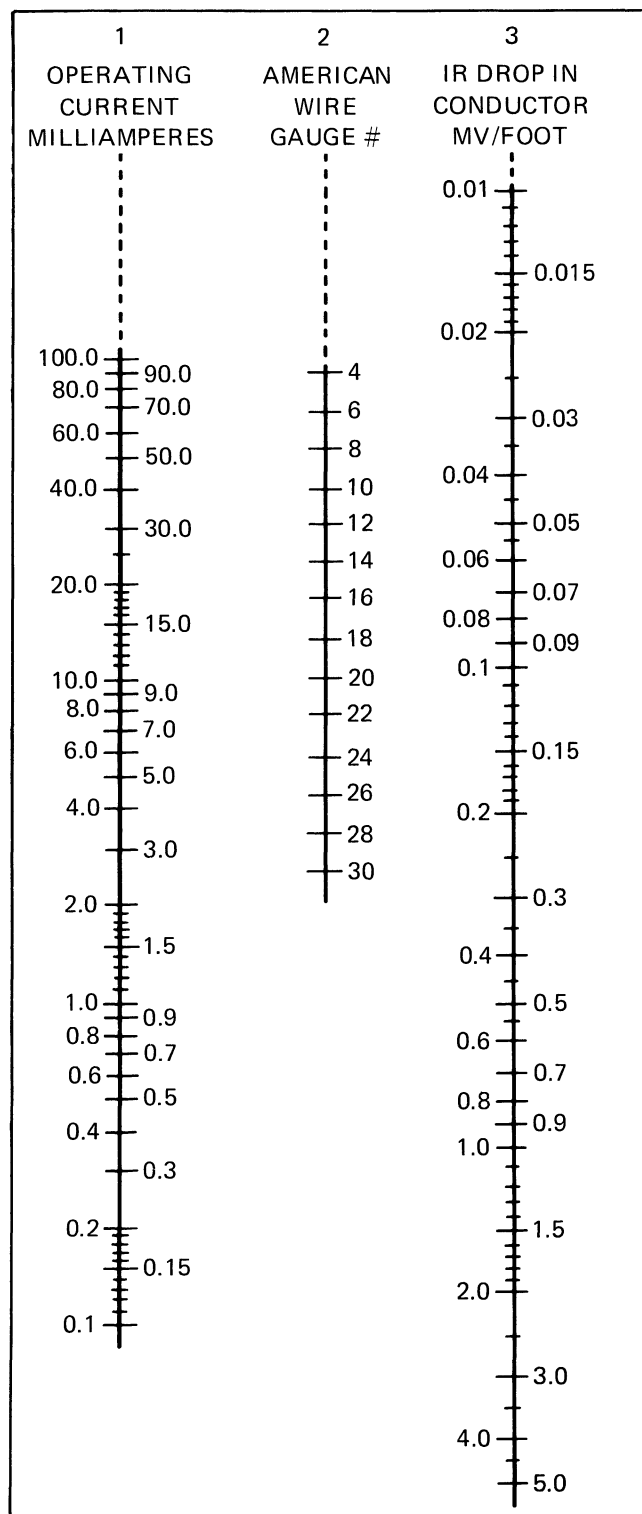


Figure 2-3. Nomograph of Voltage Drop Across Load Wires

2-24. Using the nomograph of Figure 2-3, lay a straight edge from the value of the output current, represented on scale 1, to the gauge of the connecting wires used, represented on scale 2. The voltage across the connecting wires, expressed in millivolts per foot, is obtained from scale 3. To determine the total voltage across the connecting wires, multiply the total length in feet by the value obtained from scale 3. For example, assume that two AWG #28 wires, each 3-feet long, are used to connect a load, requiring 50 milliamperes, to the instrument. With a straight edge, connect the known current on scale 1 (50 mA) and the wire size on scale 2 (#28). The resulting IR drop on scale 3 is approximately 3.2 millivolts per foot. Therefore, the connecting wires will develop a total voltage of 19.2 millivolts ($2 \times 3 \text{ ft.} \times 3.2 \text{ mV/ft} = 19.2 \text{ mV}$), which is several times the published load regulation of the instrument at 1000 volts output. To compensate for this, the instrument is equipped with remote sensing, which maintains regulation at the load. Consequently, the voltage across the connecting wires will have no effect. Determine if the wire leads, used to connect the instrument to the load, will cause a voltage drop in excess of the load regulation specifications. If this voltage drop is excessive, remote sensing should be used. To prepare the instrument for remote sensing, proceed as follows:

1. With the POWER switch set to OFF, or STDBY/RESET, remove the front panel shorting links between the SENSE and OUTPUT terminals.
2. Using a twisted pair of insulated wires, connect the + SENSE terminal to the positive side of the load, and connect the - SENSE terminal to the negative side of the load.

CAUTION

Insure that the SENSE terminals are connected to the load in the proper polarity. Incorrect connections will result in loss of regulation and possible damage to the instrument.

2-25. Guard Connection

2-26. When the instrument is connected to another instrument (both instruments grounded through their respective power cords), a potential difference may exist between the power line grounds of these two instruments. This potential difference can create circulating ground currents, which could cause errors in the output voltage. To prevent these errors from occurring, the instrument is equipped with a guard. This guard, when properly connected to the load, will provide a separate path for the circulating ground currents; thus eliminating possible

errors in the output voltage. For proper connection, connect the GUARD terminal directly to the grounded side of the load, at the load. Figure 2-4 illustrates the correct GUARD terminal connection and the rerouted circulated ground current path.

2-27. OPERATION AS A VOLTAGE STANDARD

2-28. When the 335D is to be used as a voltage standard operate it in accordance with the following procedure:

1. Set the voltmeter controls as follows:

NULL ZERO	OPR
INPUT MODE	TVM
SENSITIVITY	V

2. Set the POWER switch to STDBY/RESET. Allow at least a 10 minute warm-up period if the instrument has just been energized.
3. Connect the SENSE terminals to the OUTPUT terminals with the shorting links provided.

4. Set the CURRENT LIMIT control fully clockwise (60) or to a predetermined value, using the Current Limit Setting procedure.
5. Set the RANGE switch to the desired output voltage range (10, 100, or 1000).
6. Set the voltage TRIP and VERNIER controls fully clockwise or to a predetermined value, using the Trip Setting procedure.
7. Set the readout dials to the value of the output voltage desired.
8. Connect the VM AC COMMON terminals to the GUARD terminals with the shorting link provided or if desired, connect the GUARD terminal to the grounded side of the load in accordance with the Guard Connection procedure.

NOTE

The SENSE terminals may remain connected to the OUTPUT terminals. If remote sensing is required, connect the SENSE terminals to the load in accordance with the SENSE Connections Procedure.

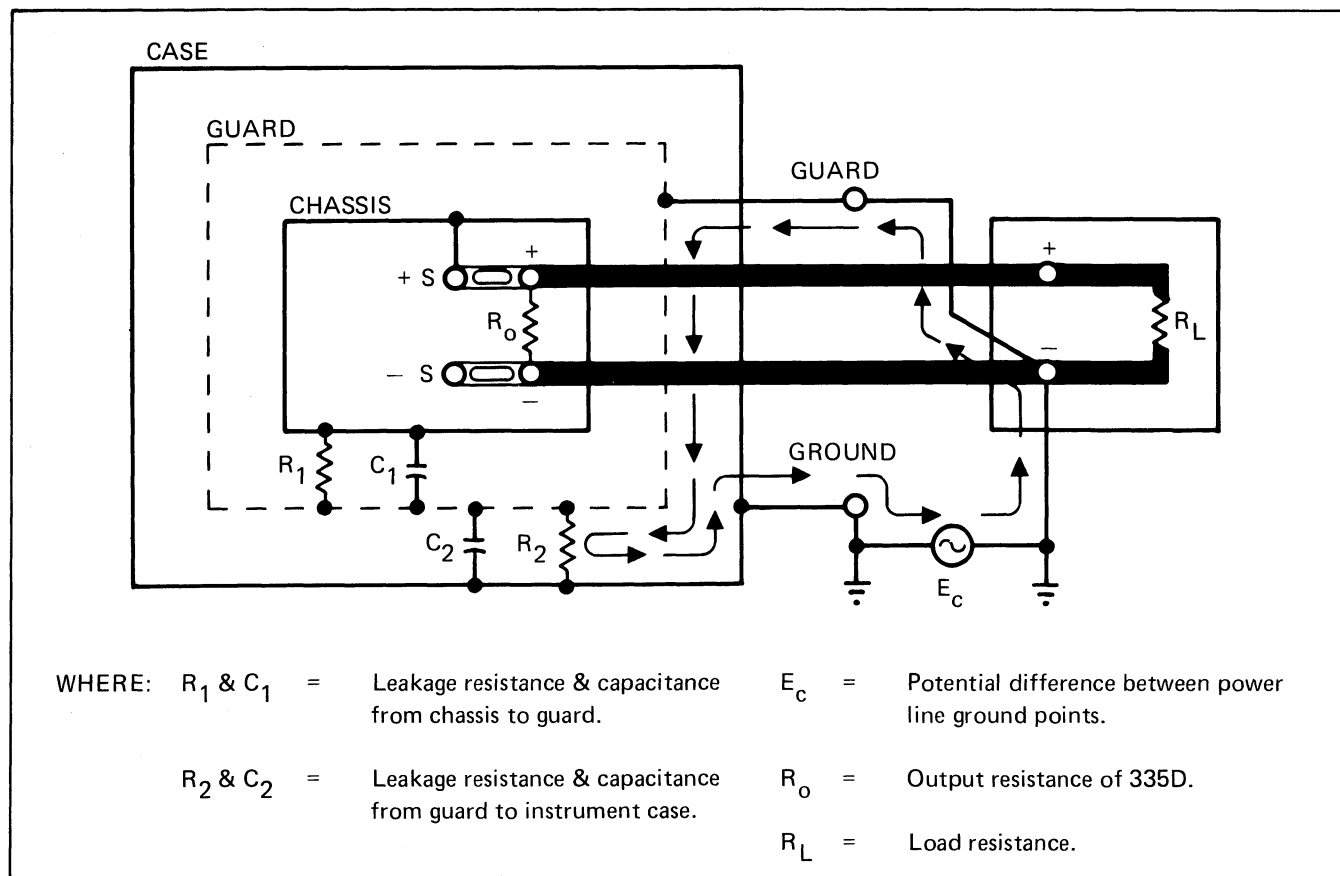


Figure 2-4. Guard Connection

9. Connect the load to the OUTPUT terminals.
10. Set the POWER switch to OPR.
11. The output voltage provided to the load will be the voltage indicated on the readout dials. To monitor the output voltage or current, place the SENSITIVITY switch in either the V (voltage) or I (current) position.

2-29. OPERATION AS A HIGH IMPEDANCE VOLTMETER OR NULL DETECTOR

2-30. Use the following procedure for operating the instrument as a high impedance voltmeter or null detector.

1. Set the VOLTAGE STANDARD controls as follows:

RANGE	10
TRIP	10
VERNIER	Fully clockwise
CURRENT LIMIT	Fully clockwise
Readout Dials	All Zero
2. Set the NULL DETECTOR controls as follows:

NULL ZERO	OPR
INPUT MODE	TVM
SENSITIVITY	1 kV
3. Connect the VM AC COMMON to the ground terminal with the shorting link provided.
4. Set the POWER switch to STDBY/RESET.
5. Connect the voltage source to the INPUT terminals of the Model 335D.
6. Set the SENSITIVITY switch to the lowest range that will allow an on-scale deflection. As indicated on the meter, a deflection to the left of zero represents a negative input voltage; whereas a deflection to the right of zero represents a positive input voltage.
7. When using the higher sensitivity ranges (1 mV, 100 μ V, or 10 μ V), the electrical zero should be adjusted. Set the NULL ZERO switch to ZERO and the SENSITIVITY switch to 10 μ V. Rotate the ADJUST control until the meter indicates zero. After the adjustment has been completed, return the SENSITIVITY switch to its original position; then set the NULL ZERO switch to OPR.

2-31. OPERATION AS A DIFFERENTIAL VOLTMETER

2-32. To operate the instrument as a differential voltmeter, proceed as follows:

1. Set the front panel controls as follows:

POWER	STDBY/RESET
NULL ZERO	OPR
INPUT MODE	TVM
SENSITIVITY	1 kV
RANGE	As desired
TRIP	1000
VERNIER	Fully clockwise
CURRENT LIMIT	Fully clockwise (60)
Readout Dials	All zero

2. Connect the VM AC COMMON terminal to the ground terminal with the shorting link provided.
3. Set the POWER switch to OPR.
4. Connect the external voltage source to the INPUT terminals.
5. Use the instrument as a high impedance voltmeter to determine the approximate value of the unknown input voltage. Adjust the RANGE switch and readout dials, so that this value is indicated on the front panel readout.
6. If the front panel meter indicates to the right (+) side of zero, set the INPUT MODE switch to DIFF+. If the front panel meter indicates to the left (-) side of zero, set the INPUT MODE switch to DIFF-.
7. Adjust the readout dials for a null (zero) indication on the front panel meter. Set the SENSITIVITY switch to successively more sensitive positions and adjust the readout dials for a null indication (on the front panel meter) at each setting.
8. Check and adjust, if necessary, the meter's electrical zero. If an electrical zero adjustment was necessary, readjust the readout dials for a null indication on the front panel meter.
9. The value of the voltage indicated on the front panel readout is that of the external voltage source.

2-33. OPERATION WITH A RECORDER

2-34. To use the instrument with a recorder for measuring a voltage or voltage excursions, proceed as follows:

1. Set the front panel controls as follows:

POWER	STDBY/RESET
NULL ZERO	OPR
INPUT MODE	DIFF+
SENSITIVITY	1
RANGE	10
Readout Dials	1.000000
TRIP	1000
VERNIER	Fully clockwise
CURRENT LIMIT	Fully clockwise (60)
Terminal Connections	See Figure 2-2

2. Connect the recorder to the RECORDER OUTPUT terminals at the rear panel. The recorder outputs may be floated up to 100 volts dc above ground.
3. Connect a jumper between the HI and LO INPUT terminals.

4. Set the POWER switch to OPR.
5. The front panel meter should indicate full-scale to the left of zero (-1). This full-scale deflection will allow up to 1 volt at the RECORDER OUTPUT terminals, depending upon the setting of the RECORDER OUTPUT ADJUST control.
6. Adjust the RECORDER OUTPUT ADJUST control to provide the desired recorder deflection for the full-scale front panel meter deflection.
7. Set the INPUT MODE switch to TVM and remove the short from the INPUT terminals.
8. Set the SENSITIVITY switch to the 1000 volt position.
9. Connect the voltage source to be measured to the INPUT terminals and operate the instrument as either a differential voltmeter or high impedance voltmeter.

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section describes the theory of operation of the Model 335D Voltage Standard-Differential Voltmeter-Null Detector. The description is separated into three parts: Basic Functional Description, Voltage Standard Analysis, and Voltmeter-Null Detector Analysis.

3-3. BASIC FUNCTIONAL DESCRIPTION

3-4. The Model 335D, as shown in Figure 3-1, houses a precision voltage standard and a high impedance voltmeter-null detector in one chassis. These two units may be used separately or they may be combined to function as a differential voltmeter.

3-5. The dc Voltage standard section is a precisely controlled, series-regulated power supply whose output can be selected in highly accurate increments from 0 volts to 1200.000 volts. The series pass element is controlled by an error amplifier whose input is proportional to the output voltage selected and any error in that voltage. As shown in Figure 3-1, selection of an output voltage sets up a divider network made up of the Sample String resistance and the range calibration resistance. The voltage across this divider is the difference between a constant master reference voltage and the input on the -sense terminal. Therefore, the voltage felt at the input of the error amplifier (summing point) is a composite of the basic voltage required to produce the selected voltage at the \pm output terminals and the negative feedback error voltage. The +sense input provides a master bias for the voltage standard circuitry. The \pm SENSE terminals may either be connected through shorting links to the \pm OUTPUT terminals to provide compensation for output voltage errors or the \pm SENSE terminals may be connected to the load; as described in Section 2, SENSE

CONNECTIONS: to compensate for both errors in output voltage and errors caused by the interconnecting cables. Usually, series regulated power supplies are inefficient when providing a low level output because the series pass element must dissipate the bulk of the input power. The 335D incorporates a pre-regulation circuit that monitors the output voltage at the series pass element and controls the primary power input so that the high voltage transformer provides exactly the amount of power necessary for load requirements.

3-6. The voltmeter-null detector section of the Model 335D may be operated as either a high impedance voltmeter-null detector or a differential voltmeter. The position of INPUT MODE switch, S4, determines the function. When operated as a high impedance voltmeter-null detector (INPUT MODE switch in the TVM position), the input divider (SENSITIVITY switch, S5) is connected directly across the HI and LO INPUT terminals. The front panel meter indicates the full value of the unknown voltage applied to the INPUT terminals. When operated as a differential voltmeter (INPUT MODE switch in either the DIFF+ or DIFF- position) a variable precision reference voltage (\pm SENSE from the Model 335D Voltage Standard section) is placed in series with the LO INPUT section. The polarity of the reference voltage is opposite the polarity of the unknown voltage. The meter will indicate the difference between the unknown voltage and the reference voltage, when the meter indicates a zero difference, the READOUT DIALS display the exact value of the unknown voltage.

3-7. VOLTAGE STANDARD

3-8. Introduction

3-9. The theory of operation of the Model 335D Voltage Standard section consists of a detailed functional description and a circuit analysis of each PCB. The

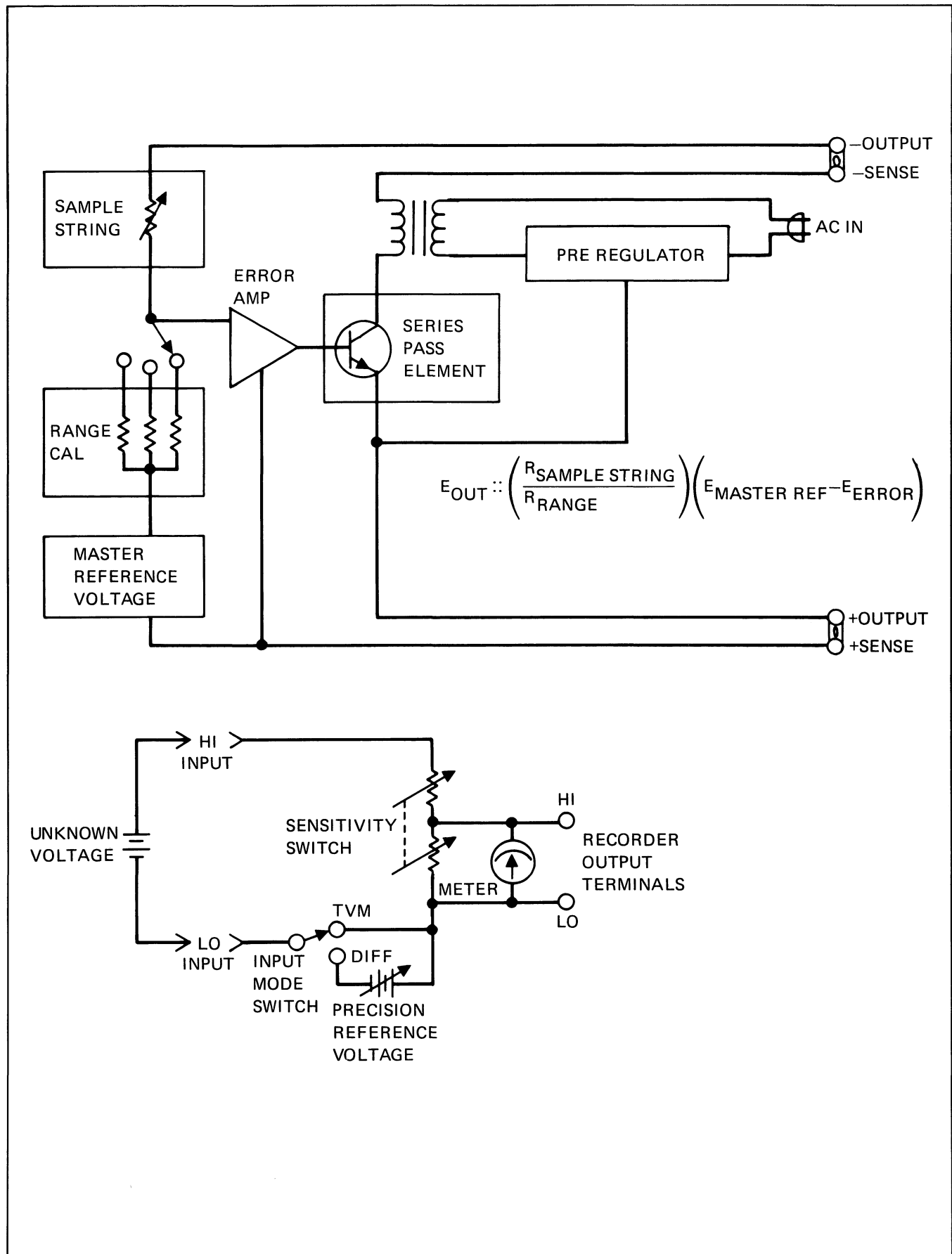


Figure 3-1. Basic Functional Diagram

detailed functional description will be illustrated by the DC Voltage Standard Simplified Schematic, Figure 3-2. The circuit analyses of the individual PCB's are supported by the schematics in Section 8 of this manual.

3-10. Detailed Functional Description

3-11. HIGH VOLTAGE CIRCUITRY

3-12. Refer to DC Voltage Standard Simplified Schematic, Figure 3-2, input power to the High Voltage Transformer, T2, comes from the Main Power Transformer, T1, pins 6 and 7. One leg of this input power passes through the A8A2 Pre-Regulator PCB Assembly (to control the amount of power available to the high voltage circuit) and the control relay A8A2K2 (to de-energize the input to the DC Voltage Standard for overvoltage, overcurrent conditions or actuation of the interlock circuit). The secondary of the High Voltage Transformer, T2, passes through a rectifier and filter on the A8 High Voltage Motherboard PCB Assembly. The negative side passes through the contacts of the control relay A8K1 (to de-energize the output of the DC Voltage Standard for overvoltage or overcurrent conditions or actuation of the interlock circuit) to the -OUTPUT terminals. The positive side of the high voltage rectifier/filter is regulated by the A8A1 Series Pass Element PCB Assembly and passes through sensing element R22 on the A5A2 Series Pass Driver PCB Assembly to the +OUTPUT terminal.

3-13. HIGH VOLTAGE CONTROL CIRCUITRY

3-14. Comparing the Model 335D Basic Functional Diagram, Figure 3-1 (Voltage Standard section) to the DC Voltage Standard Simplified Schematic, Figure 3-2, the Master Reference Voltage, Range Calibration, and Sample String portions of the voltage control circuit are the same, but the error amplifier of the Basic Functional Diagram is shown in the simplified schematic to be composed of a chopper amplifier, a differential amplifier, and a drive amplifier.

3-15. Operational amplifier A2 on the A5A1 Master Voltage Reference PCB Assembly is the source of the Master Reference Voltage. A2 is stability referenced by an oven enclosed circuit.

3-16. The resistance of the A4 Range Cal, PCB Assembly selected by the RANGE switch and the resistance on the A2 Sample String PCB Assembly selected by the Readout Dials form a voltage divider with the Master Reference Voltage and -SENSE voltage acting through it. The voltage present at the summing point of this divider network is a function of output voltage error and the position of the RANGE switch and Readout Dials. AC changes at the summing point are

directly input to the differential amplifier on the A5A3 Differential Amplifier PCB Assembly. DC changes at the summing point are processed through the A5A4 Chopper Amplifier PCB Assembly before being input to the Differential Amplifier.

3-17. The chopper amplifier on the A5A4 Chopper Amplifier PCB Assembly is biased by the +SENSE voltage and has two inputs. One input is DC changes from the summing point of the Range Cal/ Sample String voltage divider. The other input is from the zero output adjust circuitry located on the A5A1 Master Voltage Reference PCB Assembly.

3-18. The differential amplifier on the A5A3 Differential Amplifier PCB Assembly alters its output to the drive amplifier on the A5A2 Series Pass Driver PCB Assembly for an AC or DC voltage change at the Range Cal/Sample String PCB Assembly. The differential amplifier is also biased by the +SENSE voltage.

3-19. The drive amplifier on the A5A2 Series Pass Driver PCB Assembly controls the base bias of Q8, the final state of the series pass element on the A8A1 Series Pass Element PCB Assembly. This completes the negative feedback loop of the voltage control circuitry.

3-20. PRE-REGULATED CIRCUITRY

3-21. The unijunction pulse oscillator on the A8A1 Series Pass Element PCB Assembly is a VCO (Voltage Controlled Oscillator) monitoring the +OUTPUT voltage at the regulated end of the series pass element. Circuitry insures that the unijunction oscillator will put out a pulse train each half cycle of the input power. The +OUTPUT voltage determines when in each half cycles that pulse train starts - the lower the +OUTPUT voltage the shorter the time from the start of each half cycle and the generation of the first unijunction pulse. The clipped, full-wave rectified 16 volt signal, from the +150V power supply on the A8A1 Series Pass Element PCB Assembly, synchronizes the unijunction oscillator to each half cycle of line frequency. The unijunction pulses are coupled through transformer A8T1 to the pre-regulator control and latch circuitry on the A8A2 Pre-Regulator PCB Assembly.

3-22. The pre-regulator control and latch circuitry on the A8A2 Pre-Regulator PCB Assembly is synchronized to each half cycle of line frequency by +V and -V from the power supply on the same pcb. Both the pre-regulator control circuit and the unijunction oscillator are synched by line frequency. At the beginning of each half cycle, Q1 is turned on, allowing conduction through the pre-regulator bridge. This allows input line power to pass through the primary of the high Voltage Transformer, T2. When the first unijunction pulse is received by the pre-regulator control and latch circuit, Q1

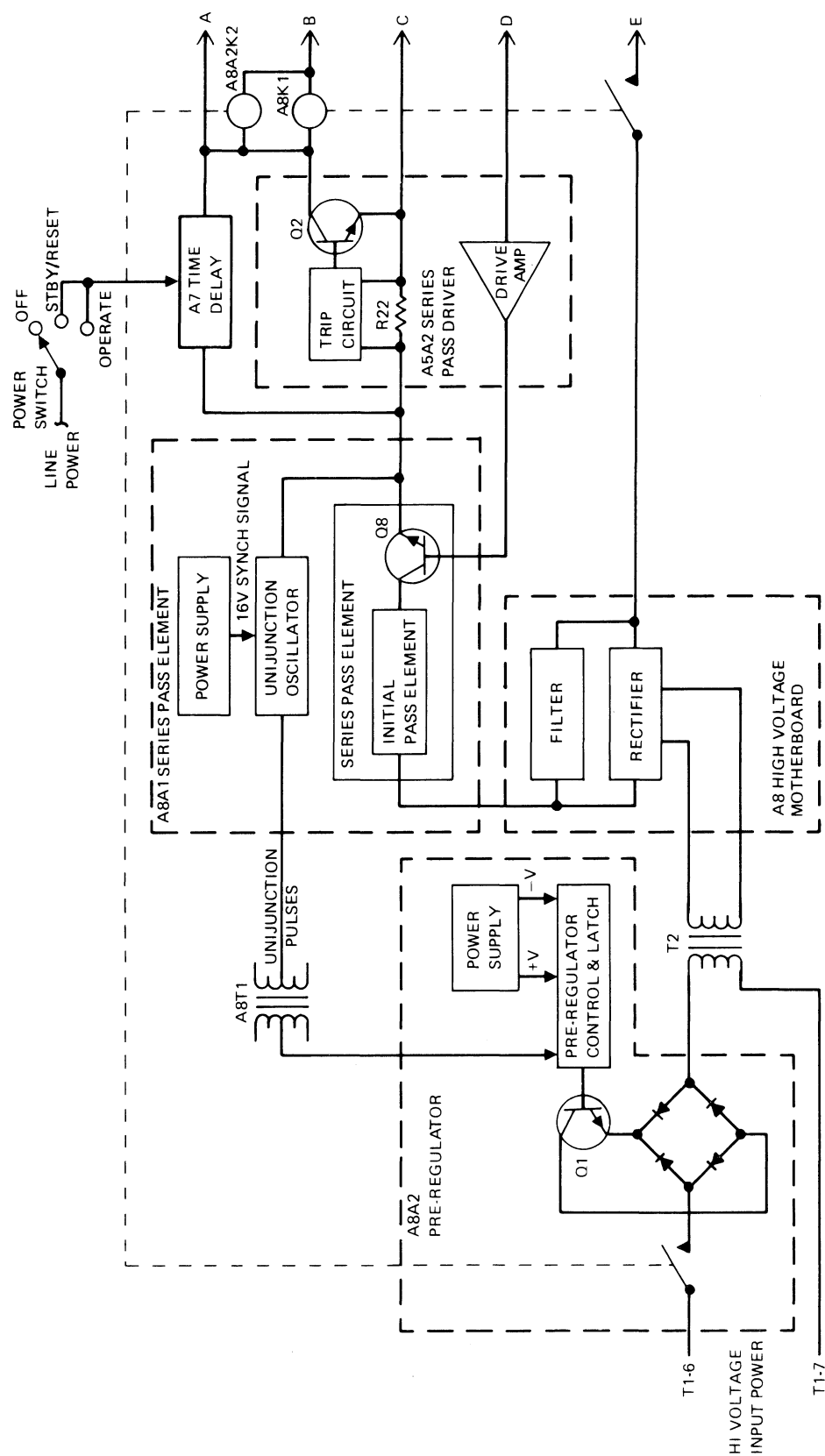


Figure 3-2. DC Voltage Standard Simplified Schematic

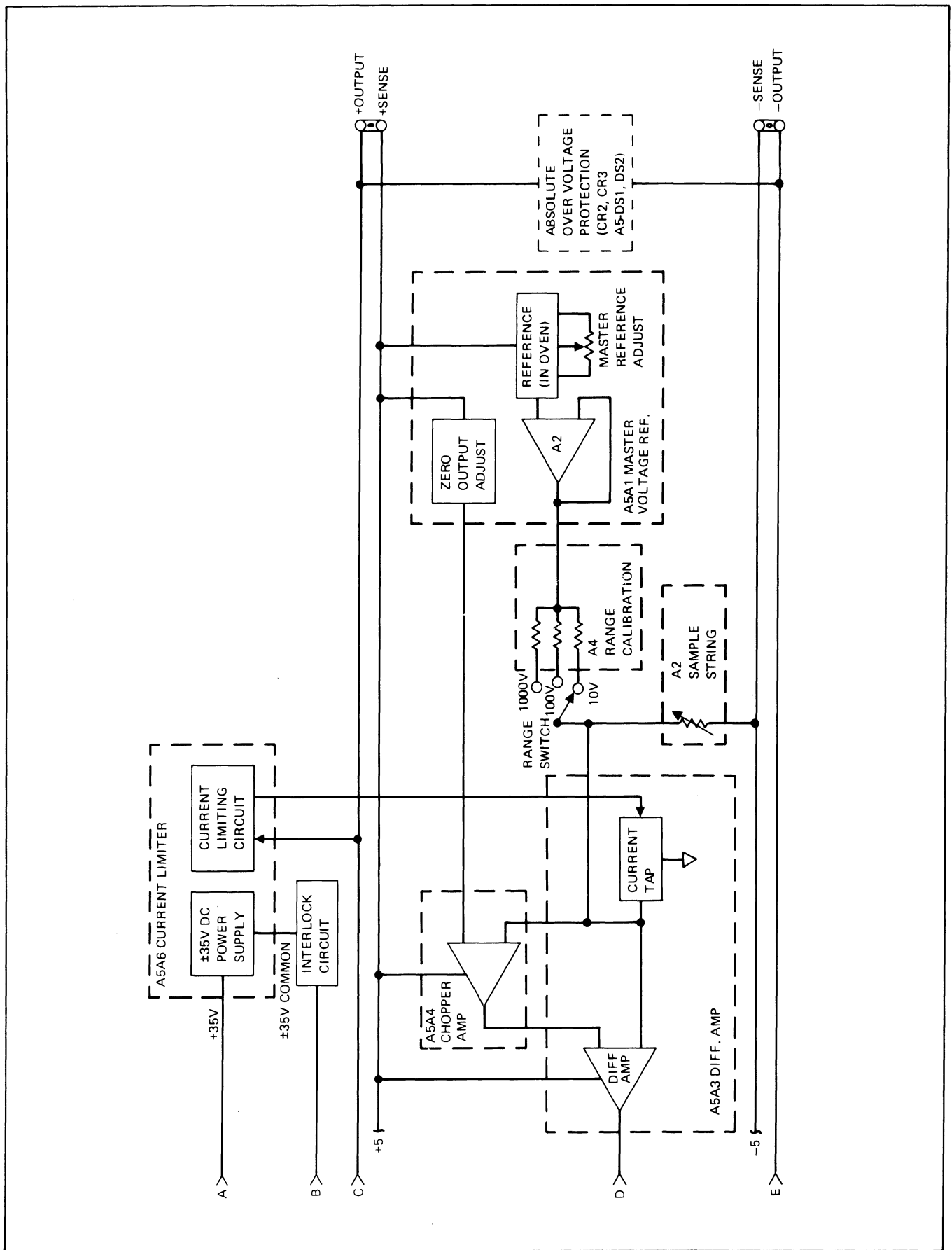


Figure 3-2. DC Voltage Standard Simplified Schematic (cont)

is turned off and latched off for the rest of that half cycle. Therefore, power is allowed to flow through the primary of the High Voltage Transformer, T2, from the beginning of each half cycle until very shortly after the generation of the first unijunction pulse. The lower the +OUTPUT voltage, the shorter the time that power passes through the primary of T2. This decrease in power available at the secondary of T2 prevents loss of efficiency in the series pass element, by limiting power available to just what is needed to generate the selected voltage.

3-23. TIME DELAY CIRCUITRY

3-24. The A7 Time Delay PCB Assembly delays the enabling of the high voltage section by about 3 seconds to allow time for the various power supply voltages.

3-25. CURRENT LIMITER CIRCUIT

3-26. The A5A6 Current Limiter PCB Assembly provides a means of varying the limiting point of the output current. the current limit circuitry monitors the +OUTPUT. When the selected value of output current is exceeded, the current limiting circuitry enables and controls the current tap circuit on the A5A3 Differential Amplifier PCB Assembly to bypass some of the current at the Range Cal/Sample String summing point. This reduces the output voltage, reducing the output current.

3-27. TRIP CIRCUIT

3-28. The purpose of the trip circuitry is to disable the high voltage circuit power input and voltage output if an overvoltage or overcurrent condition exists. If there is a catastrophic failure, in which the current limiting circuitry would not function, an excessive current (about 120 milliamperes) would enable the trip circuitry. The voltage limit may be selected by a combination of the TRIP switch and the VERNIER control. If the +OUTPUT exceeds this value, the trip circuitry is enabled. Enabling of the trip circuitry turns Q2 on, effectively grounding the +35V relay power for A8K1 relays. This will open the input power path to the pre-regulator and open the -OUTPUT path.

3-29. INTERLOCK CIRCUIT

3-30. For personal safety, the instrument has an interlock circuit that breaks the +35V relay power return path. It has the same functional effect as the trip circuitry.

3-31. ABSOLUTE OVERVOLTAGE PROTECTION

3-32. DS1 and DS2 on the A5 Main Motherboard PCB Assembly and CR2 and CR3 on the chassis insure that the difference in potential between +OUTPUT and

-OUTPUT can never exceed approximately 50V in 10V range, 100V in the 100V range and 1200V in the 1000V range.

3-33. Voltage Standard Circuit Analysis

3-34. A2 SAMPLE STRING PCB ASSEMBLY

3-35. The A2 Sample String PCB Assembly is shown on schematic diagram 335A-1003. The resistance of the Sample String may be selectively incremented by the front panel Readout Dials. The output voltage of the instrument is proportional to the Master Reference Voltage times the ratio of this selected Sample String resistance and the resistive leg on the Range Calibration Assembly that is selected by the RANGE switch. Between the precisely selected resistances of the Sample String and the Range Calibration Assembly, the voltage output may be incremented in small steps through the output voltage range of the instrument.

3-36. A3 CAPACITOR SWITCH PCB ASSEMBLY

3-37. The capacitor switching circuitry is located on the A3 Capacitor Switch PCB Assembly (Figure 8-5). When downranging from 1000V RANGE capacitor C4 (on the chassis) will tend to charge to a voltage level proportional to the difference between the charge on C5 (on the chassis) and the parallel combination of the output capacitors C1 and C2 (on the chassis). If this difference is too great, the charging potential across C4 will be great enough to cause dielectric absorption problem. Excessive settling time will result. (Dielectric absorption is the tendency of a capacitor to absorb and retain a small charge.) To prevent this, C5 is discharged through R7 (on the Capacitor Switch PCB Assembly) when the RANGE switch is downranged from the 1000V position to either the 100V or 10V position. This prevents C4 from receiving an overcharge. The capacitor switch, Q1 and associated circuitry, delay the closing of contacts K1A (on A3 board) for a few seconds to allow C5 sufficient discharge time. When the relay contacts close, the low resistance, R6, is placed in parallel with R7. This essentially shorts C5 and corrects the loop gain to the proper value. In the capacitor switch circuitry, C1 (on the A3 board) provides the time delay. Upon downranging from 1000V, C1 begins to charge from the +35 volt supply through R1 and R2. After several seconds, the charge accumulated on C1 is sufficient to cause Q1 to conduct. Conduction of Q1 energizes relay K1 (on the A3 board), closing the K1A contacts.

3-38. A4 RANGE CALIBRATION PCB ASSEMBLY

3-39. Resistors R1 through R12 on the A4 Range Calibration Assembly, PCB Assembly (Figure 8-5) form

three resistive legs that can be connected to the A2 Sample String PCB Assembly (335A-1003). The output voltage of the instrument is proportional to the Master Reference Voltage times the ratio of Sample String resistance to Range Calibration resistance. Use of the RANGE switch to select one of the legs on the Range Calibration Assembly will alter the resistance ratio by a factor of 10. Potentiometers R12, R8, and R4 provide adjustment for the 10V, 100V, and 1000V ranges respectively.

3-40. A5 MAIN MOTHERBOARD PCB ASSEMBLY

3-41. The main function of the A5 Main Motherboard PCB Assembly is to interface the A5A1 through A5A6 PCB Assemblies to each other and the rest of the instrument. In addition, there are two circuits. One is the voltage divider network shown in Figure 8-5. The other is the voltage limiting circuit for +OUTPUT to -OUTPUT in the 10V and 100V ranges shown in Figure 8-5. Both DS1 and DS2 are 50V neons, so the voltage limits are 50V for the 10V range and 100V for the 100V range.

3-42. A5A1 MASTER VOLTAGE REFERENCE PCB ASSEMBLY

3-43. The A5A1 Master Voltage Reference PCB Assembly performs two functions, one function is to supply the -15V dc Master Reference Voltage. The other function is a divider network for compensation of offset voltages when the output is set to zero.

3-44. The Master Reference Voltage circuit is composed of differential amplifier A2 and zener reference amplifier A3. The reference amplifier is enclosed in an oven which maintains a constant temperature for environmental stability. Selection of the values of R7A and R7B scales the output of the Reference Supply to +15V dc. Variable resistor R9 allows adjustment of the resulting VREF output. Temperature coefficient of the base/emitter voltage for A3 is accurately matched to the zener element through selection of R13. The resulting stable reference at the collector of A3 is applied to the non-inverting input of A2. The other input to A2 receives an equivalent voltage from the divider composed of R14 and R15. Any change in VREF is sensed at the base of A3 and the resulting amplified change applied to the non-inverting input of A2. This change then alters the conduction of A2 such that VREF is maintained at +15V dc.

3-45. Constant operating temperature for the reference amplifier, A3, is provided by the Oven Temperature Regulator, Q1 and A1. The series-pass regulator composed of Q1 and A1 establishes a constant voltage across the heater element of A3. Any variation in heater voltage is sensed by A1 and amplified. The resulting

output of A1 then alters the conduction of Q1 to eliminate the voltage variation across the heater element. The heater element consists of a semiconductor material which has moderate conductivity at temperatures below a specific stabilization point and a marked decrease in conductivity as the temperature approaches the stabilization point. Application of a constant voltage to the heater provides a fast warm-up and a much more stable operating temperature.

3-46. The Zero Output Adjustments are shown on Figure 8-5. The divider networks of R1 through R6 provide bias voltage to one input of the Chopper Amplifier PCB Assembly, A5A4. Potentiometers R2, R4, and R6 are adjusted to compensate for offsets in the 10V, 100V, and 1000V ranges respectively, when the output is set to zero.

3-47. A5A2 SERIES PASS DRIVER PCB ASSEMBLY

3-48. The A5A2 Series Pass Driver PCB Assembly (Figure 8-5) performs two functions. One function is to de-energize the output and input in case of an overvoltage or overcurrent condition. The other function is to provide sufficient drive current for error signals to the A8A1 Series Pass Element PCB Assembly.

3-49. Transistors Q5, Q6, Q7 and their associated circuitry constitute the driver portion. Transistor Q7 (common base amplifier) provides part of the voltage gain necessary for control of the Series Pass Element. Current gain is provided by common collector amplifiers Q5 and Q6. The output of Q5 is applied to main series pass transistor Q8 on the A8A1 Series Pass Element PCB Assembly.

3-50. The purpose of the trip circuit is to remove ac power from the primary of the high voltage transformer and open the negative output path, if an overvoltage or catastrophic overcurrent condition exists. Transistor Q3 is a constant source for relays A8K1 and A8A2K2 (on the Pre-Regulator PCB Assembly) closed, current is provided to A8A2K1 which completes the primary circuit for the high voltage transformer. With relay A8K1 (on the High Voltage Motherboard PCB Assembly) closed, the negative output path is completed and power may be supplied to the load. The current sensing resistor, R22, is effectively connected through R24 to the base of normally off Q4. In the event of a catastrophic failure, in which the current limiting circuitry would not function, an excessive current approaching 120 millamperes would develop sufficient voltage across R22 to turn on Q4. Because of the regenerative configuration, transistors Q4 and Q2 would become saturated. With Q2 saturated, the potential at pin 10 becomes nearly the same as the positive buss potential. This bypasses the current away from the relays, which

causes them to open. With the relays open, the OUTPUT terminals are de-energized, the input power to the high voltage transformer is interrupted, and the OPR indicator lamp goes out. To reset the instrument, once the cause of the overload has been corrected, the POWER switch is placed in the STDBY/RESET position, then to the OPR position. With the POWER switch in the STDBY/RESET position, the circuit common is connected through a section of the POWER switch and pin 10 to the emitter of Q2. This results in turning off both Q2 and Q4, and thus returning them to their original state. The overvoltage trip element is Q1. The base of Q1 is connected to R15 and the appropriate resistor selected by the TRIP switch. The voltage trip point is selected by the VERNIER control (R5), which sets a reference bias on Q1 (maintaining Q1 cut off). As the output voltage increases, the voltage at the base of Q1 increases negatively until it exceeds the selected trip voltage and causes Q1 to conduct. The conduction of Q1 saturates Q2 and results in de-energizing the instrument output terminals, as previously described.

3-51. A5A3 DIFFERENTIAL AMPLIFIER PCB ASSEMBLY

3-52. The A5A3 Differential Amplifier PCB Assembly is illustrated on Figure 8-6. Error signals, in the form of ac changes, are applied to the differential amplifier through C1 to the gate of Field Effect Transistor (FET) Q2. Error signals appearing as dc changes are applied to the chopper amplifier at the base of Q6. Using a separate path for ac changes allows rapid regulation of the output voltage for rapid changes in load requirement. The Differential Amplifier PCB Assembly provides an output that is proportional to the amplified dc error signal from the Chopper Amplifier PCB Assembly. Use of a Field Effect Transistor for Q2 provides high input impedance and low noise. Transistor Q8 is a current source for one stage of the differential amplifier. Use of the current source provides high gain and good common mode rejection at the input of the amplifier. The compound configuration of Q4-Q5 and Q6-Q7 provides high input impedance and minimizes temperature effects. The output signals from the collector of Q9 is applied to the base of the common collector amplifier Q11. Transistor Q11 provides impedance matching between the high output impedance of Q9 and the low input impedance of the series pass driver circuit.

3-53. A5A4 CHOPPER AMPLIFIER PCB ASSEMBLY

3-54. The A5A4 Chopper Amplifier PCB Assembly (Figure 8-6) compares low frequency and dc control signals from the A2 Sample String output to the -SENSE terminal voltage and amplifies any difference. The circuitry consists of an input filter, a MOSFET chopper,

an operational amplifier, a synchronous demodulator, an output filter, and a multivibrator.

3-55. Low frequency and dc control signals at terminal 7 are passed through the input filter C2, R1, and C3 to reject frequencies above 30 Hz. The MOSFET chopper Q1 modulates the signal appearing at the junction of its drain and R2. C4 couples the resultant to the gate of JFET Q2. The output signal at the drain of Q2 is then amplified by the operational amplifier IC1, which has a gain of approximately 420. The paraphase amplifier Q3 amplifies the output of IC1 and provides two equal amplitude, but 180° out-of-phase signals the collector signal of Q3 is coupled by C16 to the shunt demodulator Q4. The resulting demodulated signal appearing at the junction of C17 and R24 is filtered by R24, R26, and C18, leaving only the amplified dc and low frequency signals. The emitter signal of Q3 is applied through C14, R21, C15, R25, R23, and C22 to C18, where it is used to cancel any chopper ripple at 270 Hz.

3-56. The 270 Hz multivibrator is formed by Q6, Q7 and associated timing networks, in addition to a driver Q5. Variable resistor R43 adjusts the level of the signal applied to the driver Q5, and subsequently the output signal applied to the gate of Q1. The collector signal of Q5 is applied to the drain of Q1 to compensate for spikes coupled between the gate and drain. Variable resistor R34 provides adjustment of the compensation signal. An output signal at the collector of Q7 is applied to the base of Q4, which synchronously demodulates the Chopper Amplifier output.

3-57. A5A5 AUXILIARY POWER SUPPLY PCB ASSEMBLY

3-58. Operating voltages for the temperature regulating circuit, zener reference circuit, chopper amplifier, and differential amplifier are provided by the A5A5 Auxiliary Power Supply PCB Assembly (Figure 8-9). The auxiliary power supply consists of the 25 volt supply and -15 supply circuits. The auxiliary supply reference element is located in the 25 volt supply. The output of the 25 volt supply is then used as the reference for regulation of the -15 volt supply. +40 volts relay power for the operate relay, K1 is tapped of the 25 volt supply rectifier.

3-59. In the -15 volt supply, CR7 through CR10, R14, and C8 provide the unregulated dc voltage to the regulating circuit consisting of series pass element Q7 and differential pair Q8 and Q9. The base of Q9 is connected to a voltage divider referenced to the +25 volt supply output. The base of Q8 is connected to the positive side of the -15 volt supply. Variation in the output voltage are sensed at the base of Q9. Any difference between the base voltages of Q8 and Q9 is amplified by the differential pair

and applied from the collector of Q8 to the base of series pass element Q7. The amplified error signal controls the conduction of Q7 and consequently the magnitude of the output voltage. The positive side of the -15 volt supply is connected to the negative side of the +25 volts supply through pins 11 and 12. The + sense line is connected to this junction and is the common for the auxiliary power supply.

3-60. A5A6 CURRENT LIMITER PCB ASSEMBLY

3-61. The A5A6 Current Limiter PCB Assembly contains two circuits. One circuit is a $\pm 35V$ dc power supply. The other circuit is the current limiting circuit.

3-62. In the diode bridge configuration of CR1 through CR4, diodes CR1 and CR2, R1 and C1 provide a positive unregulated dc voltage. Diodes CR3 and CR4, R4 and C3 provide negative unregulated dc voltage. The positive unregulated dc voltage is applied to the regulating circuit of Q1 and CR5 and through a voltage divider to the RANGE switch, for application to the appropriate decimal lamp. The 36 volt reference voltage, established by CR5, provides the input signal for the emitter follower configuration of Q1. This emitter follower configuration provides the necessary low output impedance and power gain of the power supply. The -35 volt supply functions in the same manner as the +35 volt supply. Both the +35 and -35 voltages are used on the A5A6 Series Pass Driver PCB Assembly and the A5A2 Series Pass Driver PCB Assembly (the OPERATE, indicator is between -35 volt and A5A2-11). The -35V is also used on the A5A3 Differential Amplifier PCB Assembly. The +35V is used on the A3 Capacitor Switch PCB and provides relay voltage for A8K1 and A8A2K2 in the protection circuit.

3-63. The current limit circuitry located on the A5A6 Current Limiter PCB Assembly (Figure 8-6) provides a means of varying the limiting point of the output current. Current sensing resistor R22, on the A5A2 Series Pass Driver PCB Assembly, provides a voltage to the current limiter circuit that is proportional to the output current. This voltage is applied through pin 5 and CR10 to the collector of Q5. The emitter of Q5 is connected to the wiper of the CURRENT LIMIT control (R6), which provides a variable bias for the base-emitter junction. Transistor Q5 is normally off. However, when the output current exceeds the set limit, Q5 turns on. Conduction of Q5 causes both Q4 and Q3 to conduct. Conduction of Q5 causes Q1, on the Differential Amplifier PCB Assembly, to conduct and bypass some of the sample string current. This causes the output voltage to be reduced and consequently the output current is reduced. The conduction of Q3 also turns on the regenerative pair, Q6 and Q7, which supply current to the red indicator lamp, CURRENT LIMIT.

3-64. A7 TIME DELAY PCB ASSEMBLY

3-65. The purpose of the time delay circuit, located on the A7 Time Delay PCB Assembly (Figure 8-5), is to provide a short interval for the auxiliary voltages to rise to nominal value. This insures that the control amplifiers are operating before the high voltage is available. The time delay circuit momentarily holds open relays A8K1 and A8A2K2, which prevents the closure of A8A2K1. The time delay is approximately 3 seconds. Diodes CR1 and CR2 provide a full-wave rectified voltage from a secondary winding of the power transformer between pins 20 and 22. When the POWER switch is in the STDBY/RESET position, a small current flows through R2001, S1c, K2001, R2004, and C2001. This current, although too small to actuate K2001, charges C2001. Capacitor C2001 charges until it reaches the firing point of Q2001, approximately 2 to 3 seconds. At this point A2001 conducts, increasing the current through K2001. The relay actuates and closes contact K2001A (which provides the current path when the POWER switch is in the OPR position) and opens contact K2001B. When K2001B opens, the grounding circuit is removed from the constant current source supply A8K1 and A8A2K2, and these relays are allowed to actuate.

3-66. A8 HIGH VOLTAGE MOTHERBOARD PCB ASSEMBLY

3-67. The A8 High Voltage Motherboard (Figure 8-3) has the following functions:

1. Interface the A8A1 and A8A2 PCB Assemblies to each other and the rest of the instrument.
2. High voltage rectifier and filter circuit.
3. Part of the automatic crowbar circuit.
4. The output current source circuit.
5. Various control relays.
6. Unijunction pulse transformer A8T1.
7. High voltage fuse F1 operational circuitry.
8. Noise filter for the primary of High Voltage Transformer, T2. (C10, R9).

3-68. CR1 through CR12 make up the high voltage rectifier. C1, C2, C3, R1, R2, R3, R12, R13, and R14 make up the high voltage filter.

3-69. The Automatic Crowbar circuit on the A8A1 Series Pass Element PCB Assembly drives relay A8K2

under conditions described in the analysis of the A8A1 Series Pass Element PCB Assembly. This action discharges the capacitors of the high voltage filter.

3-70. The Output Current Source is composed of A8CR13 through A8CR20 in series with R9 and R10. This quasi-constant current source is connected in opposition to the output of the instrument. The current flows through the series pass transistors and acts as a minimum load to insure that their transconductance is held above a minimum value. Another purpose of the quasi-constant current source is to provide a quick discharge path for the output capacitor C1, when down-ranging. This helps to reduce the settling time.

3-71. Two control relay functions are on the A8 High Voltage Motherboard PCB Assembly. A8K1 opens the -OUTPUT line for an overvoltage, overcurrent or open interlock condition. The normally closed contacts of OPERATE relay K1 discharge the capacitors of the high voltage filter through A8R15 when the OPERATE switch is in any position but OPERATE.

3-72. A8A1 SERIES PASS ELEMENT PCB ASSEMBLY

3-73. The A8A1 Series Pass Element PCB Assembly (Figure 8-5), contains the series pass transistors which control the instrument output voltage. It also contains a voltage controlled oscillator (VC0), Q9, and control amplifiers which are part of the pre-regulation circuitry, a power supply, and an automatic "crowbar" circuit.

3-74. The power supply composed essentially of CR1 through CR4 produces the required operating voltages for the series pass circuitry. AC voltage at terminals 8 and 9 is rectified by CR1 through CR4 to provide an unfiltered positive voltage. This voltage is isolated by CR5 and filtered by C2 to provide a +150V dc operating voltage for the series-pass transistors. The voltage divider of R1 through R3 and zener CR6 produces a clipped, full-wave rectified 16V synchronizing signal for the VC0.

3-75. Output voltage of the instrument is established and maintained by the series-pass transistors, Q1 through Q8. The transistors Q1 through Q7 are normally saturated and Q8 is absorbing the total voltage required to maintain the output of the instrument. However, when the output level or load current is changed and the voltage across Q8 exceeds 150V, Q1 through Q7 absorb the additional voltage. The pre-regulator circuitry then reduces the output of the A8 High Voltage Motherboard PCB Assembly until the voltage across Q8 is less than 150V. When this condition is reached, Q1 through Q7 again saturate and Q8 absorbs the total regulation voltage.

3-76. Unijunction transistor Q9 and C3, L3, R37, CR19, R35, and CR19 form a VC0 which furnishes turn off pulses to the pre-regulator circuitry. A clipped 16V pulse is rectified by CR32 and C5 to provide operating voltage for the base of the VC0, Q9. This voltage is clamped to zero during the ac line zero interval by amplifiers Q11 and Q12. The divider composed of R36 and R42 provides a sample of the clipped 16V pulse at the base of Q12. When the pulse is at 0V, Q12 produces an amplified positive pulse at its collector. This pulse is differentiated by C4 and R41 and the resulting positive spike momentarily turns on Q11. Conduction of Q11 clamps the output of rectifier CR32, C5 to zero, thus synchronizing the output of Q9 to the ac line zero crossing. The output pulses from Q9 are dependent upon the voltage charge on C3. The voltage is sensed across Q9 through the divider consisting of L3, R37, R35, CR18, and CR19. If this voltage increases, Q9 will produce a

and CR19. If this voltage increases, Q9 will produce a unijunction pulse to turn off the pre-regulator earlier in the ac line cycle, thus reducing the ac power available to the H.V. Motherboard.

3-77. The automatic "crowbar" consisting of Q10 monitors the total voltage drop across the series-pass transistors. Load or output changes that cause the voltage across the series-pass to exceed 225V will cause Q10 to conduct. Its conduction energizes K2 on the H.V. Motherboard and places a load across the high voltage rectifier, thus limiting the voltage across the series-pass transistors.

3-78. A8A2 PRE-REGULATOR PCB ASSEMBLY

3-79. The A8A2 Pre-Regulator PCB Assembly contains a power supply, pre-regulation circuitry and part of the protection circuit. Refer to Figure 8-5.

3-80. Operating voltages for the pre-regulator circuitry are provided by the diode bridge configuration CR1 through CR4 (Figure 8-9). Both a positive and negative full-wave rectified voltage (+V and -V) are produced. A portion of the +V voltage is filtered by C4 and C5 to provide the +10 volt supply voltage. Diode CR5 serves to isolate the +V voltage from the filter capacitors.

3-81. The series of pulses from the Unijunction Oscillator (A8A1 Series Pass Element PCB Assembly) are coupled across transformer A8T1 to the input of the Pre-Regulator on the A8A2 Pre-Regulator PCB Assembly (Figure 8-5). At the beginning of each 60 Hz half cycle, Q5 is turned on by the positive going +V voltage through R17. Conduction of Q5 saturates Q2, Q4, and Q1 (pre-regulator control transistor). Conduction of Q1 allows current flow in the primary of the high

voltage transformer, A8T2. Sometime during each half cycle, the initial pulse from the unijunction oscillator triggers regenerative pair Q6 and Q7 into saturation. Q1, Q4, and Q5 turn off and remain off while Q6 and Q7 are conducting. At the end of each half cycle, the current through Q6 and Q7 drops below the regenerative value due to the zero crossing of the full-wave rectified 60 Hz sine wave voltage ($-V$) at the emitter of Q7. The circuit is now ready for Q5 to be turned on to repeat the pre-regulation control cycle. It should be noted that the pre-regulation control transistor, Q1, is turned on at the beginning of each half cycle and is turned off by the first pulse from the unijunction oscillator. This limits the amount of power to the high voltage transformer and reduces the power dissipation requirements for the Series Pass Element.

3-82. Relay A8A2K2 de-energizes the high voltage relay A8A2K1 if an overvoltage, overcurrent, or open interlock condition occurs. This will cut off the power to the primary of the High Voltage Transformer, T2.

3-83. INTERLOCK CIRCUIT

3-84. The instrument is equipped with an interlock circuit for personnel safety. When either the top or bottom inner covers or printed circuit Assemblies A8A2, A8, A8A1, A5A1, A5A3, A5A4, A5A5, or A5A6 are removed, the ground return for the A8K1 and A8A2K2 relays is opened. This results in removal of the input power to the high voltage transformer (T2) and opens the negative output side of the instrument.

3-85. VOLTMETER-NULL DETECTOR

3-86. Introduction

3-87. The theory of operation of the Model 335D Voltmeter-Null Detector is described by a detailed functional description followed by a circuit analysis. The detailed functional description is illustrated by the Voltmeter-Null Detector Simplified Schematic, Figure 3-3. The circuit analysis is supported by the schematics in Section 8 of this manual and is divided into four parts:

1. Input Circuitry
2. A6A1 Null Detector Power Supply PCB Assembly
3. A6A2 Null Detector Amplifier PCB Assembly.
4. Indicating Circuitry.

3-88. Detailed Functional Description of the Voltmeter

3-89. The input circuit divider provides a reduced dc voltage to the A6A2 Null Detector Amplifier PCB Assembly. In TVM operation, the divider provides a reduced dc voltage proportional to the dc input voltage. In DIFF \pm operation, the divider provides a reduced dc voltage proportional to the difference between the input voltage and the voltage indicated on the readout dials. This proportional voltage is then chopped at an 84 Hz rate by a photo-chopper circuit on the Null Detector Amplifier PCB Assembly. Magnitude and polarity information is contained in the amplitude and phase, respectively, of the chopped signal. This chopped signal is then applied to a high input impedance ac amplifier whose gain is controlled by the resistance selected by the SENSITIVITY switch. Demodulation of the amplified signal is accomplished by the synchronous demodulator. The demodulator reconstructs the amplified dc level and polarity information and applies it to a fixed gain dc amplifier. A portion of the dc amplifier output is fed back to the input of the Null Detector Amplifier to control the overall amplifier gain. The other portion of the dc amplifier output is applied to the isolation amplifier, located on the A6A1 Null Detector Power Supply PCB Assembly. Here the dc signal is again modulated at 84 Hz, coupled across an isolation transformer, demodulated to reconstruct dc level and polarity information, and applied to the meter and recorder output terminals. In the TVM position of the INPUT MODE switch, the meter will indicate the full value of the applied dc input voltage. In the DIFF+ and DIFF- positions, the meter will indicate the difference between the applied dc input voltage and the voltage set on the front panel Readout Dials. In either case, the full-scale sensitivity will be that indicated by the position of the SENSITIVITY switch.

3-90. Voltmeter Circuit Analysis

3-91. INPUT CIRCUITRY

3-92. The null detector has three basic sensitivities for full-scale meter deflection: 1 millivolt, 100 microvolts, and 10 microvolts. Input voltages above 1 millivolt are reduced by the divider, consisting of R9 through R16 and two function of the SENSITIVITY switch (S5A and S5B). At 1 millivolt and, a fixed input resistance of 1 M Ω (R12) is connected across the INPUT terminals. The input resistance is 10 M Ω in the 10 and 100 millivolt ranges and 100 M Ω at 1 volt and above.

3-93. Placing the divider in the proper configuration for either null detector or differential voltmeter operation is accomplished by the INPUT MODE switch. In the TVM position, the INPUT MODE switch connects the divider directly across the HI and LO

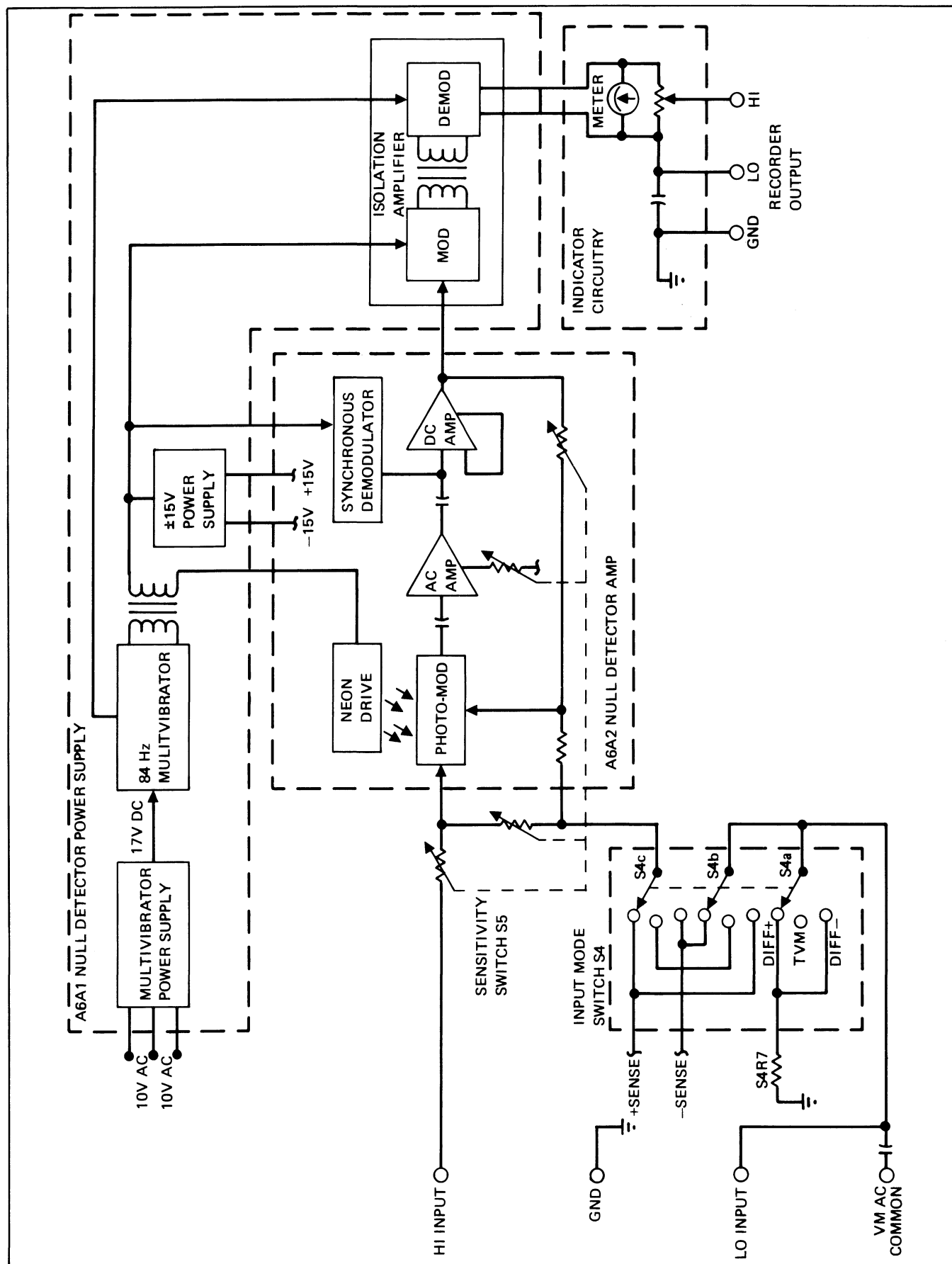


Figure 3-3. Voltmeter-Null Detector Simplified Schematic

INPUT terminals. The null detector amplifier senses across a portion of the divider. This portion of the divider provides a voltage proportional to the total input voltage. In the DIFF \pm position the instrument is connected in series with the divider in such a polarity as to oppose the unknown input voltage. The null detector amplifier then senses a voltage proportional to the difference between the voltage set on the readout dials and the unknown input voltage.

3-94. A6A1 NULL DETECTOR POWER SUPPLY PCB ASSEMBLY

3-95. The A6A1 Null Detector Power Supply PCB Assembly consists of the 84 Hz multivibrator, multivibrator power supply, ± 15 volt power supply, and isolation amplifier. Refer to Figure 8-8, for the following circuit descriptions.

3-96. The multivibrator power supply consisting of bridge rectifier CR1 through CR4, filter R1-C1, and regulating element CR5 is driven by a secondary winding of power transformer T1 between pins I1 and I2. The 17 volt rms signal is rectified, filtered, and regulated to provide a 10 volt dc operating voltage for the 84 Hz multivibrator. The 84 Hz multivibrator consists of Q1 and Q2; frequency determining elements C2, R2, R3, and frequency adjustment R4; and the primary windings of T1. A portion of the 84 Hz signal from the secondary of T1 is used to drive the neon drive circuit on the Null Detector Amplifier PCB Assembly. The secondary of T1 also provides an 84 Hz signal from the secondary T1 is rectified and filtered by CR6, CR7, C3 and C4 to provide the ± 15 volt dc operating voltages for the Null Detector Amplifier PCB Assembly. The collectors of Q1 and Q2, in the 84 Hz multivibrator, provide two signals 180° out of phase to the bases of Q6 and Q5 respectively, in the demodulator section of the isolation amplifier.

3-97. The isolation amplifier, receives a portion of the dc amplifier output through the center tap of the primary of T2. The dc signal is modulated at an 84 Hz rate by Q3 and Q4, with a phase dependent upon the polarity of the input voltage. This modulated signal is coupled across transformer T2 for isolation. The phase of the waveform at the secondary of T2 permits conduction of either Q5 or Q6 during alternate halves of the cycle, causing detection of the modulated signal.

3-98. A6A2 NULL DETECTOR AMPLIFIER PCB ASSEMBLY

3-99. The A6A2 Null Detector Amplifier PCB Assembly consists of a neon driven photo-modulator, AC amplifier, synchronous demodulator and a DC amplifier. Refer to Figure 8-8.

3-100. The proportional dc voltage from the input divider is filtered by a three stage low-pass RC-filter composed of R1-C2, R3-C3, and R4-C4. This filter reduces any ac voltage having a frequency above 1 Hz. The filtered voltage is then chopped by the photo-cells V1 and V2, which are driven alternately at an 84 Hz rate by the neon driven circuit consisting of DS1, DS2, CR3, CR4, R2, and C1. The resulting chopped signal, containing dc level and polarity information, is coupled through C5 to a high input impedance ac amplifier consisting of Q1, Q2, and Q3. The gain of the ac amplifier is controlled by the common emitter resistance selected by SENSITIVITY switch S5e. The output of Q3 is coupled through C10 to a two stage current amplifier consisting of Q4 and Q5. A fixed negative feedback, from the emitter of Q5 through C11 and R19 to the base of Q4, holds the gain of these stages constant.

3-101. The output of Q5 is coupled through C12 and R22 to the emitter of Q6 for demodulation. An 84 Hz drive signal, in-phase with the photo-chopper drive signal is applied to the base of Q6, causing detection of the magnitude and polarity of the amplified signal. The demodulated signal is filtered by R24 and C15 before application to the dc amplifier.

3-102. The dc amplifier amplifies the detected dc signal. Transistors Q7 through Q12 comprise a two-stage differential amplifier with a complementary emitter-follower output. Negative feedback from the emitters of Q11 and Q12 through C17, C18, and R31 to the base of Q8 controls the dc amplifier gain. The output of the dc amplifier is taken from the common emitters of Q11 and Q12. One portion of the output is applied to the isolation amplifier and the other portion through S5f and the selected SENSITIVITY range resistor for overall null detector amplifier gain.

3-103. INDICATING CIRCUITS

3-104. In addition to indicating voltage during null detector or differential voltmeter operation, the meter also indicates the output voltage (V position of the SENSITIVITY switch) or output current (I position of the SENSITIVITY switch and red meter scale). Resistors R3 through R6 (Series Pass Driver PCB Assembly) and the resistors selected by the RANGE switch S2f provide a drive current to the meter that is proportional to the output voltage, when the SENSITIVITY switch is in the V position. Resistors R1 and R2 (Series Pass Driver PCB

Assembly) provide a drive current to the meter that is proportional to the output current, when the SENSITIVITY switch is in the I position.

3-105. A recorder output directly proportional to meter deflection, is provided through R29, R30, and filter

capacitor C8. Recorder output level adjust, R29, provides an adjustable output from 0 to 1 volt for end scale meter deflection. The LO RECORDER OUTPUT terminal is isolated from ground by a 0.47 microfarad capacitor and may be floated up to 100 volts dc from ground.

Section 4

Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. HIGH VOLTAGES OF UP TO 1200V DC MAY EXIST IN THE INSTRUMENT. DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

CAUTION

Remove power from the instrument prior to installing or removing PCBs.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information for the Model 335D Voltage Standard. This includes service information, general maintenance, a performance test, and a calibration procedure. The performance test is recommended as an acceptance test

when the instrument is first received, and later as a preventive maintenance tool to verify proper instrument operation. A calibration cycle of 1 year is recommended to maintain the 335D within the 1 year specifications. If the 90-day specifications are to be maintained, a 90-day calibration cycle is recommended. Table 4-1, lists the recommended test equipment necessary to execute the performance test and calibration procedures. If the specified equipment is not available, alternate equipment having equivalent specifications may be substituted. Throughout this section UUT will be understood to mean Unit Under Test.

Table 4-1. Test and Calibration Equipment Required

REQUIRED EQUIPMENT	RECOMMENDED EQUIPMENT	REQUIRED SPECIFICATIONS
Low Pass Filter Network	See Performance Tests, Ripple and Noise Checks	Bandpass DC to 100 kHz noise $<5 \mu\text{V}$.
Digital Multimeter	Fluke 8000A, 8030A or equivalent	Measure resistance, AC & DC voltages and currents with 1% accuracy and have 10 MEG-OHM input impedance.
RMS Voltmeter	HP 400 series or HP 3400	True RMS reading, Low Noise. 1 mV Range to 100 kHz
Metered Auto Transformer	General Radio Variac W5MT3A or equivalent.	Output 0 to 130 VAC at 3 amps.
Resistance Box	Clarostat 240C	20 to 20 k Ω at 5% & 80 watts.

Table 4-1. Test and Calibration Equipment Required (cont)

REQUIRED EQUIPMENT	RECOMMENDED EQUIPMENT	REQUIRED SPECIFICATIONS
Resistor	Fluke P/N 168054 or equivalent	100 k Ω \pm 5% ½W Carbon Composition.
Oscilloscope	Tektronix Type 545B or equivalent and "D" type preamp.	General purpose vertical amp output of .5V/em.
Oscilloscope Preamps	Tektronix Type 1A1 or equivalent	1 mV/cm sensitivity.
Oscilloscope Probe	Tektronix P5052 or equivalent	General purpose test probe X1, X10.
DC Voltage Calibration System	Fluke 7105A	Range 0.1 to 1100V dc Accuracy 5 to 8 ppm.
* Voltage Standard 1st Null Detector & Differential VM	Fluke 335A or 335D	Stable voltage source & null detector & defferential VM or equivalent to 1100V dc 22 ppm.
*2nd Null Detector	Fluke 845AR, Fluke 895A	Low leakage & range of 1 μ V to 1000V.
Absolute Voltage Kelvin—Varley	Fluke 750A	Voltages .1 to 1000V with accuracy of 5 to 8 ppm in ref to standard cell voltage.
Linearity Kelvin—Varley	Fluke 720A	Most significant decade linearity of 0.1 ppm.
Lead Compensator	Fluke 721A	To cancel lead resistance during calibration of Kelvin—Varleys above.
DC Standard Cell Enclosure	Guideline Model 9152 or equivalent	Voltages with traceability through National Bureau of Standards of 1 ppm uncertainty.
Lead Set (shielded Fluke Cable set preferred)	Fluke P/N 259820 7101A-401 Cable Set or use Pomona 1693-12 through 1693-48	Good shielding, flexibility, with low leakage insulation, low Ohmic resistance wire, low thermal EMF connectors. Tellurium copper spade lug low resistance, low thermal EMF. NOTE: These cables are unshielded.
* If 332B or 332D is used then a separate null detector and differential VM are required.		

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke mfg. Co., Inc. is warranted for a period of 1 year upon delivery to the original purchaser. Complete warranty information is contained on the Warranty page located at the front of this manual.

4-5. Factory authorized calibration and repair service for all Fluke instruments are available at various worldwide locations. A complete list of factory authorized service centers is provided in Section 7, General Information. If requested, an estimate will be provided to the customer before any repair work is begun on instruments beyond the warranty period.

4-6. GENERAL MAINTENANCE

WARNING

HIGH VOLTAGES OF UP TO 1200V DC MAY BE EXPOSED WITH THE CASE COVERS REMOVED. USE THE FOLLOWING SAFETY PRECAUTIONS:

- 1) NEVER WORK ON THE INSTRUMENT UNLESS THERE IS ANOTHER PERSON NEARBY WHO IS FAMILIAR WITH THE OPERATION AND HAZARDS OF THE INSTRUMENT AND WHO IS COMPETENT IN ADMINISTERING FIRST AID.
- 2) WHEN AIDED BY OPERATORS, WARN THEM ABOUT DANGEROUS AREAS.
- 3) WHENEVER POSSIBLE, TURN THE INSTRUMENT OFF TO WORK ON IT. GROUND EACH PART BEFORE TOUCHING IT. (TAKE PARTICULAR CARE TO GROUND EVERY CAPACITOR LIKELY TO HOLD A DANGEROUS POTENTIAL.)
- 4) DO NOT CONTACT HIGH-VOLTAGE LINE POWER AC INPUT CONNECTIONS WHEN INSTALLING OR OPERATING THIS INSTRUMENT.
- 5) WHEN POSSIBLE USE ONLY ONE HAND WHEN WORKING ON THE INSTRUMENT. THIS REDUCES THE HAZARD OF CURRENT FLOWING THROUGH VITAL ORGANS OF THE BODY.

4-7. Maintenance Access

4-8. The following procedure is used to gain access to the interior of the Model 335D.

1. Turn off power and remove line cord from ac outlet.
2. Unfasten two Dzus fasteners on rear panel.
3. Unfasten four Dzus fasteners on calibration access panel on top cover and lift off top calibration access panel, See Figure 4-1.
4. Set instrument vertically on handles and withdraw outside cover while guiding ac power cord through hole in rear of outside cover. See Figure 4-2.
5. To remove inner top cover from instrument, unscrew 10 screws securing inner top cover to chassis and remove cover. See Figure 4-3.

WARNING

WHEN REMOUNTING THIS COVER, INSURE THAT IT IS NOT A COVER FROM AN OLD INSTRUMENT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN GUARD POTENTIAL (UP TO 1200V DC) BEING CONDUCTED TO THE OUTER CASE THROUGH THE DZUS FASTENERS ON THE ACCESS COVER. THE NEWER COVERS HAVE LARGE RECTANGULAR OPENINGS TO INSURE THAT THE DZUS FASTENERS CANNOT TOUCH THE COVER. THE OLD COVERS HAVE ROUND HOLES FOR THE DZUS FASTENERS.

6. To remove inner bottom cover from instrument, unscrew nine screws securing inner bottom cover to chassis.
7. To reassemble the instrument logically reverse this procedure.
- 4-9. Located parallel to the left side of the instrument chassis and behind the second bulkhead is the Extender PCB. This board is used as an extender for the plug-in circuit boards to provide access for adjusting and testing. The extender board is substituted for the board to be adjusted or tested. The removed board is plugged into the receptacle at the top of the extender board. All vertically mounted printed circuit boards behind the second bulkhead are removable by exerting a combined

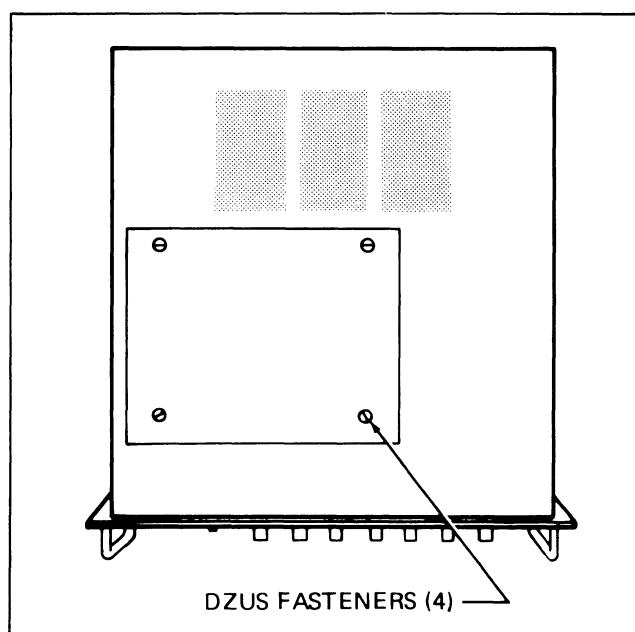


Figure 4-1. Calibration Access Panel

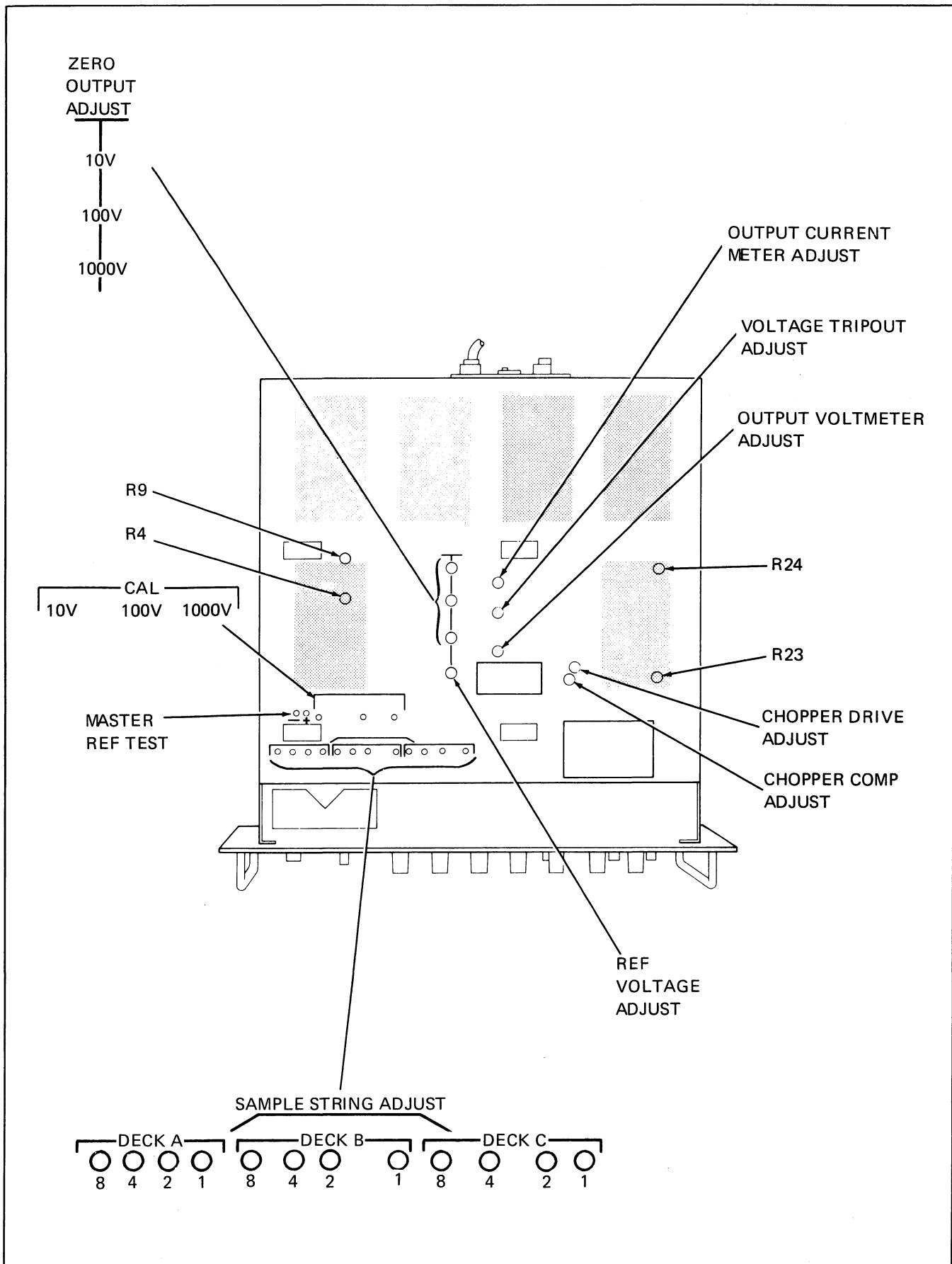


Figure 4-2. Outside Cover Removed

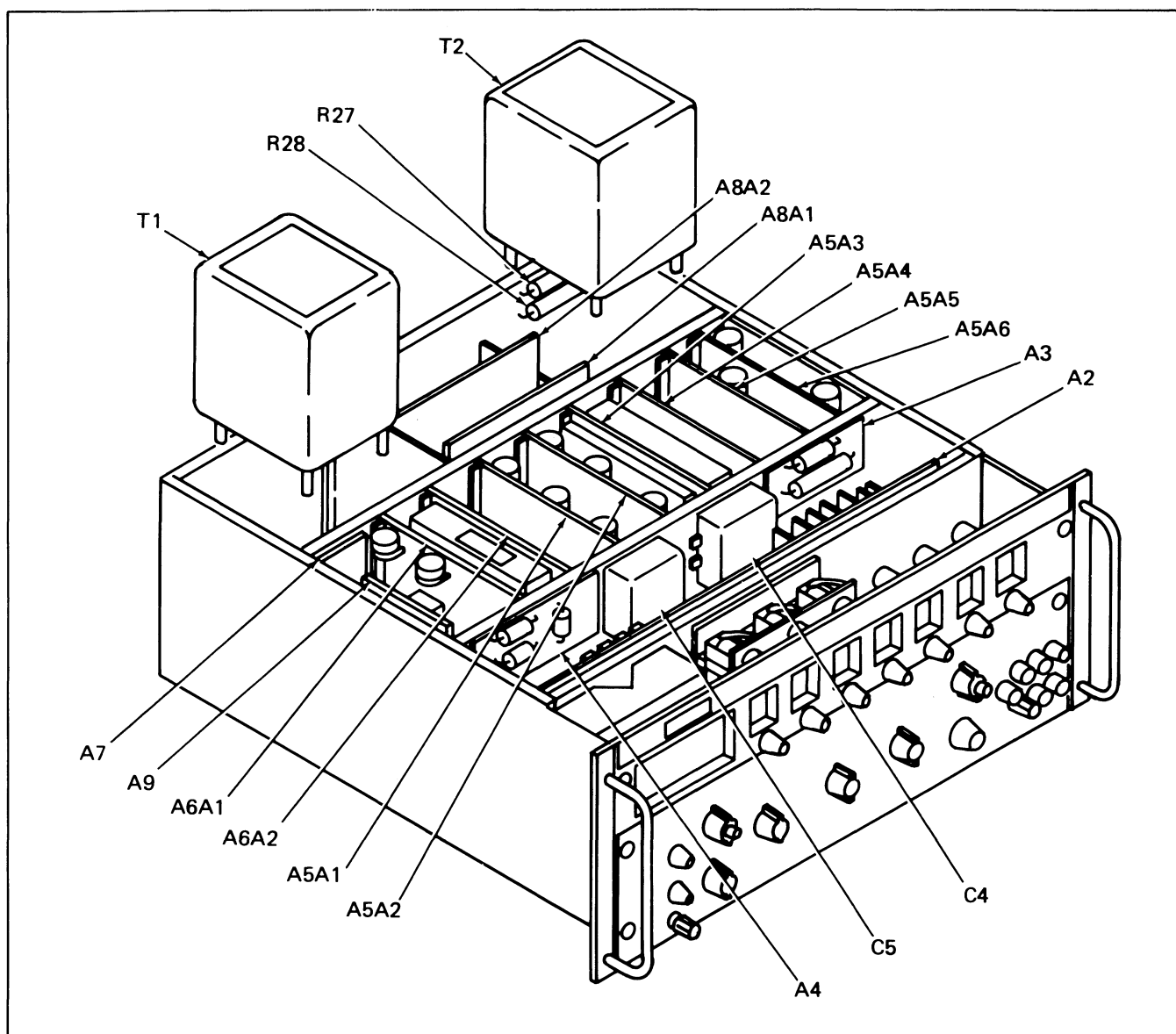


Figure 4-3. Inner Top Cover Removed

rocking and pulling force on the board itself, but never by pulling on the components. When replacing a printed circuit board, first ensure that the board is aligned within its two vertical guides. Then, it is inserted into place, ensure that the mating receptacles are correctly aligned before pressing it into final position. The extender board also must be aligned properly to be installed in its storage connector.

WARNING

WHEN OPERATING THE INSTRUMENT WITH THE CASE COVERS REMOVED, LETHAL VOLTAGES ARE PRESENT IN MANY PORTIONS OF THE INSTRUMENT. ALL NORMAL SAFETY PRECAUTIONS SHOULD BE OBSERVED. THE OUTPUT OF THE INSTRUMENT MAY APPROACH 1200V. ALL

POINTS INSIDE THE INSTRUMENT COMMON TO THE OUTPUT CIRCUITRY WILL BE AT THE POTENTIAL SELECTED FOR INSTRUMENT OUTPUT OR HIGHER. THE OUTPUT TERMINALS ARE AT THE POTENTIAL SELECTED FOR INSTRUMENT OUTPUT.

4-10. Removal of the top and/or bottom covers opens one or both power interlock switches. Hence, operation of the instrument without its cover(s) requires bypassing or cheating the interlocks. However, operation of the instrument without its case or without case and covers and with the interlocks cheated raises the chassis to the +OUTPUT potential and is extremely hazardous. Use utmost caution when working on the instrument with its case and/or cover(s) removed.

4-11. Unique Maintenance Procedures

4-12. CLEANING BOARDS

4-13. Certain circuit board assemblies are ultrasonically cleaned at the factory to prevent the possibility of electrical leakage, caused by contamination from handling during assembly. These circuit board assemblies include the Null Detector Amplifier PCB Assembly A6A2, Sample String PCB Assembly A2, and Capacitor PCB Assembly A1. When solder-in components are replaced on these assemblies, the land pattern side of the board should be cleaned and sealed as described in CIRCUIT BOARD SEALANT. Should contamination be suspected on the component side of the circuit board, use Freon TF Degreaser MS 180 (Miller-Stephenson Chemical Co.). To clean and air dry with low pressure air (i.e., 20 psi tool air).

4-14. PHOTOCELL REPLACEMENT

4-15. If the photocell assembly on the Null Detector Amplifier PCB Assembly A6A2 must be replaced, be very careful not to contaminate the photocell assembly or the plastic light transmission rods. The recommended procedure is to wear clean, white gloves when handling them. Should the photocell assembly or plastic rods become contaminated, clean them with ethyl alcohol, then with deionized water and air dry with low pressure air. When replacing the photocell assembly, insure that the plastic rods are tight against the neon lamps and photocells. Failure in these procedures will result in insufficient signals and excessive noise.

4-16. CIRCUIT BOARD SEALANT

CAUTION

The following precautions should be adhered to when using toluol: avoid inhaling the vapors, avoid excessive contact with the skin, and keep away from open flames. Insure that plastic components do not come into contact with toluol, since it will dissolve most types of plastic.

4-17. The land pattern side of all printed circuit boards within the instrument have been coated with epocast (a polyurethane resin) to inhibit fungus growth and moisture absorption. When soldering to a printed circuit land, the heat from the soldering iron decomposes the epocast resin, leaving a charred residue. Upon completion of soldering, this residue should be removed with a solvent, such as toluol. After removal of the epocast residue, the affected area should be recoated with a sealant. A spray can of Circuit Coat (Furane Plastic Inc., 4516 Brazil Street, Los Angeles, California or 16 Spiling Road, Fairfield, New Jersey) may be used for recoating.

4-18. Fuse Replacement

4-19. The fuses are contained in bayonet type fuse holders located at the rear of the instrument. Under no circumstances should replacement fuses with higher current ratings be installed in the instrument. Listed below are the correct values for the fuses:

F1	High Voltage	Type MDL, slow blow, 1/4 amp., 250V
F2	Line	Type MDA, slow blow, 3 amp., 250V (115V operation) (Fluke PN 109280)
		or
		Type MDX, slow blow, 1½ amp., 250V (230V operation) (Fluke PN 109231)

4-20. LED Replacement

4-21. The indicator LEDs are located immediately behind the front panel. The instrument case must be partially removed to gain access to the LEDs. The decimal LEDs are easily accessible and removable from the top of the instrument without the need of any special tools. Figure 4-4 illustrates terminal identification and wire color coding for each LED. The LED pins are trimmed to have a longer anode lead. When removing the connecting wires, note the color on the longer LED pin and install the new LED with the same orientation. After disconnecting the wires from the LED, the device can be removed by sliding it toward the front of the instrument.

4-22. 115/230 Conversion

4-23. Depending upon the connection of the power transformer's primary windings, the instrument may be operated from either a 115 or 230 volt ac power line. To convert it from one type of power line operation to the other, use the following procedure:

1. Disconnect the line cord from the power line.
2. Remove the instrument from the case and place it upside down on a suitable work space.
3. Orient the instrument and perform the appropriate electrical connections as illustrated in Figure 4-2.
4. Replace fuse F2, if necessary. See Fuse Replacement earlier in this section of the manual.

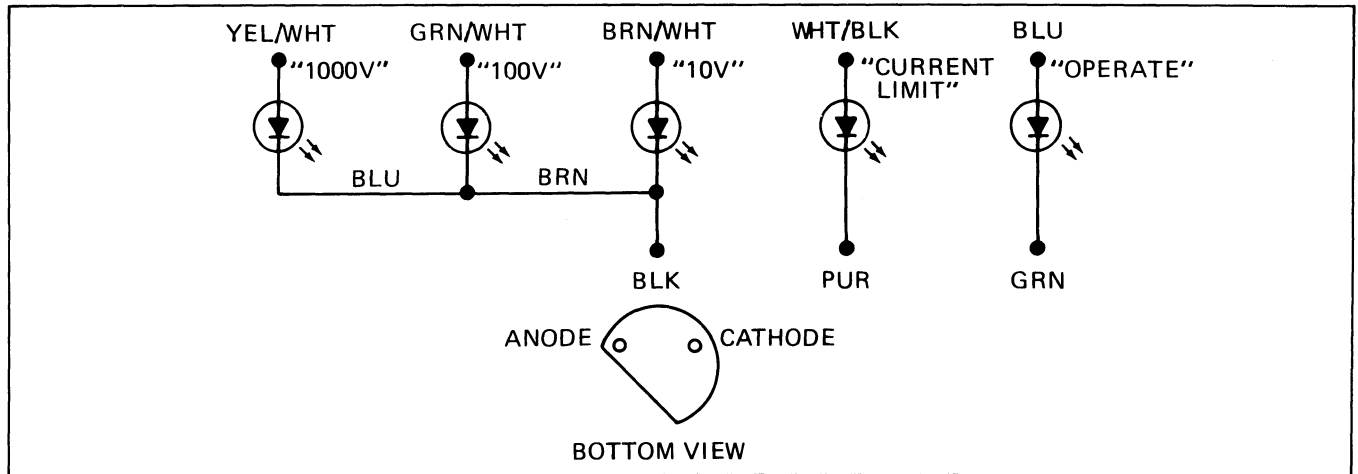


Figure 4-4. LED Terminals and Wire Coding

4-24. PERFORMANCE TEST

4-25. Introduction

4-26. The performance test is designed to compare the performance of the Model 335D with the specifications given in Section I of this manual. It may be used for incoming inspection, and is recommended prior to calibration. A list of these tests and their function may be found in Table 4-2.

4-27. The performance tests are divided into three groups: the voltage standard, the meter protection circuits, and the voltmeter. In each case, a short introductory paragraph briefly describes the purpose of each test and the circuitry involved. This should aid the technician in analyzing a malfunction.

4-28. During the following tests, it will not be necessary to remove the instrument from the case. All external equipment will be connected to the terminals provided on the instrument. Use Table 4-1, to select required test equipment.

4-29. Voltage Standard

4-30. Since the load, line, and ripple checks do not rely on calibration adjustments, out of tolerance indications should be investigated. The remaining voltage standard checks do rely on proper calibration adjustments. Should minor out of tolerance indications be observed during these checks, calibration will more than likely correct these problems. However, should the calibration adjustments be ineffectual or at their extreme limits, you will have to investigate the cause of the problem.

4-31. In the event that a malfunction is discovered, complete as many of the performance tests as possible. Record which tests the instrument does not successfully

pass and any abnormal indications. This will help in analyzing the problem and lead to more efficient troubleshooting.

4-32. LINE REGULATION

4-33. The line regulation test determines whether output voltage will remain constant, within specified limits, for a $\pm 10\%$ change in line power (103V ac to 127V ac).

1. Connect the line cord to an auto-transformer connected to an ac power line. Set the auto-transformer to 115 volts ac.
2. Set the front panel controls as follows:

POWER	STDBY/RESET
NULL ZERO	OPR
INPUT MODE	TVM
SENSITIVITY	5V
RANGE	10
Readout	All Zero
TRIP	1000
VERNIER	Fully clockwise (CW)
CURRENT LIMIT	Fully clockwise (60)

3. Connect the Model 895A Differential Voltmeter to the SENSE terminals and set to plus polarity. Connect the 240-C Load Resistance Box to the OUTPUT terminals.
4. Set the RANGE switch, readout dials, and load box to the values indicated in the first group of settings in Table 4-3. Set the POWER switch to the OPR position. Note the voltage indicated on the Model 895A. Set the auto-transformer to low line (103V). The output voltage change, indicated on the Model 895A, should not exceed the specifica-

tion listed in Table 4-3. Return the auto-transformer setting to nominal line (115V). Note the voltage indication on the Model 895A. Set the auto-transformer to high line (127V). The voltage change, indicated on the Model 895A, should not exceed the specification. Repeat this procedure for each group of settings in Table 4-3.

4-34. LOAD REGULATION

4-35. The load regulation test determines if the output voltage will remain constant, within specified limits, when the output is subjected to a no-load to full-load condition.

Table 4-2. Listing of Performance Tests

VOLTAGE STANDARD	PROCEDURE	DESCRIPTION
	Line Regulation	Checks \pm OUTPUT stability for variations in line voltage.
	Load Regulation	Checks \pm OUTPUT stability for variations in load from no-load to full load.
	Ripple	Assures that the AC component on the OUTPUT is within specifications.
	Voltage Standard Accuracy	Checks the \pm OUTPUT for accuracy.
METER AND PROTECTION	V-I Monitor	Checks the circuitry that displays output voltage and current on the front panel meter.
	Current Limit	Checks the range of the Current Limit control.
	Voltage Trip	Checks that the Trip circuit will actuate during an overvoltage condition on each RANGE setting.
VOLTMETER	Leakage Resistance	Assures that the isolation between Lo Input and ground is at least 10^{12} ohms in TVM mode.
	Mechanical Zero	Assures that the meter movement can be mechanically zeroed.
	Electrical Zero	Assures meter stability and NULL ZERO circuit function.
	Null Detector Accuracy	Checks the Null Detector for accuracy in measurement.
	Differential Voltmeter Accuracy	Checks the accuracy of the Differential Voltmeter.
	Recorder Output Voltage	Assures that the Recorder Output may be varied from zero to over 1 volt.
	Recorder Output Ground Isolation	Assures that the isolation between Recorder Output and ground is at least in the TVM mode.

Table 4-3. Control Settings, Load Requirements and Limits for Line and Load Regulation

RANGE	READOUT	LOAD (50 mA)	SPECIFICATION
10	1.000000	20 Ω	10 μ V
10	10.00000	200 Ω	20 μ V
100	10.00000	200 Ω	20 μ V
100	100.00000	2000 Ω	200 μ V
1000	100.0000	2000 Ω	200 μ V
1000	100.0000	20,000 Ω	2.0 mV

1. Connect the line cord to an auto-transformer connected to an ac power line. Set the auto-transformer to 115 volts ac.

2. Set the front panel controls as indicated:

POWER	STDBY/RESET
NULL ZERO	OPR
INPUT MODE	TVM
SENSITIVITY	1
RANGE	10
Readout	All Zero
TRIP	1000
VERNIER	Clockwise
CURRENT LIMIT	Clockwise (60)

Terminal Connections - See Figure 2-2.

3. Connect the Model 895A to the SENSE terminals.

WARNING

SET OPERATE TO STDBY/RESET BEFORE CONNECTING OR DISCONNECTING ANY LOAD. OPERATOR HAZARD OF LETHAL VOLTAGES MAY EXIST ON THE OUTPUT TERMINALS. OPERATOR INJURY OR DEATH MAY RESULT FROM CONTACT WITH THESE TERMINALS WHILE THE OPERATE SWITCH IS SET TO ON. INSTRUMENT DAMAGE MAY RESULT FROM APPLICATION OR REMOVAL OF A LOAD WHILE THE OPERATE SWITCH IS SET TO ON.

4. Set the RANGE switch and Readout Dials to the values indicated in the first group of settings listed in Table 4-3. Set the POWER switch to the OPR position. Note the voltage indicated on the Model 895A. Connect the 20 Ω load to the OUTPUT terminals of the instrument, and note the output voltage change on the Model 895A. This change should not exceed the specification listed in the chart. Repeat this step for each group of settings.

5. Repeat step 4 for low line (103V) and high line (127V).

4-36. RIPPLE

4-37. The ripple test determines if the rms value of the ac component, super-imposed on the dc output is within specified limits.

WARNING

SET THE OPERATE SWITCH TO STDBY BEFORE CONNECTING OR DISCONNECTING ANY LOAD. OPERATOR HAZARD OF LETHAL VOLTAGES MAY EXIST ON THE OUTPUT TERMINALS. OPERATOR INJURY OR DEATH MAY RESULT FROM CONTACT WITH THESE TERMINALS. INSTRUMENT DAMAGE MAY RESULT FROM APPLICATION OR REMOVAL OF A LOAD WHILE THE OPERATE SWITCH IS SET TO ON.

1. Construct the low pass filter network as shown in Figure 4-5, Low Pass Filter Network Schematic, or purchase the equivalent commercially. The specifications: BP of DC to 100 kHz (3 dB down at 100 kHz), noise level of 5 μ V or less, DC blocking of up to 1200V. The shielded environment for the filter is optional but recommended for high noise areas.

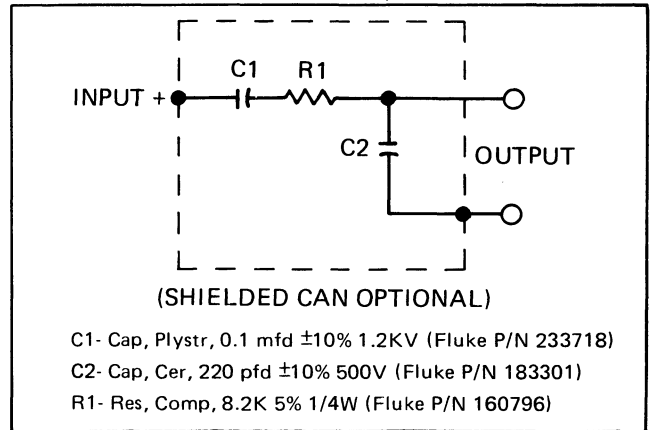


Figure 4-5. Low Pass Filter Network Schematic

2. Connect the OUTPUT terminals on the UUT to the input of the low pass filter.
3. Connect the output of the low pass filter network to the input of the low noise RMS Voltmeter.
4. On the UUT, connect a shorting link between the -OUTPUT terminal and the line power GROUND terminal.
5. Measure ripple and noise components of the UUT as follows:
 - a. Remove the connection to the input of the RMS Voltmeter and short the input of the RMS Voltmeter.
 - b. Note the ambient reading of the RMS Voltmeter.

- c. Remove the short and connect the output of the low pass filter network to the input of the RMS Voltmeter.
- d. Note the reading of the RMS Voltmeter.
- e. The measurement of the UUT ripple and noise component is equal to the reading in step d minus the ambient reading in step b.

6. Set the front panel controls as follows:

NULL ZERO	OPR
INPUT MODE	TVM
SENSITIVITY	I
RANGE	10
Readout	All Zero
TRIP	1000
VERNIER	Clockwise
CURRENT LIMIT	Clockwise (60)

Terminal Connections - See Figure 2-2.

7. With the auto-transformer set to nominal line voltage (115V ac), set the POWER switch to OPR. The ripple and noise measurement should not exceed 20 mV rms for the 10V range, 30 mV rms for the 100V range and 40 mV rms for the 1000V range.
8. Set the readout dials to 10 volts. The ripple and noise measurement should not exceed 20 mV rms.
9. Connect the 200 ohm load resistor to the OUTPUT terminals. The ripple and noise measurement should not exceed 20 mV rms. Disconnect the load resistor.
10. Set the readout dials to zero, and set the RANGE switch to 100. The ripple and noise measurement should not exceed 30 mV rms.
11. Set the readout dials to 100 volts. The ripple and noise measurement should not exceed 30 mV rms.
12. Connect the 2,000 ohm load resistor to the OUTPUT terminals. The ripple and noise measurement should not exceed 30 mV rms. Disconnect the load resistor.
13. Set the readout dials to zero, and set the RANGE switch to 1000. The ripple and noise measurement should not exceed 40 mV rms.
14. Set the readout dials to 1000 volts. The ripple and noise measurement should not exceed 40 mV rms. Disconnect the load resistor.

15. Connect the 20,000 ohm load resistance to the OUTPUT terminals. The ripple and noise measurement should not exceed 40 mV rms.

4-38. VOLTAGE STANDARD ACCURACY

4-39. If the voltage standard has successfully passed the line, load, and ripple specifications, it can be assumed to be operating correctly. The output voltage can now be checked and compared to the accuracy specifications. These checks should be accomplished after the unit has warmed up for one hour at standard reference conditions of $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$, up to 70% relative humidity, and constant line voltage. One method of checking the instrument's accuracy is by comparing the output voltages to a standard cell by means of a reference divider. Use the equipment and connections shown later under the Final RANGE Calibration Procedures.

4-40. Meter and Protection Circuits

4-41. V - I MONITOR

4-42. This check investigates the circuitry involved with monitoring and displaying, on the front panel meter, the output voltage and current.

1. With the SENSITIVITY switch in the V position, set the RANGE switch and readout dials for a 100 volt output.
2. The front panel meter should indicate 100 ± 3.0 volts.
3. Check the meter linearity at the following cardinal points, Table 4-4. All meter indications should be within $\pm 3\%$ of full scale.
4. Set the RANGE switch to 10 volts, the readout dials to 5 volts, the CURRENT LIMIT control maximum clockwise, and the SENSITIVITY switch to I.
5. Connect a 0 to 100 dc milliammeter across the OUTPUT terminals.
6. Adjust the CURRENT LIMIT control counter-clockwise until the external meter indicates 50 milliamperes. The front panel meter should also indicate 50 milliamperes on the red scale.
7. Set the RANGE switch to 100 volts then to 1000 volts. The front panel meter should indicate 50 milliamperes in each position of the RANGE switch.

Table 4-4. Control Settings for V-I Monitor Test

RANGE	READOUT
10	1.000000
100	10.00000
1000	100.0000
10	10.000000
1000	1000.0000

4-43. CURRENT LIMIT

4-44. This check determines the range of the CURRENT LIMIT control, which should be from 0.5 to 60 milliamperes.

1. Set the POWER switch to STDBY/RESET, the RANGE switch to 10 volts, the readout dials to 5 volts, and the CURRENT LIMIT control maximum clockwise.
2. Connect a 0 to 100 dc milliammeter across the OUTPUT terminals.
3. Set the POWER switch to OPR. The external meter should indicate 60 milliamperes.
4. Adjust the CURRENT LIMIT control maximum counter-clockwise. The external meter should indicate 0.5 milliamperes.
5. Adjust the CURRENT LIMIT control clockwise until the external meter indicates 50 milliamps. The front panel meter of the instrument should also indicate 50 milliamps on the red scale $\pm 3\%$ of full scale.
6. Set the RANGE switch to 100 volts and then to 1000 volts. The front panel meter should indicate 50 milliamps $\pm 3\%$ of full scale in each position of the RANGE switch when the external meter reads 50 milliamps.

4-45. VOLTAGE TRIP

4-46. This test determines if the trip circuit will actuate during an overvoltage condition on each RANGE setting.

1. Adjust the TRIP VERNIER maximum clockwise. Set the RANGE, TRIP, and readout dials to the values indicated in Table 4-5. In each case, adjust the VERNIER counter-clockwise from the maximum clockwise position until the trip circuitry just actuates. In each case, the VERNIER control should be approximately 30° from the maximum clockwise position.

2. Set the RANGE switch to 10V, the Readout Dials to 4V.
3. Set the TRIP switch to the 10V position and the VERNIER control to the 12 o'clock position.
4. Set the RANGE switch to 100 volts. The trip circuitry should actuate.
5. Set the TRIP switch to the 100 volt position and reset the instrument.
6. Set the RANGE switch to 1000 volt position. The trip circuit should actuate.
7. Set the TRIP switch to the 1000 volt position and the VERNIER control maximum clockwise. Reset the instrument.
8. Set the RANGE switch to 100 volts then to 10 volts. The trip circuit should not actuate in either position.

Table 4-5. Control Settings for Voltage Trip Check

RANGE	TRIP	READOUT DIALS
10	10	10.X00000
100	100	10X.00000
1000	1000	10XX.X00

4-47. Voltmeter

4-48. A good indication of correct operation of the null detector is the electrical zero test. Should the instrument fail this test, you should investigate the cause of the problem.

4-49. LEAKAGE RESISTANCE

4-50. This test determines if the isolation between the LO INPUT terminal and GROUND, in the TVM mode, is at least 10^{12} ohms.

WARNING

THE CHASSIS WILL BE AT A POTENTIAL 1000V. THIS IS A LETHAL VOLTAGE. CONTACT WITH CHASSIS MUST BE AVOIDED.

1. Disconnect the Model 335D under test from the power line. Using teflon coated leads, connect the 335D to a Model 415B Fluke Programmable/HV Power Supply and a Model 845AR Fluke High Impedance Voltmeter/Null Detector as illustrated in Figure 4-6.

2. Connect a 100 k Ω ($\pm 5\%$) 1/2 watt resistor across the INPUT and COMMON terminals of the Model 845AR.
3. Set the Model 845AR POWER switch to ON and the RANGE switch to 100 microvolts. Set the INPUT MODE switch to TVM and insure that the VM AC COMMON terminal is linked to (ground).
4. Apply 1000 volts from the Model 415B.
5. The indication on the Model 845AR should not exceed 100 microvolts. This indicates that the isolation is 10^{12} ohms or greater.
6. Return the Model 415B to zero output and remove all equipment interconnections.

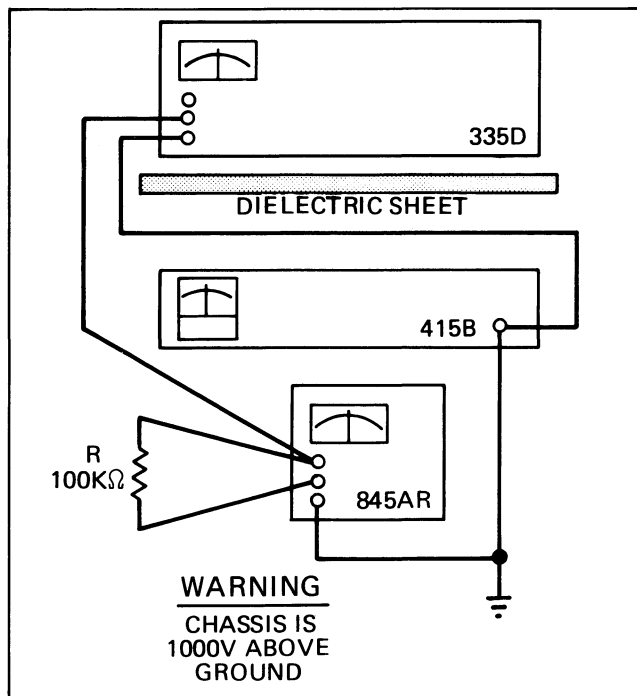


Figure 4-6. Leakage Resistance Test Connections

4-51. MECHANICAL ZERO

4-52. With the instrument still de-energized, adjust mechanical zero screw (located just below the meter) so that the meter pointer is over the center scale zero position.

4-53. ELECTRICAL ZERO

4-54. Connect the instrument to the power line and set the POWER switch to the STDBY/RESET position. Allow the 335D to warm-up for at least 1 hour before proceeding with this test.

1. Set the controls as follows:

Readout Dials	All Zero
INPUT MODE	TVM
NULL ZERO	ZERO
SENSITIVITY	10 μ V
2. Rotate the NULL ZERO control through its full range. The meter pointer should deflect a total of 16 microvolts.
3. Set the meter pointer over the center scale zero position with the NULL ZERO control.
4. Observe the meter pointer for a period of 10 seconds. The peak-to-peak excursions of the pointer should not exceed 0.5 microvolts.

4-55. NULL DETECTOR ACCURACY

4-56. The null detector accuracy can now be checked. Place the INPUT MODE switch in the TVM position. Known voltages may now be applied to the INPUT terminals to check the null detector at the desired cardinal points. Null detector accuracy is $\pm 3\%$ of full-scale. For example, set the SENSITIVITY switch to the 1000V position and apply from the voltage standard 1000V, 900V, 800V, etc., the meter should read correctly ± 30 V. Check both positive and negative inputs, lower voltage levels as desired.

4-57. DIFFERENTIAL VOLTAGE ACCURACY

4-58. The null detector accuracy can now be checked. Place the INPUT MODE switch in the TVM position. Known voltages may be applied to the INPUT terminals to check the null detector at the desired cardinal points. Null detector accuracy is $\pm 3\%$ of full scale.

4-59. The differential voltmeter operation may also be checked for accuracy by placing the INPUT MODE switch in the DIFF \pm positions. When doing so, observe the same standard reference conditions used for checking the voltage standard accuracy.

4-60. RECORDER OUTPUT VOLTAGE

4-61. Perform the Recorder Output Voltage check as follows:

1. With the INPUT MODE switch to the TVM position, set the SENSITIVITY switch to the 1 millivolt position and apply 1 millivolt to the INPUT terminals. The meter should deflect full scale.

2. Connect a Model 895A to the RECORDER OUTPUT terminals.

3. Vary the RECORDER OUTPUT ADJUST to both extremes. The voltage at the RECORDER OUTPUT terminals should vary from 0 to 1 volt (typically 1.2 volts).

4. Disconnect the Model 895A and the 1 millivolt source.

4-62. RECORDER OUTPUT GROUND ISOLATION

4-63. Perform the recorder output ground isolation check as follows:

1. Set the controls as follows:
 INPUT MODE TVM
 SENSITIVITY 10 microvolts
2. Connect the Voltage Standard to the INPUT terminals of the UUT and apply 10 microvolts.
3. Connect the Model 895AR to the RECORDER OUTPUT terminals.
4. Adjust the RECORDER OUTPUT ADJUST for 1.0 volt on the 895A. (UUT meter should deflect full-scale.)
5. Remove the Voltage Standard from the INPUT terminals of the UUT.
6. Connect the Voltage Standard to the RECORDER OUTPUT terminals of the UUT and apply 100V.
7. The change in deflection on the front panel meter should be less than 0.5 microvolts.
8. Remove connections.

4-64. PRE-CALIBRATION PROCEDURES

WARNING

THE INNER CHASSIS IS AT + OUTPUT POTENTIAL. LETHAL VOLTAGES EXIST BETWEEN INNER CHASSIS AND FRONT PANEL.

4-65. Introduction

4-66. The pre-calibration procedures set up the instrument protection circuits and gross align the instrument control circuitry. Perform the pre-calibration procedures following any instrument repairs. After pre-calibration procedure is accomplished, perform the calibration adjustments.

4-67. MECHANICAL ZERO

4-68. With the instrument de-energized for at least three minutes, adjust the mechanical zero screw (located just below the front panel meter) so that the meter pointer is over the center scale zero position.

4-69. NULL DETECTOR DRIVE FREQUENCY

4-70. Extend the Null Detector Power Supply PCB Assembly (A6A1) on the extender card provided. Set the POWER switch to STDBY/RESET and allow approximately one minute for warm-up. Proceed as follows:

1. Set the oscilloscope vertical input to 20 volts/centimeter and the horizontal sweep for 2 milliseconds/centimeter.
2. Connect the oscilloscope at either the collector of Q1 or Q2. (Refer to Figure 4-7.)
3. Refer to Figure 4-8, and adjust R4 until the period of the squarewave is 11.9 milliseconds.

4-71. NULL SENSITIVITY ADJUST

4-72. Proceed as follows:

1. Adjust the meter electrical zero. Set the INPUT MODE switch to TVM, the SENSITIVITY switch to 1 millivolt, and NULL ZERO to OPR.
2. Apply +1 millivolt to the INPUT terminals.
3. Refer to Figure 4-8, and adjust A6A1R9 for a full scale meter deflection $(1.0) \pm 1/2$ a small division.
4. Apply -1 millivolt to the INPUT terminals. The meter pointer should deflect full scale to the left of zero $\pm 1/2$ a small division.
5. Apply to each of the remaining SENSITIVITY ranges, the corresponding voltage that will cause a full scale deflection. In each case, the meter pointer should deflect full scale, ± 1 small division.

4-73. Auxiliary Power Supply

4-74. This procedure checks the operating control and output voltages of the Auxiliary Power Supply for normal, high and low power input.

1. Set the POWER switch to the OFF position.
2. Connect the 335D through the Variac metered auto-transformer to the power line and adjust the auto-transformer for nominal line voltage.

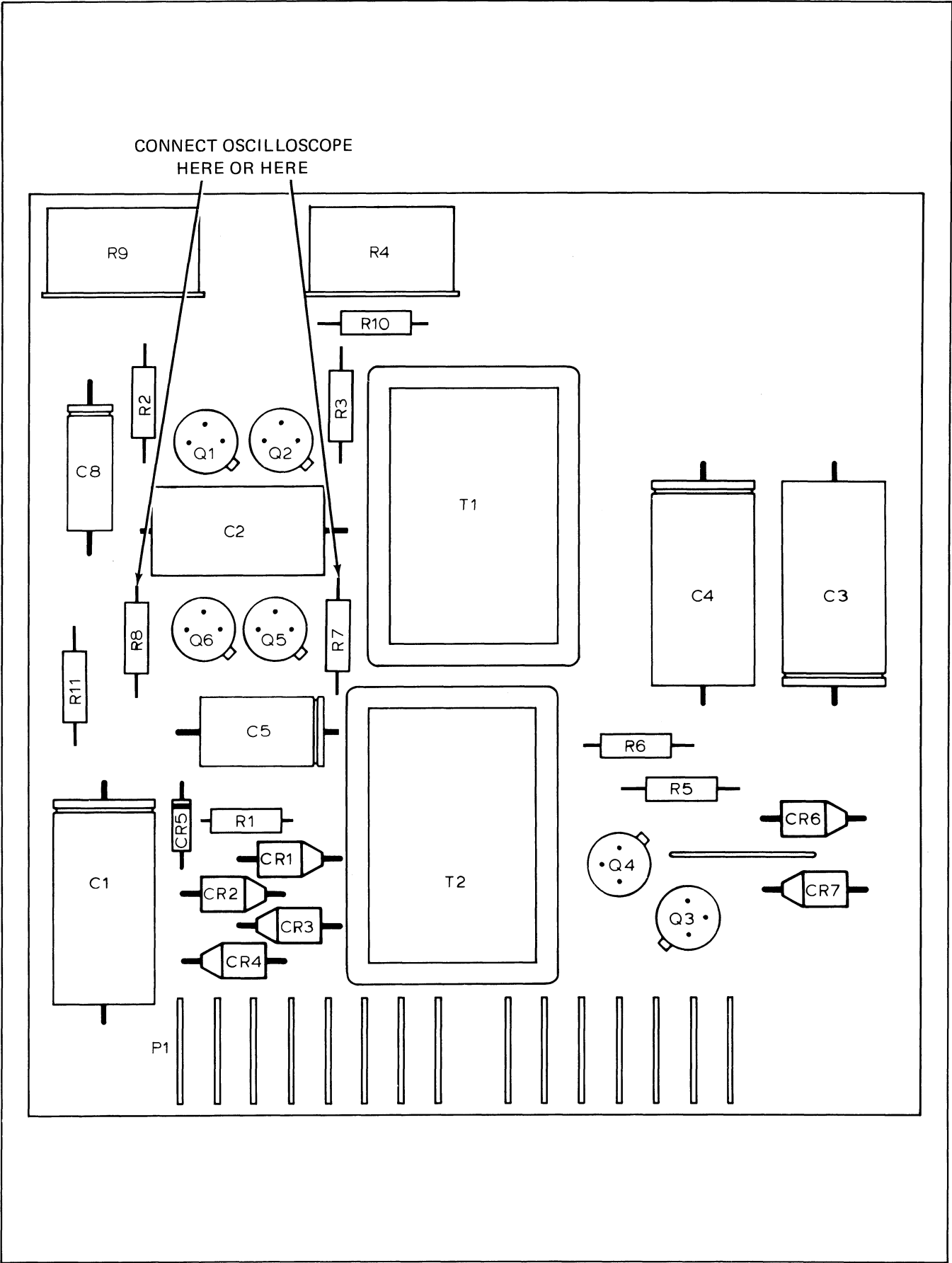


Figure 4-7. Null Detector Power Supply Test Points

3. Extend the Auxiliary Power Supply PCB Assembly, A5A5, on the extender card provided.
4. Place the POWER switch in the STDBY/RESET position. Allow about 10 minutes for warm-up, before proceeding to step 5.
5. Using the +SENSE terminal as common, connect a Model 895A to pin 10 on the Auxiliary Power Supply PCB Assembly (+25 VOC).
6. Referring the Figure 4-8, adjust A5A5R9 until the Model 895A indicates 25 volts, ± 10 millivolts.
7. While varying the line voltage from 100 to 130 volts ac, the Model 895A indication should not change more than 40 millivolts.
8. Set the auto-transformer to nominal line voltage.
9. Using the Model 895A Differential Voltmeter, measure the voltage between the test points listed in Table 4-6 and the +SENSE terminal, which is common.
10. Where indicated, perform the adjustment to determine that it can be made. These should be rechecked during calibration of the instrument.
11. Set the POWER switch to OFF. Disconnect the Model 895A. Replace the Auxiliary Power Supply PCB Assembly. Return the POWER switch to the STDBY/RESET position.

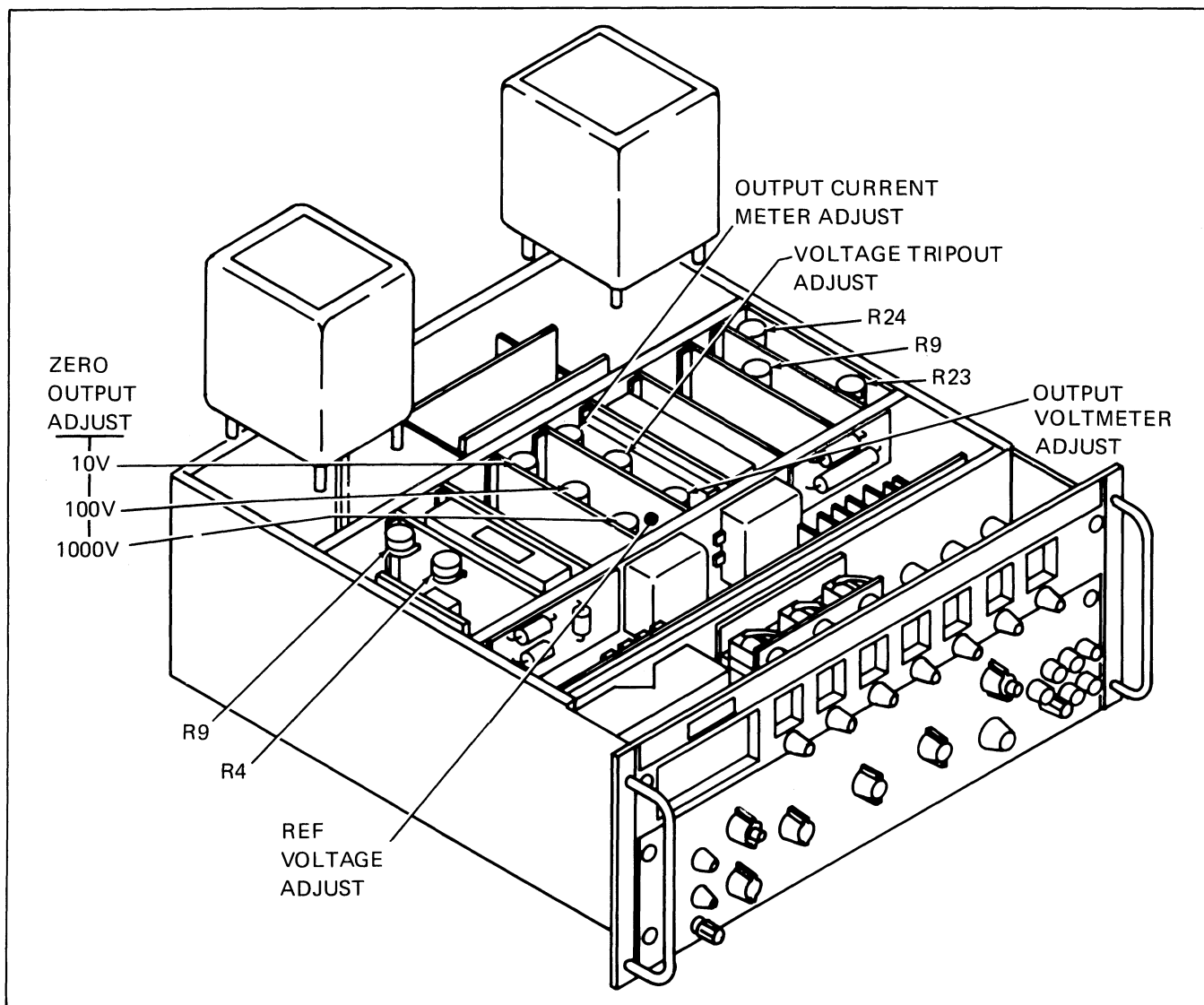


Figure 4-8. Location of Adjustments

Table 4-6. Reference and Auxiliary Voltages

ASSEMBLY	PIN	VOLTS DC
Auxiliary Power Supply	10	23 to 27 ¹
Auxiliary Power Supply	9	-14 to -16
Current Limiter	1	-33 to -39
Current Limiter	3	33 to 39
Range Cal	Test Points	14.9 to 15.1 ²
Reference Supply	Collector Q1	26 to 35 ³
Series Pass	Collector Q8	Approx. 140
Rear bulkhead power resistor, 100 k Ω	Yellow lead	650 to 725

NOTES:

¹ Adjustable 25 volts ± 10 mV with R

² Adjustable 15.0 volts ± 10 μ V with R9 on Reference Supply PCB

³ Approximately 1 volt at turn-on, rising to 26 to 35 volts after 10 minute warm-up

4-75. Chopper Drive and Compensation Adjustment

CAUTION

Improper alignment of the chopper circuitry will result in high ripple output and in some cases, a complete loss of control. In extreme cases, loss of control can cause instrument damage.

4-76. The Chopper drive and compensation adjustment procedure is divided into two parts due to the temperature sensitivity of the MOS-FET compensation circuitry. Part 1 is the adjustment with the Chopper Amplifier PCB Assembly A5A4 on the extender board. Part 2 is a waveform check with the Chopper Amplifier in the instrument. Both parts must be repeated in sequence until the proper waveform is observed in part 2.

4-77. PART 1

1. Set the POWER switch to OFF.
2. Extend the Chopper Amplifier PCB Assembly A5A4 on the extender board provided.
3. On the Chopper Amplifier, short pin 6 to pin 12. (See Figure 4-9.)
4. On the Chopper Amplifier, adjust R43 (Chopper Drive Adjust) fully clockwise (CW). (See Figure 4-9.)
5. Referring the Figure 4-9, connect the oscilloscope through an X10 probe to the positive side of C13. Connect the probe common to chassis.

6. Set the oscilloscope to 0.1V/CM vertical and 500 μ sec/CM horizontal, AC coupled input.
7. Short the +OUTPUT terminal to the power line GROUND terminal.
8. Set POWER switch to STDBY/RESET.
9. The waveform on the oscilloscope should appear as in Figure 4-10.
10. On the Chopper Amplifier, adjust R43 counter-clockwise (CCW) until the noise in both sections of the waveform is about equal. Then adjust R43 clockwise (CW) until the noise dies to zero in the previously quiet region. Adjust R43 at least 1/3 turn clockwise (CW) from this point.
11. On the Chopper Amplifier, adjust R34 (Chopper Compensation Adjustment) (See Figure 4-10) until the amplitude of the negative spike leading the noisy region is no greater than 3/4 (but at least 1/2) of the amplitude of the negative spike leading the quiet region. If there is insufficient range of adjustment in R34, add or remove the jumper across R33 as required.

CAUTION

If high temperatures cause this negative spike to go positive, the instrument will probably oscillate at 1 - 5 Hz. Instrument damage may result.

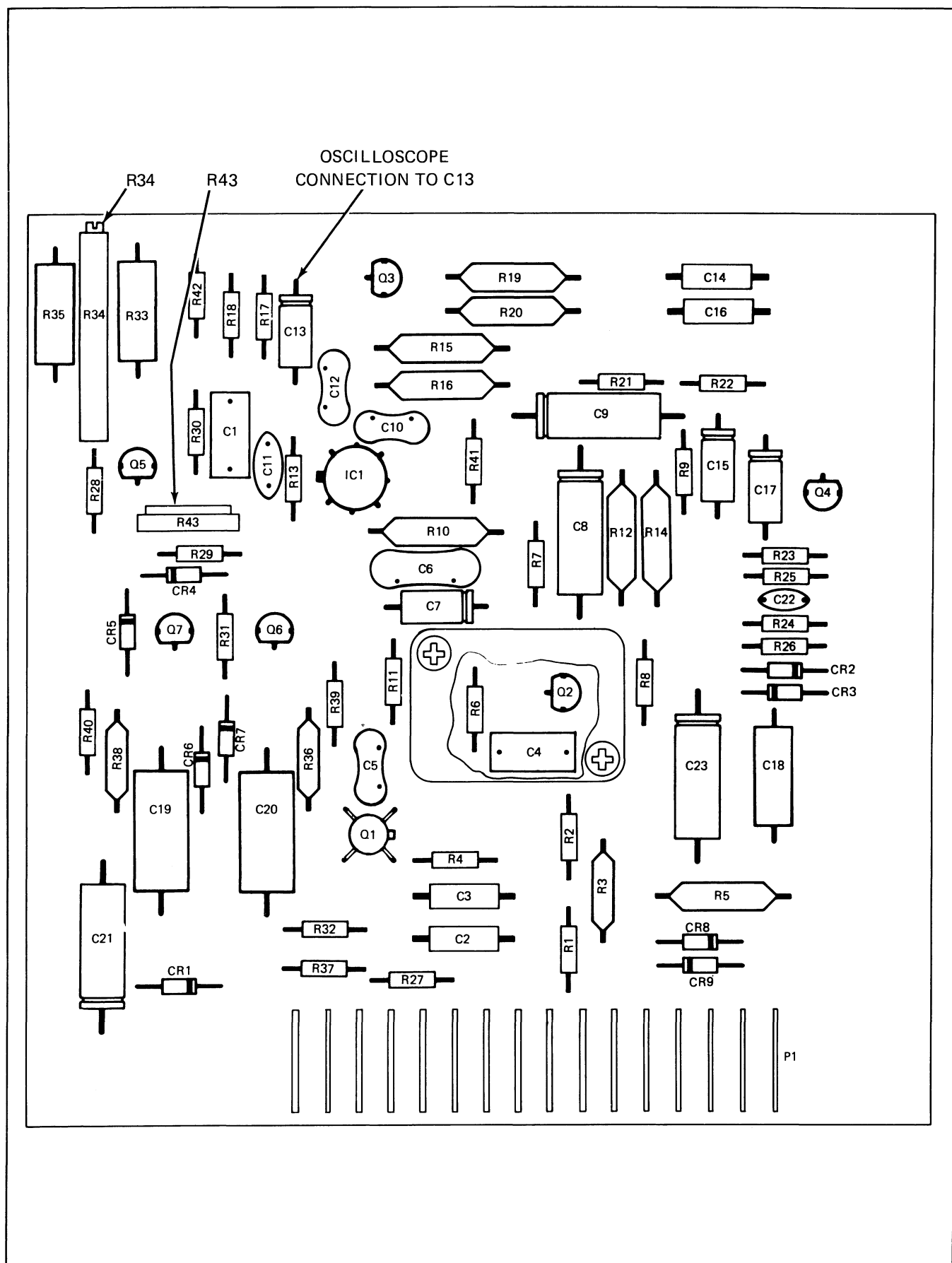


Figure 4-9. Chopper Amplifier Component and Test Point Locations

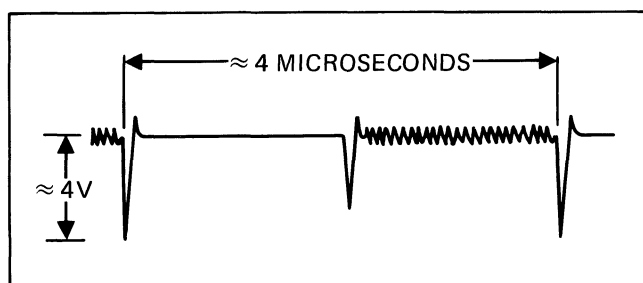


Figure 4-10. Chopper Amplifier Adjustment Waveform

4-78. PART 2

1. Set POWER switch to OFF.
2. Remove the short between pin 6 and pin 12.
3. Place the Chopper Amplifier back into its normal slot.
4. Leave the oscilloscope connected through the X10 probe to the positive side of C13. Probe common still to chassis.
5. Set controls as follows:

Readout Dials	All Zero
RANGE	10 volt
6. Set the POWER switch to OPERATE.
7. The waveform on the oscilloscope should appear as in Figure 4-10.
8. If necessary, reperform Part 1, step 11 of this procedure.
9. This should insure proper operation of the instrument up to 50°C.
10. Check the ripple on the \pm OUTPUT. Using the set up and test procedure described in Ripple Performance Check.
11. If desired, R34 may be fine adjusted (but no more than 1/4 turn from the setting in step 9 of this paragraph) for less ripple. This will sacrifice high temperature operation. In all cases, the instrument should meet ripple specifications.

4-79. Current Limit

1. Set the controls as follows:

POWER	STDBY/RESET
RANGE	10
Readout Dials	5.000000
TRIP	1000
VERNIER	Maximum (CW)
CURRENT LIMIT	Maximum (CW)

2. Connect a 0 to 100 dc milliammeter across the OUTPUT terminals. Set the POWER switch to OPR.
3. Referring the Figure 4-8, adjust R23 for a 60 milliampere indication on the external meter.
4. Rotate the CURRENT LIMIT control maximum counter-clockwise. Referring the Figure 4-8, adjust R24 for a 0.5 milliampere indication on the external meter.
5. If necessary, readjust R23 and R24 until the range of the CURRENT LIMIT control is from 0.5 to 60 milliamperes.
6. Set the POWER switch to STDBY/RESET. Replace the top inner cover on the Model 335D.

4-80. Output Current Monitor

- 4-81. Proceed as follows:

1. Set the SENSITIVITY switch to I.
2. Adjust the CURRENT LIMIT control to obtain a 50 milliampere indication on the external meter.
3. Rotate the adjustment labeled OUTPUT CURRENT METER ADJUST until the front panel meter pointer indicates 50 milliamperes on the red scale.
4. Set the RANGE switch to 100 volts; then to 1000 volts. The front panel meter should indicate 50 milliamperes in each position of the RANGE switch.
5. Set the POWER switch to STDBY/RESET. Remove the external meter connections from the instrument.

4-82. Output Voltage Monitor

- 4-83. Proceed as follows:

1. Set the front panel controls as follows:

SENSITIVITY	V
RANGE	100
Readout Dials	100.00000
2. Rotate the adjustment labeled OUTPUT VOLTMENTER ADJUST until the front panel meter indicates 100 ± 0.5 volts.

3. Meter linearity may be checked at the cardinal points listed in Table 4-7. All full-scale meter indications should be within $\pm 3\%$ of the readout dial settings.

Table 4-7. Control Settings for Voltage Monitor Linearity Check

RANGE	READOUT DIALS
10	1.000000
100	10.00000
1000	100.0000
10	10.000000
1000	1000.0000

4-84. Voltage Trip

- 4-85. Proceed as follows:

- Set the controls as follows:

RANGE	100
Readout Dials	10X.00000
VOLTAGE	Maximum
TRIP	100
VERNIER	30° from maximum clockwise
TRIP	100
VERNIER	30° from maximum clockwise
- Rotate the VOLTAGE TRIP OUT ADJUST until the output is de-energized, as indicated by the illumination of the red indicator lamp and the audible click of relays.
- Set the POWER switch to STDBY/RESET. Rotate the VERNIER control to the maximum clockwise position.
- Set the POWER switch to OPR. Set the RANGE switch, TRIP switch, and readout dials as listed in Table 4-8. Check the trip action on each range by rotating the VERNIER control counter-clockwise. The trip point should occur in each RANGE switch position when the VERNIER control is approximately 30° from the maximum clockwise position.
- Set the output of the instrument for 4 volts on the 10 volt range. Set the VOLTAGE TRIP switch to the 10 volt position and the VERNIER control to the 12 o'clock position.
- Set the RANGE switch to 100 volts. The trip circuit should actuate.

- Set the VOLTAGE TRIP switch to the 100 volt position and reset the instrument.
- Set the RANGE switch to the 1000 volt position. The trip circuit should actuate.
- Set the VOLTAGE TRIP switch to the 1000 volts position and the VERNIER maximum clockwise. Reset the instrument.
- Set the RANGE switch to 100 volts then to 10 volts. The trip circuit should not actuate in either position.

Table 4-8. Control Settings for Trip Range Check

TRIP	RANGE	READOUT DIALS
10	10	10.X00000
1000	1000	10XX.X000

4-86. MASTER REFERENCE

- 4-87. Proceed as follows:

- Set the controls as follows:

POWER	OPR
RANGE	1000
Readout Dials	00X.0000
TRIP	1000
VERNIER	Maximum (CW)
CURRENT LIMIT	Maximum (CW)
- Connect a Model 895A to the MASTER REFERENCE TEST points through the top inner cover.
- Adjust CAL 1000V, CAL 100V, and CAL 10V mechanically to mid-point of travel.
- Rotate REFERENCE VOLTAGE ADJUST to obtain an indication of 15.00 volts $\pm 10 \mu\text{V}$ on the Model 895A.

4-88. CALIBRATION ADJUSTMENTS

4-89. Introduction

- 4-90. The calibration adjustments fine align the instrument control circuitry. The calibration adjustments should be performed if the instrument is out of specifications or if the instrument has been repaired. If the instrument has been repaired, perform the pre-calibration procedures prior to starting the calibration adjustment. Allow the instrument at least 3 hours of warm-up time before proceeding.

4-91. Zero Output Adjustment

1. Set the instrument's readout dials to zero.
2. Connect the 845AR Null Detector across the instrument's OUTPUT terminals.
3. Set the instrument's POWER switch to the OPERATE position.
4. Zero the 845AR.
5. At each RANGE switch position of the instrument, vary the corresponding ZERO OUTPUT ADJUST (10V, 100V, 1000V) (Refer to Figure 4-1) for a null indication ± 1 microvolt on the 845AR.

4-92. Sample String Linearization and Range Calibration Circuit Adjustment

1. Using the Model 7105A DC Calibration System or equivalent components, make the equipment connections shown in Figure 4-11.
2. Self calibrate the 720A.
3. Adjust the output of the 335D in the Model 7105A to approximately 11 volts.
4. Set the RANGE switch and the READOUT DIALS to the settings listed in Table 4-9. Adjust the RANGE CAL and SAMPLE STRING ADJUST potentiometers as indicated (refer to Figure 4-1, for location).
5. Repeat the paragraphs, Zero Output Adjustment, and Sample String Linearization and Range Calibration Circuit Adjustment, 1 through 4.

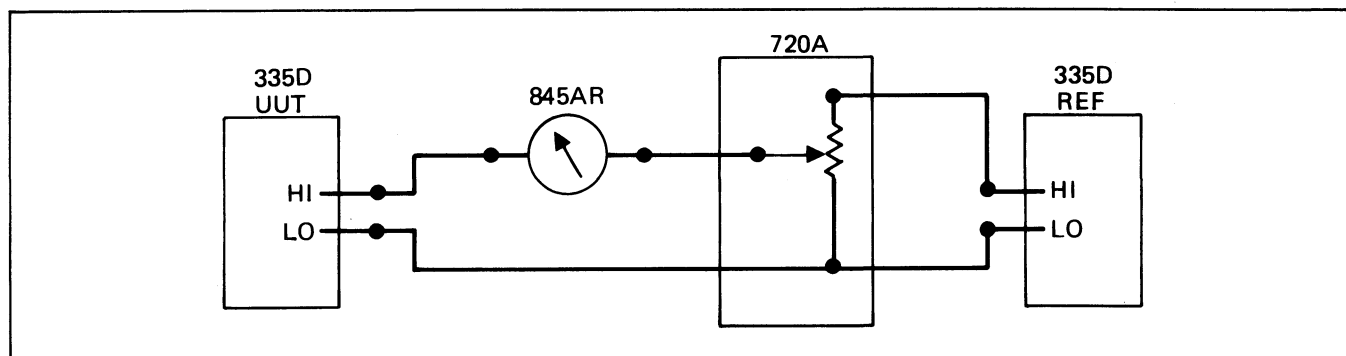


Figure 4-11. Equipment Connections for Sample Linearization Checks

Table 4-9. Final Linearization of Deck C, B and A

STEP	720 SETTING	UUT RANGE	UUT READOUT SETTING	NULL ADJUSTMENT	845AR NULL
1	0000000	1000V	000.0000	* 845AR	$\pm 1 \mu\text{V}$
2	.1000000	1000V	000.X00	1000V CAL 332	$\pm 1 \mu\text{V}$
3	.1000000	1000V	001.0000	Deck C-1	$\pm 1 \mu\text{V}$
4	.2000000	1000V	002.0000	Deck C-2	$\pm 1 \mu\text{V}$
5	.4000000	1000V	004.0000	Deck C-4	$\pm 2 \mu\text{V}$
6	.8000000	1000V	008.0000	Deck C-8	$\pm 4 \mu\text{V}$
7	1.0000000	1000V	00X.0000	** 720A	$\pm 5 \mu\text{V}$
8	Step 7 null	1000V	0010.0000	Deck B-1	$\pm 5 \mu\text{V}$
9	0000000	100V	00.00000	* 845AR	$\pm 1 \mu\text{V}$
10	.1000000	100V	01.00000	100V CAL 332	$\pm 1 \mu\text{V}$
11	.2000000	100V	02.00000	Deck B-2	$\pm 1 \mu\text{V}$
12	.4000000	100V	04.00000	Deck B-4	$\pm 2 \mu\text{V}$
13	.8000000	100V	08.00000	Deck B-8	$\pm 4 \mu\text{V}$
14	1.0000000	100V	0X.00000	** 720A	$\pm 5 \mu\text{V}$

Table 4-9. Final Linearization of Deck C, B and A (cont)

STEP	720 SETTING	UUT RANGE	UUT READOUT SETTING	NULL ADJUSTMENT	845AR NULL
15	Step 14 null	100V	10.0000	Deck A-1	$\pm 5 \mu\text{V}$
16	0000000	10V	0.000000	* 845AR	$\pm 1 \mu\text{V}$
17	.1000000	10V	1.000000	10V CAL 332	$\pm 1 \mu\text{V}$
18	.2000000	10V	2.000000	Deck A-2	$\pm 1 \mu\text{V}$
19	.4000000	10V	4.000000	Deck A-4	$\pm 2 \mu\text{V}$
20	.8000000	10V	8.000000	Deck A-8	$\pm 4 \mu\text{V}$

NOTES:

* Adjust the 845AR ZERO ADJ to obtain a system zero.

** Adjust 720A readout dials for a null on the 845AR. Retain this setting for the next step.

4-93. Final RANGE Calibration Adjustments

WARNING

DURING THIS PROCEDURE, HIGH VOLTAGE IS PRESENT AT THE TERMINALS OF ALL TEST INSTRUMENTS EXCEPT THE STANDARD CELL. CONTACT WITH HIGH VOLTAGE MUST BE AVOIDED.

- Using the Model 7105A DC Calibration System or equivalent components, connect the equipment as shown in Figure 4-12.
- Set the readout dials of the 750A to the Standard Cell Voltage.
- Standardize the voltage reference. This procedure standardizes the voltage reference output of the 335D in the 7105A using the Standard Cell as a reference.

CAUTION

Before pushing the switch to connect the standard cell into the circuit, make sure that the proper settings have been made on the 750A.

- Referring to Figure 4-12, connect the 845AR in position A.
- Push Standard Cell circuit to MOMENTARY and null the 845AR with the reference 335D in the 7105A.
- Referring to Figure 4-12, connect the 845AR in position B.
- Make the instrument settings indicated in Table 4-10. Make the adjustments indicated as required. Standardize the voltage reference (step 3, this paragraph) between each step.

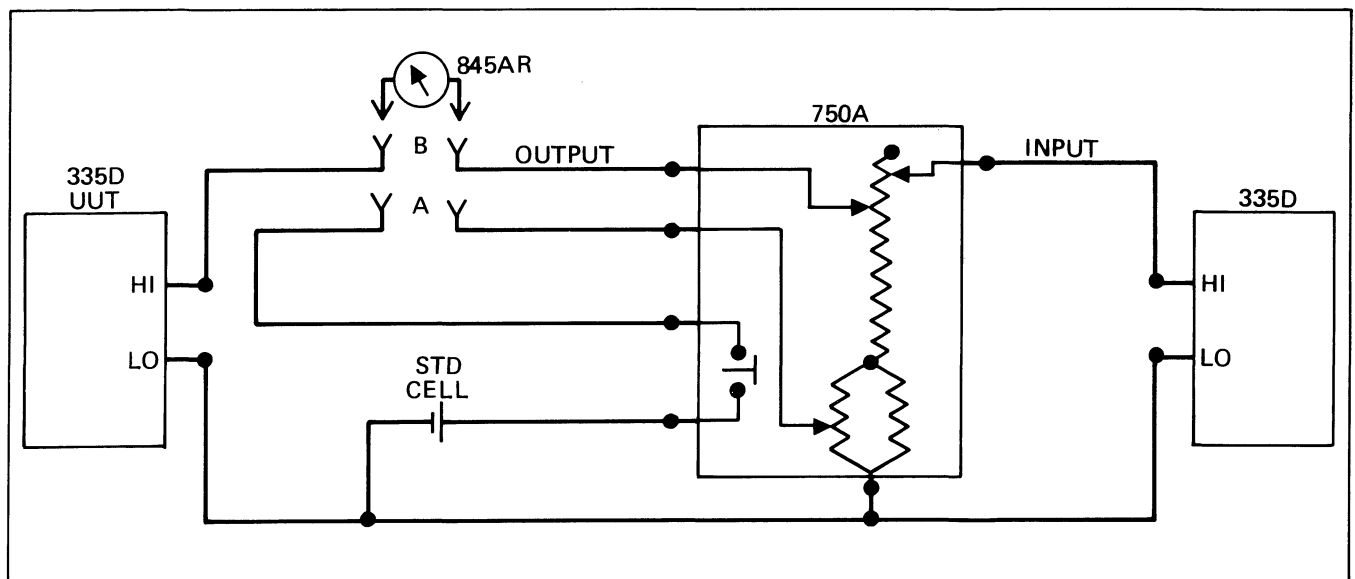


Figure 4-12. Equipment Connections for Range Calibration Checks

Table 4-10. Final Range Calibration

STEP	750A SETTING OUTPUT	UUT RANGE	UUT READOUT SETTING	RANGE CAL POT NULL ADJUSTMENT	845AR NULL
1	1000V	1000V	1000.0000	1000V Cal	$\pm 5 \mu\text{V}$
2	100V	100V	100.00000	100V Cal	$\pm 5 \mu\text{V}$
3	10V	10V	10.000000	10V Cal	$\pm 5 \mu\text{V}$

4-94. Calibration Check**WARNING**

DURING THIS PROCEDURE, HIGH VOLTAGE IS PRESENT AT THE TERMINALS OF ALL TEST EQUIPMENT EXCEPT THE STANDARD CELL. CONTACT WITH HIGH VOLTAGE MUST BE AVOIDED.

1. Perform steps 1, 2, and 3 of Final RANGE Calibration.
2. Standardize the voltage reference as often as necessary (Final RANGE Calibration, step 3).
3. Perform the checks in Table 4-11, by setting the instruments as specified in each step and checking the specified tolerance against the 845AR null indicator.

4-95. TROUBLESHOOTING**4-96. Introduction**

4-97. The two best aids to troubleshooting the 335D are a logical, technically trained mind and a thorough knowledge of the instrument functions and theory of operation. It is recommended that Section 3 be reviewed prior to troubleshooting the instrument.

4-98. The Troubleshooting Procedures are divided into four parts. The first part details troubleshooting procedures peculiar to this instrument. The second part is a fault isolation guide for use when the instrument will not turn on or will not remain in operation, Table 4-12. The third part is a fault isolation guide for the Voltage Standard functions, Table 4-13. The fourth part is a fault isolation guide for the Voltmeter/Null Detector functions, Table 4-14.

4-99. If the instrument is operational, both the Performance Test, and Calibration are useful in isolating the problem area. Use instrument symptoms to determine which procedures should be performed. Table 4-2, lists the procedures that comprise the Performance Test and gives a functional description of each. Table 4-15, lists the Calibration procedures and gives a functional description of each.

Table 4-11. Control Settings and Tolerances for Calibration Check

STEP	750A SETTING		UUT		
	INPUT	OUTPUT	RANGE	DIAL SETTING	TOLERANCE
1	1100	5	10V	5.000000	$\pm 60 \mu\text{V}$
2	1100	10	10V	10.000000	$\pm 110 \mu\text{V}$
3	1100	5	100V	05.00000	$\pm 70 \mu\text{V}$
4	1100	10	100V	10.00000	$\pm 120 \mu\text{V}$
5	1100	50	100V	50.00000	$\pm 520 \mu\text{V}$
6	1100	100	100V	100.00000	$\pm 1020 \mu\text{V}$
7	1100	5	1000V	005.0000	$\pm 275 \mu\text{V}$
8	1100	10	1000V	010.0000	$\pm 350 \mu\text{V}$
9	1100	50	1000V	050.0000	$\pm 950 \mu\text{V}$
10	1100	100	1000V	100.0000	$\pm 1700 \mu\text{V}$
11	1100	500	1000V	500.0000	$\pm 7.7 \text{ mV}$
12	1100	1000	1000V	1000.000	$\pm 15.2 \text{ mV}$
13	1100	1100	1000V	10X0.0000	$\pm 16.7 \text{ mV}$
14	1100	1100	1000V	1099.999X	$\pm 16.7 \text{ mV}$

Table 4-12. Power-Up Fault Isolation

STEP NO.	INSTRUCTION	YES	NO	GOTO
1	Does OPERATE indicator light when POWER switch is place in OPERATE?	x	x	2 1a
1a	Proceed to Troubleshooting part 3 or 4 as indicated.			
2	Is the CURRENT LIMIT indicator lit?	x	x	3 8
3	Are the CURRENT LIMIT, TRIP, and VERNIER settings correct?	x	x	5 4
4	Set the CURRENT LIMIT, TRIP, and VERNIER to the proper setting as indicated.			1
5	Is the Pre-Regulator PCB Assembly A8A2 humming loudly? R8 burning nicely?	x	x	6 7
6	Crowbar relay is stuck. Troubleshoot and repair.			1
7	Troubleshoot and repair problem pcb board or boards.			1
8	Does a separate voltmeter read an approximately correct reading across the OUTPUT terminals?	x	x	9 12
9	Is the voltage across DS4, the OPERATE indicator, 25V dc?	x	x	10 11
10	Replace DS4.			1
11	Wring out wiring to DS4.			1
12	Is main power fuse, F2, blown?	x	x	13 38
13	Is the high voltage fuse, F1, blown?	x	x	14 16
14	Replace F1 and F2.			15
15	Have you been here before?	x	x	18 1
16	Replace F2.			17
17	Have you been here before?	x	x	31 1
18	Does a visual inspection of T1, T2, A8 or A8A1 show any problems?	x	x	19 20
19	Troubleshoot and repair.			1
20	Remove A8A1, replace F1 and F2. Do they still blow?	x	x	22 21
21	Troubleshoot and repair the Pre-Regulator Assembly.			1
22	Is there a short between T1, pins 25 and 26?	x	x	23 26

Table 4-12. Power-Up Fault Isolation (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
23	Remove the wires to T1, pins 25 and 26. Is the short still there?	x	x	24 25
24	Replace T1.			1
25	Wring out wiring harness. Repair as necessary.			1
26	Is there a short between T2, pins 4 and 5?	x	x	28 27
27	Troubleshoot and repair the Hi Voltage Motherboard PCB Assembly A8 and associated wiring.			1
28	Remove the wires to T2, pins 4 and 5. Is the short still there?	x	x	30 29
29	Wring out the wiring and reapi as necessary.			1
30	Replace T2.			1
31	Does a visual inspection of T1, A5A5, A5A6, A6A1, A7, A8A1, or A8A2 show any problem?	x	x	32 33
32	Troubleshoot and repair.			1
33	Remove the PCB Assemblies A5A5, A5A6, A6A1, A7, A8A1, and A8A2 from the instrument.			34
34	Replace the boards one at a time, the A8A2 (Pre-Regulator) last. Does fuse F2 blow on any board?	x	x	35 1
35	Remove that board and continue replacing the boards. Set aside any boards that blow fuse F2. Troubleshoot and repair as indicated. (Remember that the diodes in the bridge or the filter elements are the most likely problem.)			1
36	Is the High voltage fuse, F1, blown?	x	x	37 38
37	Replace F1.			15
38	Is the voltage at A8A2 pin 6 0V dc?	x	x	40 39
39	Check the instrument interlock switches and board seating.			1
40	Is the voltage at pin 10 on the Series Pass Driver PCB Assembly A5A2 -24V dc to -35V dc?	x	x	41 42
41	Troubleshoot and repair as necessary.			
42	Remove the Time Delay PCB Assembly A7. Is A5A2 pin 10 -24V dc to -35V dc?	x	x	43 44
43	Troubleshoot and repair the A7 Time Delay Assembly.			1
44	Is the voltage between pins 5 and 9 on the Series Pass Driver PCB Assembly A5A2 -35V dc?	x	x	45 46
45	Troubleshoot and repair the Series Pass Driver Assembly.			1

Table 4-12. Power-Up Fault Isolation (cont)

STEP NO.	INSTRUCTION	YES	NO	GOTO
46	Is the voltage between pins 1 and 13 on the Current Limiter PCB Assembly A5A6 —35V dc?	x	x	47 48
47	Open circuit on the Main Motherboard PCB Assembly A5. Troubleshoot and repair as indicated.			1
48	Is the voltage between pins 7 and 13 on the Current Limiter PCB Assembly A5A6 44V ac?	x	x	49 50
49	Troubleshoot and repair the Current Limiter Assembly.			1
50	Is the voltage between pins 1/2 and 3/4 on T1 115V ac?	x	x	51 54
51	Is the voltage between pins 21 and 20, 21 and 22 on T1 both 44V ac?	x	x	52 53
52	Wring out the wiring between T1 and A5. Repair as necessart.			1
53	Replace T1.			1
54	Is the voltage between S1a (STDBY terminal) S1b (STDBY/RESET terminal) 115V ac?	x	x	55 56
55	Wring out wiring between S1 and T1. Repair as necessary.			1
56	Is the voltage between arm of S1a and arm of S1b 115V ac?	x	x	57 58
57	Replace S1.			1
58	Is the voltage between arm of S1b and fuse F2 115V ac?	x	x	59 60
59	Wring out wiring between S1b arm and F2. Repair as necessary.			1
60	Disconnect the power cord. Is the resistance across the terminals of F2 very near zero?	x	x	62 61
61	Troubleshoot and repair the fuse holder area.			1
62	Check power cord for open/short. Repair as necessary.			1
63	If this still does not solve your porblem. . .			41

Table 4-13. Voltage Standard Fault Isolation

STEP NO.	INSTRUCTION	YES	NO	GOTO
A	No OUTPUT			1
B	Loss of control of OUTPUT OUTPUT wanders OUTPUT has 1-5 Hz oscillation Meter pegs on voltage scale			14 12 26
C	Fails Load Regulation Check			14
D	Fails Ripple Check			14
E	Fails Accuracy Check			27
F	Won't Calibrate			28
G	Has storage problem — too long settling time when switching from 1000V RANGE to 100V or 10V RANGES.			29
1	Will the instrument go into OPERATE?	x	x	3 2
2	Exit this procedure go to the Power-Up Fault Isolation Procedure.			
3	Is the Pre-Regulator PCB Assy humming (buzzing) loudly? Is R8 burning nicely?	x	x	4 5
4	Crowbar circuit is on continuously. Troubleshoot and repair.	x	x	7 6
5	Will the instrument pass the Auxiliary Power Supply checks?	x	x	7 6
6	Troubleshoot and repair as indicated.			A
7	Is there voltage present at pin 11 on the Series Pass Element PCB Assy A8A1?	x	x	9 8
8	Troubleshoot and repair A8, A8A2, or A8A1 as indicated.			A
9	Is there any voltage between the —OUTPUT terminal and the CR9-CR10 junction on the Hi Voltage Motherboard PCB Assy A8?	x	x	10 11
10	A8K1 is open. Troubleshoot and repair as indicated.			A
11	Is the +OUTPUT voltage present at pin 5/10 on the Series Pass Element PCB Assy A8A1?	x	1 x	12 13
12	Troubleshoot and repair wiring and circuitry between the A8A1 board and the +OUTPUT terminal?			A
13	Troubleshoot and repair the Series Pass Element.			A
14	Perform the Chopper Drive and Compensation Adjustment Procedure. Can these adjustments be made?	x	x	B 15
15	Troubleshoot and repair the Chopper Amplifier PCB Assy A5A4.			B
16	Will the instrument pass the Auxiliary Supply Voltage checks?	x	x	18 17

Table 4-13. Voltage Standard Fault Isolation (cont)

STEP NO.	INSTRUCTION	YES	NO	GOTO
17	Troubleshoot and repair as indicated.			B
18	Will the instrument pass the Chopper Amplifier Alignment Check?	x	x	19 14
19	Will the instrument pass the Unijunction Oscillator check?	x	x	21 20
20	Troubleshoot and repair as indicated.			B
21	Will the instrument pass the Pre-Regulator check?	x	x	23 22
22	Troubleshoot and repair as indicated.			B
23	Will the instrument pass the Series Pass Element check?	x	x	25 24
24	Troubleshoot and repair as indicated.			B
25	Troubleshoot and repair as necessary.			
26	Troubleshoot Q1 circuit on Differential Amplifier PCB Assy A5A3.			B
27	Will instrument calibrate?	x	x	E F
28	Troubleshoot and repair section indicated by failure of calibration. Recalibrate.			
29	Are A1C1, A1C2, C4, and C5 all right?	x	x	31 30
30	Replace as necessary.			
31	Check cables connecting the RANGE switch, Differential Amplifier Assembly and A1C1, A1C2, C4, and C5. Repair or replace as necessary.			

Table 4-14. Voltmeter-Null Detector Fault Isolation

STEP NO.	INSTRUCTION	YES	NO	GOTO
A	Photo Modulator inoperative (lights out).	x		1
B	Meter movement inoperative.	x		4
C	Meter pegs or wanders.	x		9
D	Erratic or unstable condition while zeroing or measuring voltage.	x		34
E	Meter deflects in one direction only.	x		36
F	Slower response in negative direction.	x		37
G	Measurements low on high sensitivity.	x		38
H	Poor stability.	x		39
I	Noise on 10 uV position of the SENSITIVITY switch.	x		40
J	Unguarded leakage poor.	x		45
K	Guarded leakage poor.	x		48
L	Poor overload.	x		52
1	Is there a squarewave of 200 volts peak-to-peak or over between pin 1 on J1 and pin 6 on T1 on the Null Detector Power Supply PCB Assy A6A1?	x	x	3 2
2	Troubleshoot T1 and its associated drive circuitry.			A
3	Troubleshoot DS1 and DS2 and associated circuitry on the Null Detector Power Supply PCB Assy.			A
4	Does panel meter peg when checked with an ohmmeter?	x	x	6 5
5	Replace meter.			B
6	On the Null Detector Power Supply PCB Assy A6A1. Measure the voltage at pin 2 and pin 3. Are both near zero?	x		7
	Is one near zero and the other O.K.?	x		8
7	Troubleshoot T1 and associated circuitry.			B
8	Troubleshoot the associated diode and capacitor.			B
9	Is the meter movement mechanically stuck?	x	x	10 11
10	"Unstuck" it and check for proper operation — the meter may have to be replaced.			C
11	Connect a DC coupled oscilloscope to the Emitter of Q6 on the Null Detector Amplifier PCB Assy A6A2. (For connections, refer to Figure 4-13). Short INPUT SENSITIVITY switch to 10 uV position.			
12	Adjusting the ZERO control to the positions indicated in Figure 4-14, does the waveform(s) on the oscilloscope:			
	a. Agree with Figure 4-14?	x		13
	b. Look more like waveform in Figure 4-15?	x		14
	c. Look like a squarewave?	x		16

Table 4-14. Voltmeter-Null Detector Fault Isolation (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
	d. No change when ZERO control is rotated?	x		15
	e. No signal?	x		28
	f. None of the above?	x		33
13	Troubleshoot Q7, Q8, Q9, Q10, Q11, Q12, and associated circuitry.			C
14	Troubleshoot Q6 and associated circuitry for open.			C
15	Troubleshoot for shorts R1, base Q1, V1, or V2.			C
16	Connect the oscilloscope to the collector of Q5 with conditions as indicated in the Figure 4-15. (Refer to Figure 4-13 for oscilloscope connections.) Does squarewave disappear and waveform appear as in Figure 4-15.	x	x	17 18
17	Troubleshoot C12 for shorted condition.			C
18	Remove Q4 and connect oscilloscope to the collector of Q3 (For connections, refer to Figure 4-13.) Set controls for condition indicated in Figure 4-16. Does oscilloscope display appear as in Figure 4-16?	x	x	19 20
19	Troubleshoot Q4, Q5.			C
20	Is display a squarewave or even close?	x	x	21 33
21	Short the base of Q1 to common. Does the squarewave disappear?	x	x	23 22
22	Troubleshoot Q1.			
23	Remove short in 21 and place it from common to the junction of V1, C4, and R4. Does the squarewave disappear?	x	x	25 33
24	Troubleshoot photocells, C4 and associated circuitry.			C
25	Remove short in step 23 and place it from common to the junction of R1 and the SENSITIVITY switch. Does the squarewave disappear?	x	x	26 27
26	Replace SENSITIVITY switch. Remove the short in step 25.			C
27	Troubleshoot CR1 and CR2. Remove the short in step 25.			C
28	Is there a signal at the collector of Q5?	x	x	30 29
29	Troubleshoot Q6 for a short.			C
30	Is there a signal at the collector of Q3?	x	x	31 32
31	Troubleshoot Q4 and associated circuitry.			C
32	Troubleshoot Q1, Q2, Q3, CR5, C7 and associated circuitry.			C
33	Troubleshoot and repair as necessary.			
34	Most probable cause is S6 erratic contact. Clean contacts with crocus cloth. Does condition clear?	x	x	D 35

Table 4-14. Voltmeter-Null Detector Fault Isolation (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
35	Replace S6.			D
36	Troubleshoot on the Null Detector Power Supply PCB Assy A6A1, T2, Q3, Q4, Q5, Q6, and associated circuitry.			E
37	Leaky C6 on the Null Detector Power Supply PCB Assy A6A1. Test and replace as indicated.			F
38	Troubleshoot C17 and C18 on the Null Detector Power Supply PCB Assy A6A1 for shorted condition. Replace as necessary.			G
39	On the Null Detector Power Supply PCB Assy A6A1, CR5 defective. Replace as necessary.			H
40	Connect oscilloscope at collector of Q3. Short the INPUT terminals and the ZERO control switch. SENSITIVITY on the 10 uV position. Does the oscilloscope display appear as in Figure 4-17?	x	x	42 41
41	Troubleshoot Q1 and Q2 and their associated circuitry for defects or dirty contacts on Q1 or Q2.			I
42	Connects oscilloscope to emitter of Q3. Remove short across INPUT terminals and apply 10 mV. SENSITIVITY still in the 10 uV position. Compare the oscilloscope display to Figure 4-18: a. Is there excessive noise? b. Is the signal shape correct, but too small in amplitude? c. None of the above?	x x x		43 44 33
43	Check positioning of neon lamps.			I
44	Check photocells for slow response. Replace if necessary.			I
45	Are the grommets dirty on the Null Detector Power Supply PCB Assy A6A1?	x	x	46 47
46	Clean grommets.			J
47	Check for leakage in T1 or T2 on the Null Detector Power Supply PCB Assy A6A1. Replace as necessary.			J
48	Clean binding posts on the Null Detector Power Supply PCB Assy A6A1.			49
49	On the Null Detector Power Supply PCB Assy A6A1, are any of the pins on T1 to T2 touching the circuit board?	x	x	50 51
50	Correct the condition.			K
51	Check T1 and T2 on the Null Detector Power Supply PCB Assy A6A1 for leakage.			K
52	On the Null Detector Power Supply PCB Assy A6A1, test and replace as necessary R1, CR1, CR2, C2, C3, or C4 and associated circuitry.			L

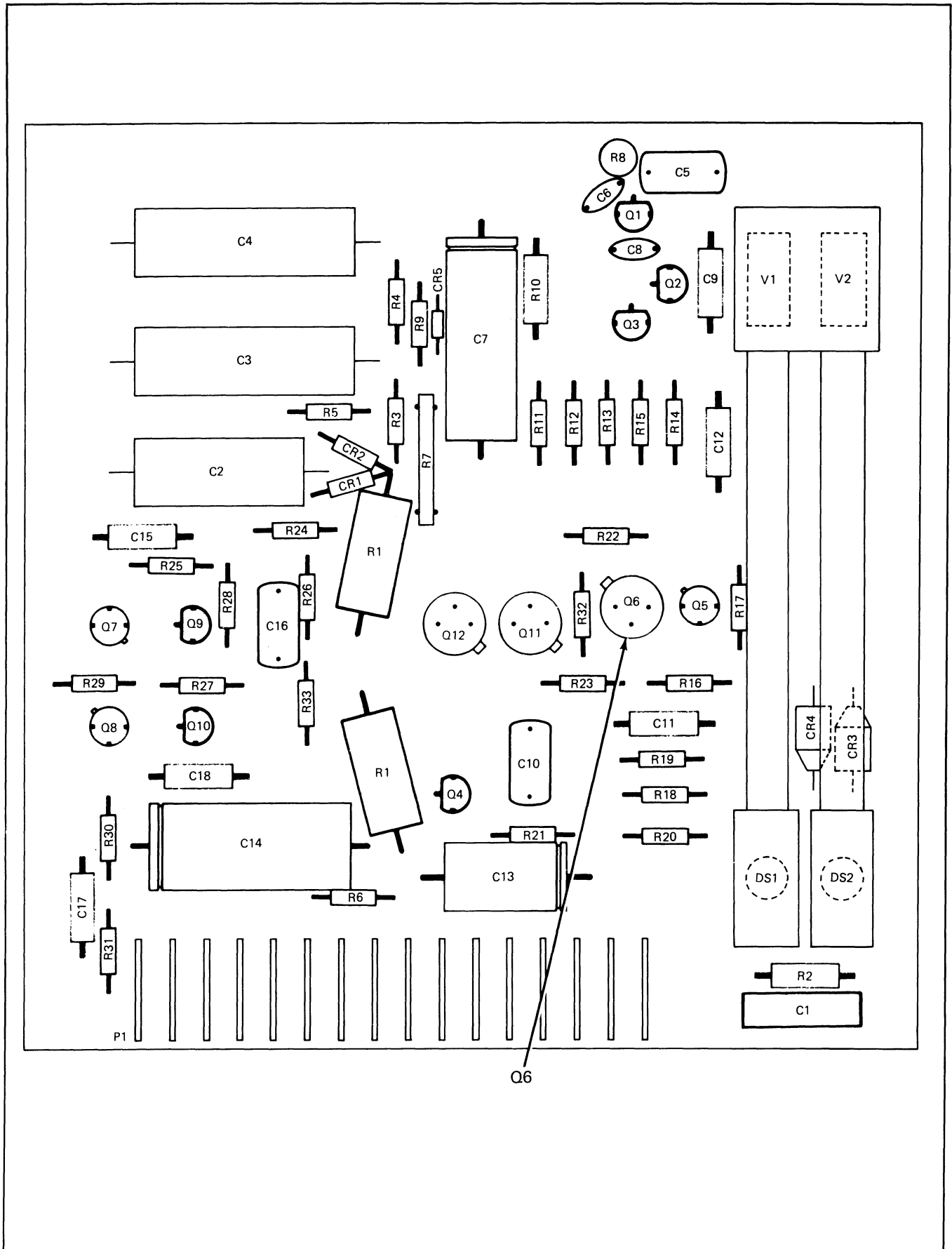
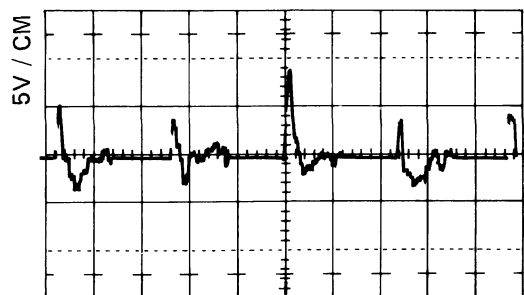
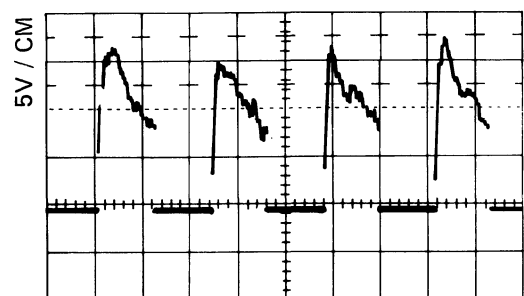


Figure 4-13. Null Detector Amp Test Point

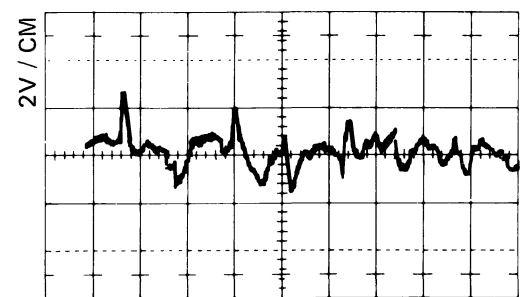


5MS / CM
INPUT SHORTED- ZERO CONTROL CENTERED



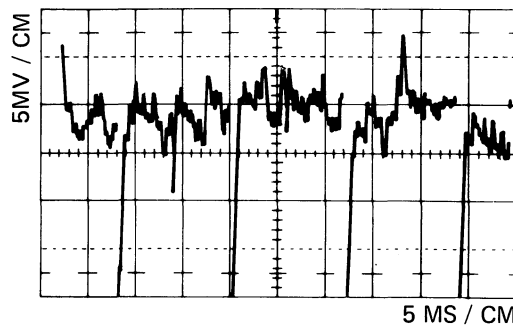
5MS / CM
INPUT SHORTED- ZERO CONTROL
FULLY CLOCKWISE- SENSITIVITY 10 μ V

Figure 4-14. Waveforms at Emitter of Q6



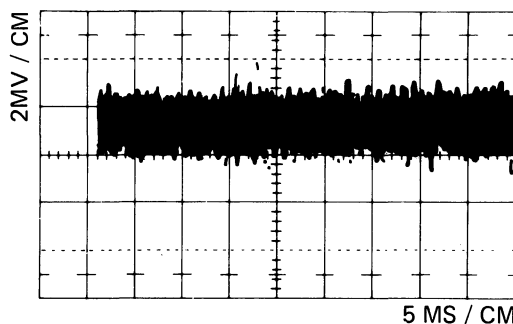
5MS / CM
INPUT SHORTED- ZERO CONTROL
CENTERED- SENSITIVITY 10 μ V

Figure 4-15. Waveform at Collector of Q5



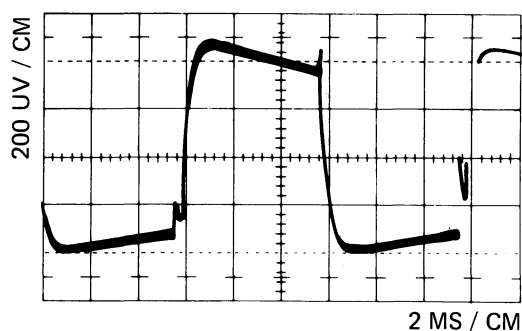
5 MS / CM
INPUT SHORTED-ZERO CONTROL CENTERED-
Q4 REMOVED- SENSITIVITY 10 μ V

Figure 4-16. Waveform at Collector of Q3-Q4 Removed



5 MS / CM
INPUT SHORTED- ZERO CONTROL SHORTED-
SENSITIVITY 10 μ V

Figure 4-17. Waveform at Collector of Q3



2 MS / CM
INPUT OF 10 MV ON 10 μ V RANGE

Figure 4-18. Waveform at Emitter of Q3

Table 4-15. Listing of Calibration Procedures

PROCEDURE		DESCRIPTION
PRECALIBRATION	Auxiliary Power Supply	Checks and adjusts if necessary, the auxiliary power supply voltages and checks stability of the output for variations in line voltage.
	Chopper Drive and Compensation Adjustment	Sets Chopper Amplifier circuitry for proper operation.
	Current Limit	Sets up the Current Limit Adjust range
	Output Current Monitor	Sets up Current Monitor on all ranges.
	Voltage Trip	Sets up the voltage trip circuitry and insures that the circuitry is enabled during overvoltage conditions in each range.
	Master Reference	Sets up the Master Reference voltage.
CALIBRATION	Zero Output Adjust	Sets the zero output level for all ranges.
	Sample String Linearization/Range Cal. circuitry adjust	Aligns the Sample String and Range Cal pots as a unit divider network.
	Final Range Calibration and Calibration Check	Fine aligns the Range Cal circuitry and checks the unit for proper voltages out in each range.

4-100. Resistance Measurements

4-101. These checks verify correct output resistances of the auxiliary power supplies and correct gross resistance of the Sample String.

1. Disconnect the instrument power plug from ac power. Disengage the chassis from the case by loosening the two Dzus fasteners on the rear of the instrument. Slide the unit out of the case and remove the top inner cover. This will open interlock.

2. Remove the Pre-Regulator PCB Assembly A8A2.

3. Set the front panel controls as follows:

POWER	OFF
METER	V
VOLTAGE RANGE	100V
TRIP	1000V
VERNIER	Fully Clockwise (CW)
CURRENT LIMIT	Fully Clockwise (CW)
Readout Dials	50.00000

4. Auxiliary Power Supply output resistance check. Measure the resistance between the test points indicated in Table 4-16 and +SENSE terminal. Extend the indicated PCB Assemblies on the extender board provided.

5. Sample String gross resistance check.

- a. Disconnect the shorting links between the SENSE AND OUTPUT terminals.

- b. Remove the Differential Amplifier PCB Assembly A5A3.

- c. Measure the resistance between pin 5 of the Differential Amplifier socket and -SENSE terminal. The ohmmeter should indicate less than 0.5 ohm.

- d. Leaving the ohmmeter connected as in step c above, step each dial through its range. The level of each increment is listed in Table 4-17. Return each dial to zero after checkout.

NOTE

This check detects gross errors only, such as an open resistor. Resistors are factory selected for accuracy and temperature coefficient.

6. Reconnect the links between the SENSE and OUTPUT terminals.
7. Replace the Differential Amplifier and Pre-Regulator Assemblies.

Table 4-16. Auxiliary Power Supply Output Resistances

ASSEMBLY	PIN	RESISTANCE (APPROX)
Auxiliary Power Supply	9	8.4 kilohms
Auxiliary Power Supply	10	2.1 kilohms
Current Limiter	1	6.0 kilohms
Current Limiter	3	3.0 kilohms

Table 4-17. Sample String Resistance Increments

READOUT DIALS	RESISTANCE INCREASE OHMS PER STEP
Seventh	0.1
Sixth	1.0
Fifth	10
Fourth	100
Third	1000
Second	10,000
First	100,000

4-102. Standby Power

4-103. This check measures power consumption in the STDBY/RESET mode. It reveals possible gross faults such as wiring errors or shorted components in the auxiliary power supply, voltage control circuitry and protection circuitry. A metered Variac and differential voltmeter are required for this test.

1. Remove the top inner cover if not already accomplished.
2. Remove the Pre-Regulator PCB Assembly A8A2 if not already accomplished. Connect the instrument through a Variac to a 115 volt, 60 Hz, power line with a wattmeter or ammeter in series between the Variac and the

instrument. Set the Variac output to zero. Set the front panel controls as follows:

POWER	OFF
VOLTAGE RANGE	100
TRIP	1000
VERNIER	Maximum
	Clockwise
CURRENT LIMIT	Maximum
	Clockwise
Readout Dials	50.000000

3. Set the POWER switch to STDBY/RESET and slowly increase the output of the Variac to 115 volts. The CURRENT LIMIT and center decimal lights should come on and the time delay relay (A6-K2001) should operate. The wattmeter should indicate 30 to 40 watts power drain.

4-104. Auxiliary Supply Voltages

4-105. This procedure checks the output voltages, master reference voltage and series pass voltage of the Auxiliary Power Supply PCB Assembly A5A5.

1. Remove the top inner cover if not already accomplished.
2. Extend the Auxiliary Power Supply PCB Assembly A5A5 on the extender board provided.
3. Using the differential voltmeter measure between the test points listed in Table 4-6 and the +SENSE terminal which is common.
4. Where indicated, perform the adjustment to determine that it can be made.
5. Replace the Auxiliary Power Supply Assembly into the instrument.

4-106. Chopper Amplifier Alignment Check

4-107. This procedure checks the Chopper Amplifier for proper alignment. Improper alignment will result in loss of control of the output.

1. Remove the top inner cove if not already accomplished.
2. Set the POWER switch in the OFF position if not already accomplished.
3. Remove the Pre-Regulator PCB Assembly A8A2 if not already accomplished.

4. Set the POWER switch in the STDBY/RESET position.
5. Connect the oscilloscope to the positive side of C13 on the Chopper Amplifier Assembly PCB A5A4. Refer to Figure 4-7.
6. Set the oscilloscope sweep speed to 500 usec/CM and vertical sensitivity to 0.1V/CM, AC coupled input.
7. Set the instrument controls as follows:

Readout Dials	All Zeros
RANGE	10 volts
8. Set the POWER switch to the OPERATE position.
9. The waveform on the oscilloscope should appear as in Figure 4-10. If it does not, perform the Chopper Amplifier Calibration Procedure.
9. The positive pulses should disappear from the oscilloscope display.
10. Set the output of a laboratory power supply to 5.5V dc.
11. Connect the lab supply to the corresponding OUTPUT terminals of the 335D.
12. Set the 35D controls to the positions indicated in Table 4-18. Observe the display of the oscilloscope for the corresponding display of unijunction pulses.
13. Place the POWER switch in the OFF position.
14. Replace the Series Pass Element in the instrument.

Table 4-18. Unijunction Pulses

RANGE	DIALED VOLTAGE	UNIUNCTION PULSES
10V	5.000000	Should appear
10V	6.000000	Should disappear
100V	05.00000	Should appear
100V	06.00000	Should disappear
1000V	005.0000	Should appear
1000V	006.0000	Should disappear

4-108. Unijunction Oscillator

4-109. This procedure checks the operation of the unijunction oscillator and its output to the Pre-Regulator circuitry for error signal input conditions.

1. Remove the top inner cover if not already accomplished.
2. Place the POWER switch in the OFF position if not already accomplished.
3. Remove the Pre-Regulator PCB Assembly A8A2 on the extender board provided.
4. Extend the Series Pass Element PCB Assembly A8A1 on the extender board provided.
5. Connect the oscilloscope through a X10 probe to pin 15 of the Series Pass Element Assembly. Use pin 14 for probe ground. Set the oscilloscope sweep speed to 1 millisecond/cm and vertical sensitivity to 1 volt/cm.
6. Set the POWER switch to the STDBY/RESET position.
7. Positive pulses of 1.0 to 2.0 volts peak-to-peak should be observed on the oscilloscope.
8. Set the POWER switch to OPERATE.

4-110. Pre-Regulator

4-111. This check verifies operation of the Pre-Regulator circuitry Q1 through Q8.

1. Remove the top inner cover if not already accomplished.
2. Set the POWER switch in the OFF position if not already accomplished.
3. Replace the Pre-Regulator PCB Assembly A8A2, if not already in the instrument.
4. Set the instrument front panel controls as follows:

POWER	OFF
RANGE	1000
TRIP	1000
VERNIER	Fully Clockwise (CW)
CURRENT LIMIT	Fully Clockwise (CW)

WARNING

TO AVOID ELECTRICAL SHOCK USE A SCOPE CAPABLE OF MAKING DIFFERENTIAL MEASUREMENTS, I.E., MEASURING A FLOATING INPUT SIGNAL. DO NOT GROUND ANY OF THE MEASUREMENT POINTS SPECIFIED TO SCOPE CHASSIS (VIA THE LOW INPUT LEADS).

5. Connect the oscilloscope common to the emitter of Q1 and connect the input to the base (refer to Figure 4-19). Set the vertical input to dc, sweep speed to 1 millisecond/cm and the vertical sensitivity to 0.5 volt/cm.
6. Set the front panel controls as follows:

Readout Dials	50.0000
POWER	STDBY/RESET
7. The oscilloscope waveform should appear as in Figure 4-20.
8. Set the POWER switch in the ON position.
9. The oscilloscope waveform should appear as in Figure 4-21.
10. Set the POWER switch to STDBY/RESET.
11. Remove the oscilloscope connections.
12. Bypass the interlocks.
13. Set the POWER switch to the OPERATE position.
14. The voltmeter should indicate 50 ± 10 volts.
15. Set the RANGE switch to the 10 volt position.
16. The voltmeter should indicate 5 ± 1 volts.
17. Set the RANGE switch to 1000 volt position.
18. The voltmeter should indicate 500 ± 100 volts.
19. Set the POWER switch to the OFF position.
20. Using an X10 probe, connect the oscilloscope across the 50 watt zener diode on the Pre-Regulator Assembly (see Figure 4-19). Connect the probe to the cathode and probe common to the anode. Set oscilloscope sensitivity to 50V/cm and sweep speed to 2 ms/cm.
21. Connect the 335D through an auto-transformer to the ac power line.
22. Connect the Clarostat 240C resistance load box across the OUTPUT terminals of the 335D. Set the load for 20 k Ω .
23. Set the front panel controls as follows:

CURRENT LIMIT	60 mA
RANGE	1000V
Readout Dials	1100.000
POWER	OPERATE
24. Adjust the line voltage to 115V.
25. The oscilloscope waveform should appear as in Figure 4-22A, and should not exceed 150 volts peak.
26. Adjust line voltage to 100V ac.
27. The oscilloscope waveform should appear as in Figure 4-22B.
28. Adjust the line voltage to 130V ac.
29. The oscilloscope waveform should appear as in Figure 4-22C.
30. Set the POWER switch in the OFF position.
31. Remove the oscilloscope connection.
32. Remove the line isolator from the oscilloscope power cord.

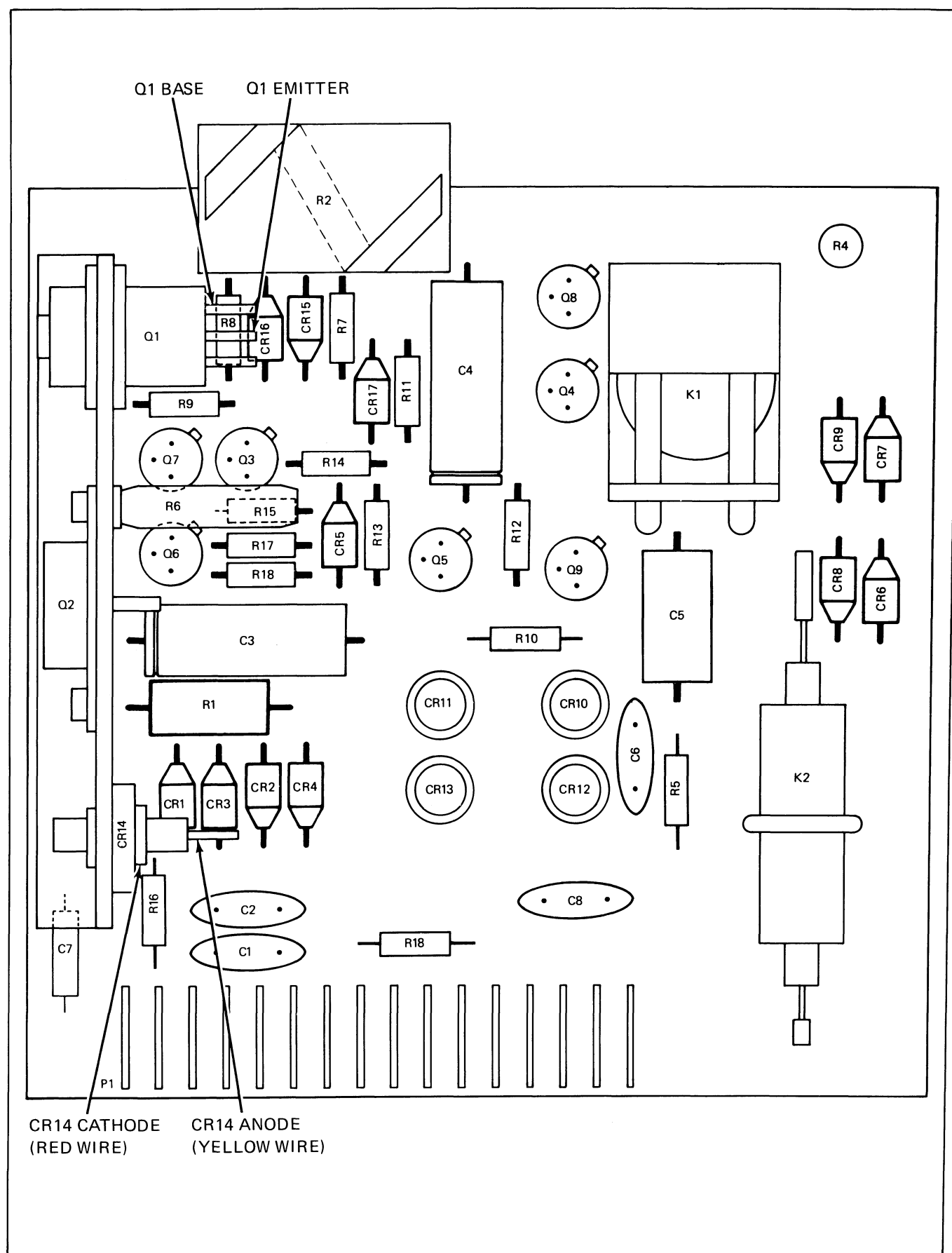


Figure 4-19. Pre-Regulator Test Points

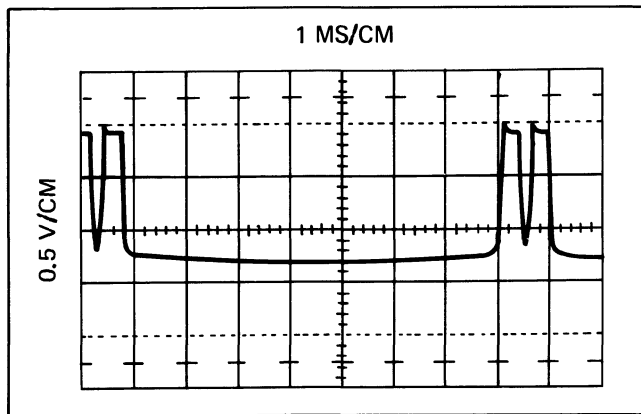


Figure 4-20. Pre-Regulator Q1 Waveform on STBY/RESET

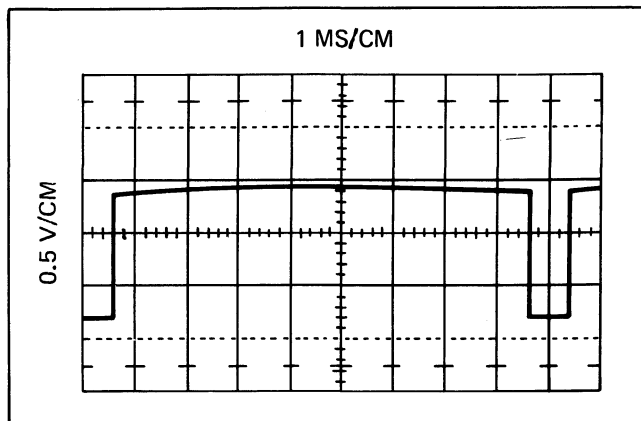


Figure 4-21. Pre-Regulator Q1 Waveform on OPR

4-112. Series Pass Element

4-113. This check verifies proper operation of the Series Pass Element PCB Assembly A8A1.

1. Set the POWER switch to the OFF position, if not already accomplished.
2. Remove the top inner cover, if not already accomplished.
3. Connect the 335D through an auto-transformer to the ac power line.
4. Connect a voltmeter between the collector of Q1 and the emitter of Q8 on the Series Pass Element. (Refer to Figure 4-23.)
5. Set the front panel controls as follows:

Readout Dials	All Zeros
RANGE	10V
6. Set the POWER to OPERATE.
7. Adjust input power to 100V ac.
8. The voltmeter should read no less than 2V dc between the points in step 4.

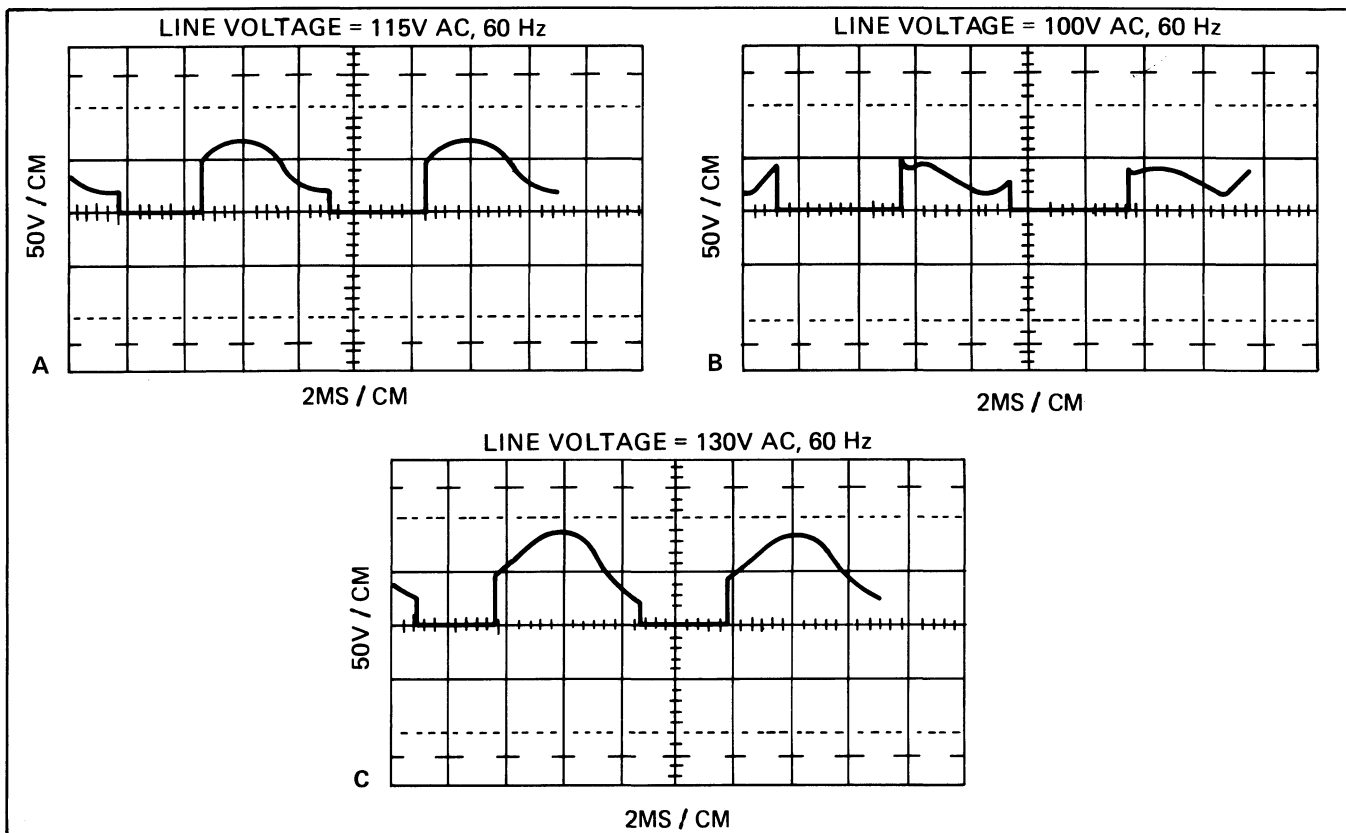


Figure 4-22. Waveforms Across Zener Diode CR14

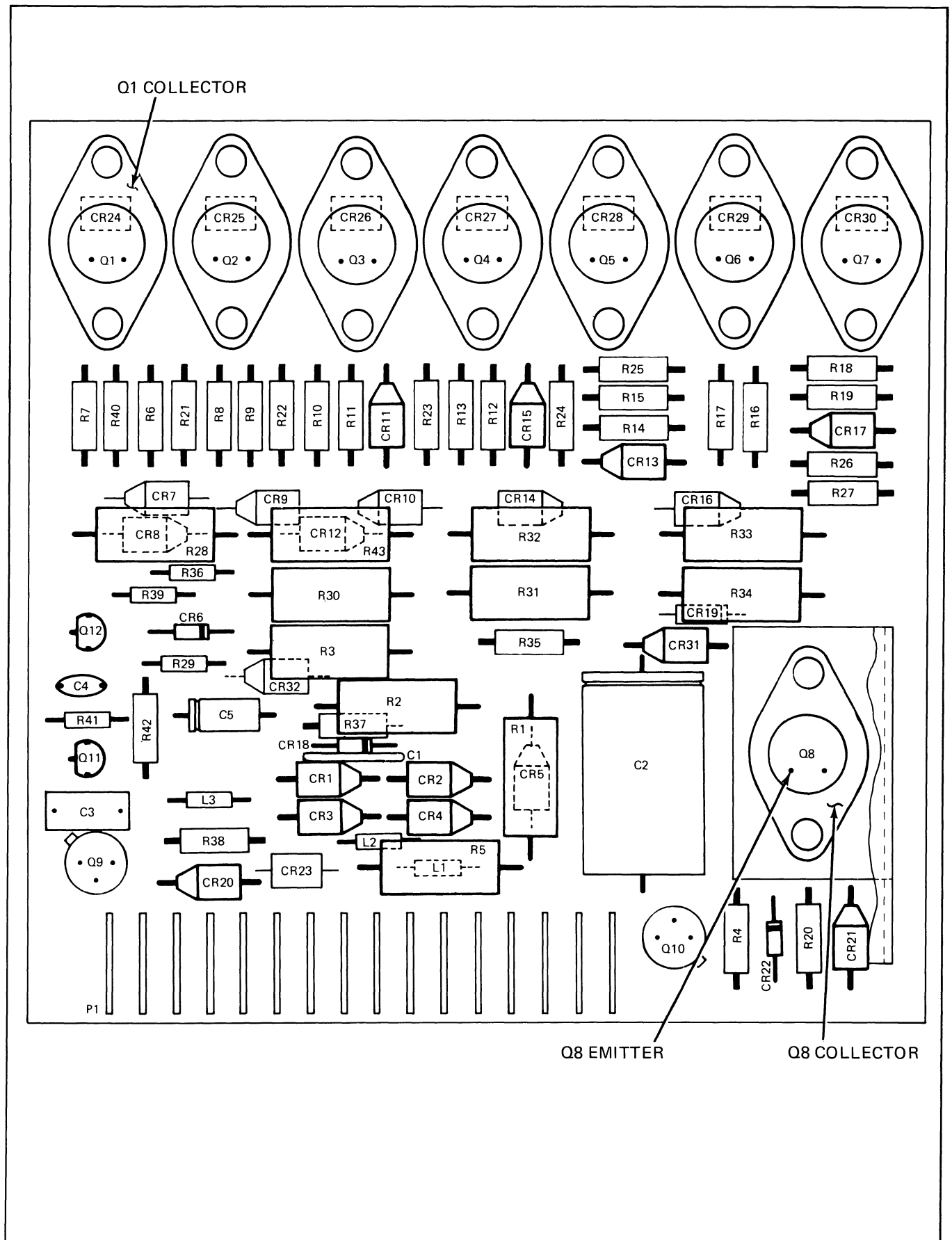


Figure 4-23. Series Pass Element Test Points

9. Set the POWER switch to the OFF position.
10. Connect the voltmeter between the collector and emitter of Q8.
11. Set the POWER switch to OPERATE.
12. Set the line voltage and instrument controls to the settings specified in Table 4-19 Section A. The voltage should be within the limits specified in Table 4-19 Section A.
13. Set the POWER switch to OFF.
14. Connect the Clarostat 240C resistance load box across the OUTPUT terminals of the 335D. Set the resistance box for as close to 18,333 ohms as possible.
15. Set the line voltage and instrument controls to the settings specified in Table 4-19, Section B. The voltage should be within the limits specified in Table 4-19, Section B.
16. Set the POWER switch to OFF.
17. Connect the voltmeter to the OUTPUT terminals.
18. Set the RANGE switch to 1000V.
19. Sequence the Readout Dials to 100V, 300V, 600V, 900V and 1100V settings.
20. At each position of the Readout Dials in step 19, short the OUTPUT terminals momentarily.
21. The output should return to normal upon removal of the short.

Table 4-19. Series Pass Element Voltage Checks

	RANGE	READOUT DIALS	LINE VOLTAGE	LOAD	VOLTAGE LIMITS ACROSS Q8	
					MIN	MAX
A	10	0	100	0	45	120
	10	0	130	0	45	120
B	1000	1100	100	18 - 1/3Ω	42	55
	1000	1199	130	18 - 1/3Ω	42	55

Section 5

List of Replaceable Parts

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5-15.	A6A1 Null Detector Power Supply PCB Assembly	5-36
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5-19.	A8A1 Series Pass Element PCB Assembly	5-45
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5-22.	A9 Extender PCB Assembly	5-51
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5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alphanumerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

- a. Reference Designation or Item Number.
- b. Description of each part.
- c. Fluke Stock Number.
- d. Federal Supply Code for Manufacturers.
- e. Manufacturer's Part Number or Type.
- f. Total Quantity per assembly or component.
- g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc, that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.

- h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the **FLUKE STOCK NUMBER**. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instruction, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

- a. Quantity
- b. **FLUKE** Stock Number
- c. Description
- d. Reference Designation or Item Number
- e. Printed Circuit Board Part Number and Rev. letter as printed in ink on the PCB.
- f. Instrument model and Serial number



CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. 335D Final Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CODE
	FINAL ASSEMBLY FIGURE 5-1	ORDER	MODEL	335D			
	FRONT END ASSY	ORDER	NEXT	HIGHER ASSY			
	FRONT PANEL ASSY	ORDER	NEXT	HIGHER ASSY			
	COVER, OUTER, ASSY	ORDER	NEXT	HIGHER ASSY			
	CHASSIS, FAB ASSY	ORDER	NEXT	HIGHER ASSY			
A3	CAPACITOR SWITCH PCB ASSY	227603	89536	227603	1		
A5	MAIN MOTHER BOARD PCB ASSY	219230	89536	219230	1		
A5A1	REFERENCE SUPPLY PCB ASSY	467514	89536	467514	1		
A5A2	SERIES PASS DRIVER PCB ASSY	354258	89536	254258	1		
A5A3	DIFFERENTIAL AMP PCB ASSY	219162	89536	219162	1		
A5A4	CHOPPER AMP PCB ASSY	251918	89536	251918	1		
A5A5	AUX PS PCB ASSY	219188	89536	219188	1		
A5A6	CURRENT LIMITER PCB ASSY	354266	89536	354266	1		
A6	ISOLATED MOTHER BOARD PCB ASSY	219147	89536	219147	1		
A6A1	NULL DET PS PCB ASSY	219121	89536	219121	1		
A6A2	NULL DET AMP PCB ASSY	219139	89536	219239	1		
A7	TIME DELAY PCB ASSY	192260	89536	192260	1		
A8	HIGH VOLTAGE MOTHER BOARD PCB ASSY	219220	89536	219220	1		
A8A1	SERIES PASS ELEMENT PCB ASSY	314823	89536	314823	1		
A9	EXTENDER PCB ASSY	187344	89536	187344	1		
C3	CAP, CER, 0.005UF, 3000V	188003	71590	2DDH6R502M	1		
C4	CAP, PLOY, .1UF, 1500V	234260	96733	C-60232A	1		
C5	CAP, PLOY, .1UF, 1500V	393850	02799	P1407	1		
C6	CAP, CER, .1UF, 300V	320275	89536	320275	2		
C7	CAP, CER, .1UF, 300V	320275	89536	320275	REF		
C8	CAP, TA, 10UF, 15V	160259	56289	150D103X9020B	1		
C9	CAP, FILM, .47UF, 250V	184366	89536	184366	1		
CR1	DIODE	116111	05277	1N4817	1		
CR2	DIODE	112383	05277	1N4822	2		
CR3	DIODE	112383	05277	1N4822	REF		
F1	FUSE, HIGH VOLTAGE, 1/4A-SB	166306	71400	MDL1-4	1		
F2	FUSE, MAIN PWR, 3A-SB, 115VAC OPER OR	109280	71400	MDL3	1		
	FUSE, MAIN PWR, 1-1/2A-SB, 230V OPER	109231	71400	MDX1-1/2	1		
H1	SCREW, TH, SHT MTL, #6B	156489	89536	156489	19		
H2	NUT, HEX	110532	73734	8011	14		
H3	WASHER, FLAT	110262	81349	AN960-10L	8		
H4	WASHER, SPLIT	111484	73734	1362	8		
H5	CLAMP, CABLE	100081	95987	3-8 3NA	4		
H6	CLAMP, CABLE	103796	89536	103796	1		
H7	WASHER, FLAT #6	110270	89536	110270	9		
H8	WASHER, LOCK, #6	110338	89536	110338	2		
H9	SCREW, SEMS, 6-32 X 1/4	114124	89536	114124	10		
H10	SCREW, SMS, 6-32 X 5/8	225482	89536	225482	5		
H11	WASHER, LOCK	129957	78189	1220-05	2		
H12	SCREW, SET, PHP, 6-32 X 5/8	129866	89536	129866	5		
H13	SCREW, PHP, 6-32 X 5/8	152181	89536	152181	2		
H14	SCREW, SMS, 6-32 X 3/8	156489	89536	156489	11		
H15	SPACER, 5/32	157792	89536	157792	2		
H16	SCREW, SEMS, 6-32 X 1/4	178533	89536	178533	4		
H17	BUSHING AND NUT	101600	16258	700-1	1		
H18	NUT, HEX, 6-32	110569	73734	70206	2		
H19	CLAMP, CABLE (NOT SHOWN)	104638	06383	SSC-2	2		
H20	WASHER, LOCK, #6 (NOT SHOWN)	110692	89536	110692	2		
H21	SCREW, PHP, 6-32 X 3/8 (NOT SHOWN)	152165	89536	152165	2		
H22	SCREW, PHP, 6-32 X 1/2	152173	89536	152173	3		

Table 5-1. 335D Final Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
H23	SPACER	157792	89536	157792	3		
H24	SPEEDNUT	156497	78553	C8097-6-67	22		
H25	LUG, SOLDER	101055	79963	9	1		
H26	LUG, SOLDER, BUTTERFLY	101014	79963	123	1		
H27	LUG, SOLDER	101048	89536	101048	3		
H28	WASHER, FLAT	110007	81349	AN960-616L	1		
H29	SOLDER, LUG, POT GND	169763	89536	169763	1		
H30	SPACER, NYLON	102665	89536	102665	4		
H31	WASHER, FIBER	130021	76854	348	4		
H32	SCREW, RHP, 4-40 X 3/4	115063	89536	115063	4		
H33	BUSHING STRAIN RELIEF	101162	18520	SA-5P-4	1		
H34	BUSHING, SNAP	102996	28520	SB-375-4	2		
H35	BUSHING, SNAP, 1/2"OD	104620	28520	SB-500-6	5		
H36	WASHER, LOCK, #10	110312	89536	110312	6		
H37	WASHER, LOCK	110395	89536	110395	6		
H38	NUT, HEX	110635	89536	110635	8		
H39	WASHER, FLAT	110775	89536	110775	8		
H40	WASHER, LOCK	111070	89536	111070	1		
H41	SCREW, RHP, 4-40 X 1-1/4	114918	89536	114918	2		
H42	SCREW, SEMS, 4-40 X 1/4	178533	89536	178533	4		
H43	SCREW, RHP, 8-32 X 1/4	228890	89536	228890	1		
H44	LUG, SOLDER	101055	89536	101055	2		
H45	SCREW, SEMS	185918	89536	185918	2		
J10	POST, BINDING, BLACK	149864	32767	BHB-10208-G21	1		
J11	POST, BINDING, RED	149856	32767	BHB-10208-G22	2		
K1	RELAY	148940	89536	148940	1		
MP2	DECAL 335A-2043 (NOT SHOWN)	227629	89536	227629	1		
MP3	DECAL, WIRED FOR 115VAC (NOT SHOWN)	176941	89536	176941	1		
MP4	DECAL ACCES COVER	268128	89536	268128	1		
MP5	SHIELD, XFMR	227009	89536	227009	1		
MP6	NAMEPLATE	393975	89536	393975	1		
MP7	DECAL, CAUTION	236968	89536	236968	1		
MP8	COVER, INNER TOP, SCREENED	314880	89536	314880	1		
MP9	COVER, BOTTOM	226829	89536	226829	1		
MP10	SHAFT, PWR SW	186858	89536	186858	1		
MP11	COUPLING	198374	89536	198374	1		
MP12	SHAFT, EXT, LEXAN	200592	89536	200592	1		
MP13	TOGGLE, LINK, 335A-2005	224832	89536	224832	1		
MP14	TOGGLE ARM 335A-2006	224857	89536	224857	2		
MP15	SPRING	160788	72792	S5A-250	2		
MP16	STANDOFF	159967	98291	013-3013-000-689	5		
MP17	EXTENDER, MTG BKT (NOT SHOWN)	186486	89536	186486	1		
MP18	PLATE, RETAINER (NOT SHOWN)	186585	89536	186585	2		
MP19	BULKHEAD, FRONT	224899	89536	224899	1		
MP20	BULKHEAD, CENTER	224915	89536	224915	1		
MP21	BULKHEAD, REAR	224931	89536	224931	1		
MP22	PLATE, FUSE MTG	224998	89536	224998	1		
MP23	BRACKET, PCB SLIDE	226852	89536	226852	1		
MP24	BRACKET, XFMR MTG (NOT SHOWN)	226860	89536	226860	1		
MP25	BRACKET, XFMR, MTG	226910	89536	226910	1		
MP26	CHASSIS SLIDE	224956	89536	224956	2		
MP27	SPRING, CONTACT	240960	89536	240960	1		
MP28	PLUG, INSERT	187799	82240	8-2328	12		
MP29	LIFTER, RELAY CONTACTS	159976	89536	159976	1		
R25	RES, COMP, 1K +/-10%, 1/2W	108536	01121	EB1021	1		
R26	RES, WW, 500 +/-3%, 25W	183533	89536	183533	1		1
R27	RES, PWR, WW, 100K, 10W	177121	89536	177121	2		1
R28	RES, PWR, WW, 100K, 10W	177121	89536	177121	REF		

Table 5-1. 335D Final Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R29	RES, VAR, 10K +/-20%, 1/2W	162800	89536	162800	1	1	
R30	RES, COMP, 47K +/-10%, 1/2W	108381	01121	EB4731	1		
S1A	SWITCH, WAFER, STANDBY	187864	89536	187864	1		
S1B	SWITCH, WAFER, POWER	187872	76854	248214-HC	1		
S7	SWITCH, INTERLOCK	187708	91929	V3L-78	2		
S8	SWITCH, INTERLOCK	187708	91929	V3L-78	REF		
T1	TRANSFORMER, MAIN POWER	222315	89536	222315	1		
T2	TRANSFORMER, HIGH VOLTAGE	222307	89536	222307	1		
TE1	TERMINAL STRIP	102533	89536	102533	1		
W1	LINE CORD SET	102822	89536	102822	1		
XF1	HOLDER, FUSE	160846	75915	342004	2		
XF2	HOLDER, FUSE	160846	75915	342004	REF		

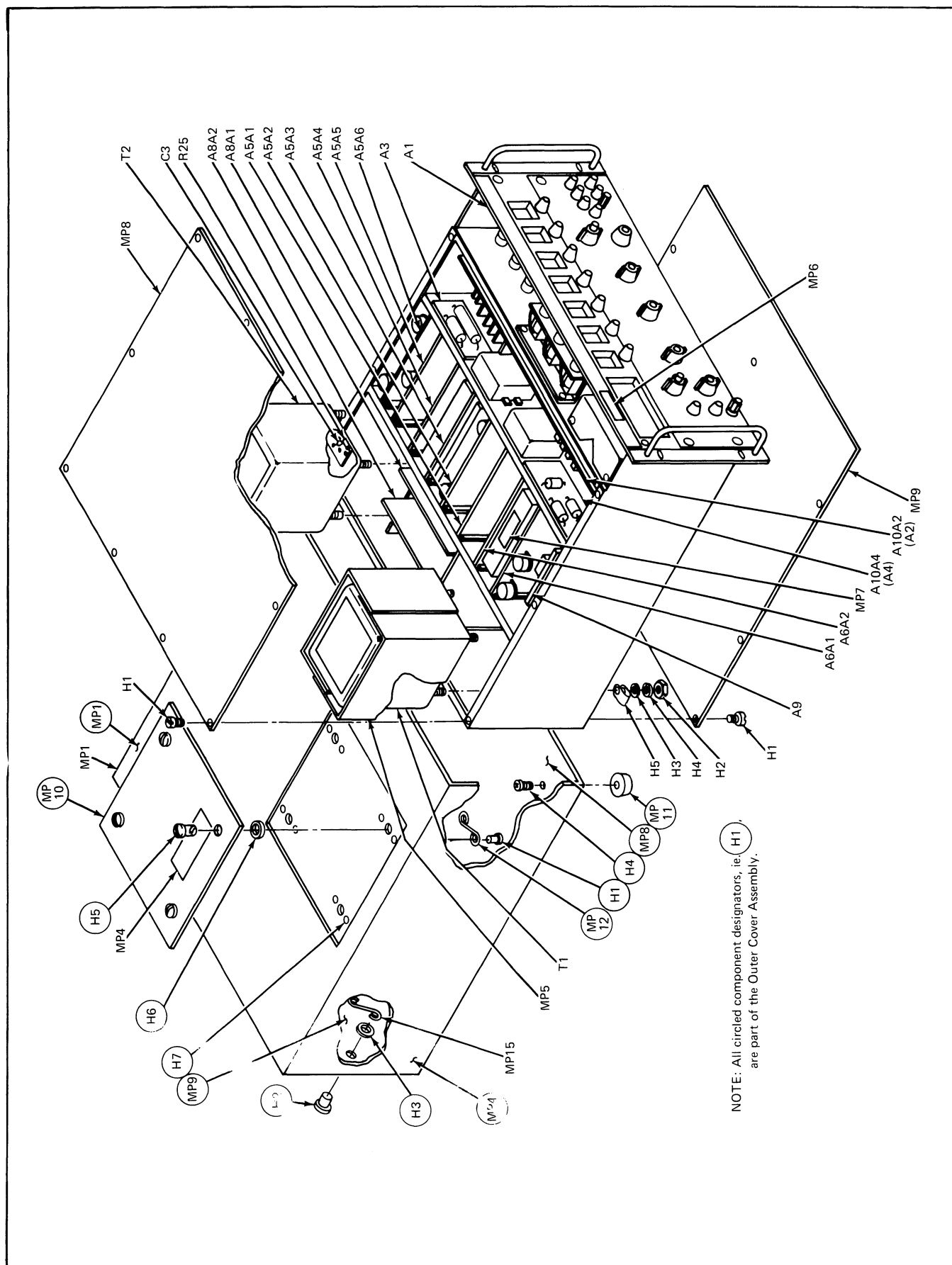


Figure 5-1. 335D Final Assembly

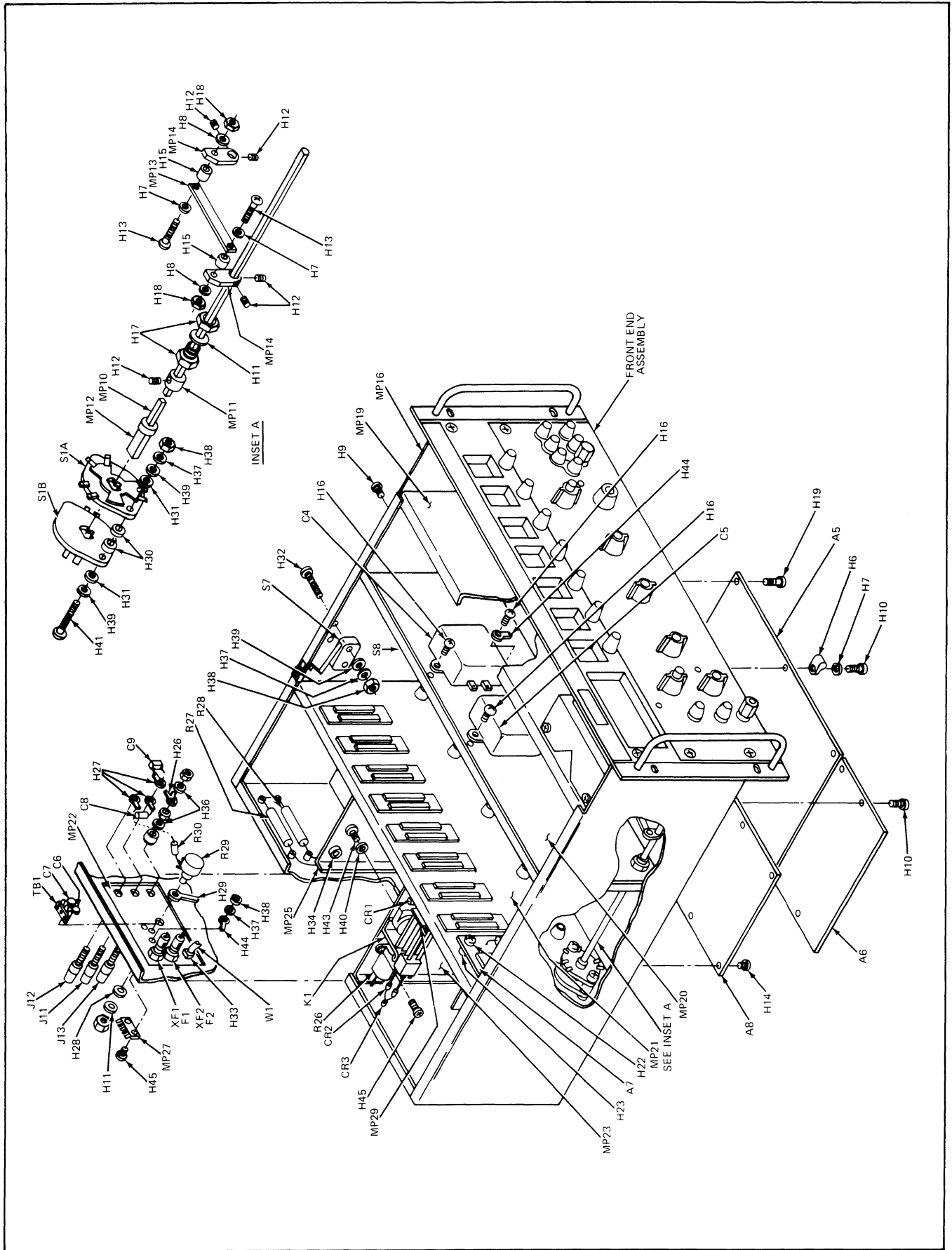


Figure 5-1. 335D Final Assembly (cont)

Table 5-2. 335D Front End Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A12	FRONT END ASSY	ORDER	NEXT	HIGHER ASSY			
	FIGURE 5-2 (335B-4079)	A12AOA					
	FRONT PANEL ASSY	ORDER	NEXT	HIGHER ASSY			
A10	MATCHED PCB SET ASSY	314997	89536	314997	1		
C1	CAP, OIL, 4MF, 1200V	183541	01884	QMLE405K12	1		
C2	CAP, .01UF, 1600V	106930	71590	DD16-103	1		
H1	NUT, SPEED, TINNEMAN	156497	78553	C8097-6-67	2		
H2	STANDOFF, TEFLON	161976	98291	013-3013-000-689	2		
H3	BUSHING, SNAP, 3/8 " ID	104620	28520	SB-500-6	4		
H4	SCREW, SEMS, 8-32 X 3/8	177022	89536	177022	13		
H5	SCREW, THP, 6-32 X 3/8	152165	89536	152165	7		
H6	CLAMP, CABLE	104406	06383	TA1S8	3		
H7	HOLDER, STRAP, PANDUIT	172080	06383	SST-1M	4		
H8	WASHER, LOCK, 3/8	129957	78189	1220-05	14		
H9	NUT, HEX	110510	73734	8009NP	14		
H10	SCREW, SET, 6-32 X 3/16	114991	89536	114991	44		
H11	CLAMP, CABLE (NOT SHOWN)	101345	95987	3-16-3NA	4		
H12	WASHER, FLAT, #4	110775	89536	110775	9		
H13	SCREW, SEMS, 4-40 X 1/4	185918	89536	189518	18		
H14	SPACER, LEXAN	200576	89536	20D576	9		
H16	LUG, SOLDER	101048	89536	101048	4		
H17	WASHER, LOCK, #4	110395	89536	110395	4		
H18	SCREW, SHT MTL, #6	156489	89536	156489	3		
H19	NUT, HEX, #4	184044	89536	184044	4		
H20	NUT, KEPS	152819	78189	511-061800-00	2		
H21	WASHER, FIBER	110684	83330	2166	10		
H22	SCREW, SET, 6-32	129866	89536	129866	34		
H23	SCREW, SET, 4-40	115105	89536	115105	4		
H24	BUSHING, NYLON	160507	96881	4L4-F	2		
H25	SCREW, 10-32	227157	89536	227157	2		
H26	SCREW, FHP, 10-32 X 3/4	114512	89536	114512	4		
H27	WASHER, MYLAR	240820	89536	240820	6		
M1	METER, API	218925	89536	218925	1		
MP1	CHANNEL ASSY, 335A-4080	227140	89536	227140	2		
MP2	BRACKET, SWITCH MOUNTING	226878	89536	226878	1		
MP3	DETENT, SAMPLE STRING	240887	89536	240887	7		
MP4	DETENT, PWR SWITCH	240895	89536	240895	1		
MP5	COUPLER	103838	89536	103838	11		
MP6	SHAFT, INSUL, 332A-251	186841	89536	186841	11		
MP7	SHAFT, EXT	240879	89536	240879	2		
MP8	COUPLER	246058	89536	246058	2		
MP9	BRACKET, METER	224808	89536	224808	1		
MP10	SHAFT, EXT, LEXAN	226779	89536	226779	7		
MP11	CLAMP, CAPACITOR	401182	89536	401182	1		
MP12	KNOB	158949	89536	158949	7		
MP13	KNOB, BAR	158956	89536	158956	4		
MP14	KNOB, BAR, CONCENTRIC	162347	89536	162347	2		
MP15	KNOB	190249	89536	190249	2		
MP16	ASSY, DIAL, 335A-2702	226985	89536	226985	6		
MP17	ASSY, DIAL, 335A-2703	226993	89536	226993	1		
MP18	KNOB, TRIM DISK	236950	89536	236950	2		
MP19	KNOB, VERNIER	241018	89536	241018	2		
R6	RES, Ww, 300 +/-10%, 2w	219741	11236	Aw2078	1	1	
S2	SWITCH, ASSY, RANGE	225052	89536	225052	1		
S3	SWITCH, ASS, TRIP	225078	89536	225078	1		
S4	SWITCH, ASSY, INPUT MODE	225060	89536	225060	1		
S5	SWITCH, ASSY, SENSITIVITY	225045	89536	225045	1		
S6	SWITCH, ASSY, POT, ZERO	225086	89536	225086	1		
W1	HARNESS, NULL DET (NOT SHOWN)	225094	89536	225094	1		
W2	HARNESS, FRONT (NOT SHOWN)	225102	89536	225102	1		

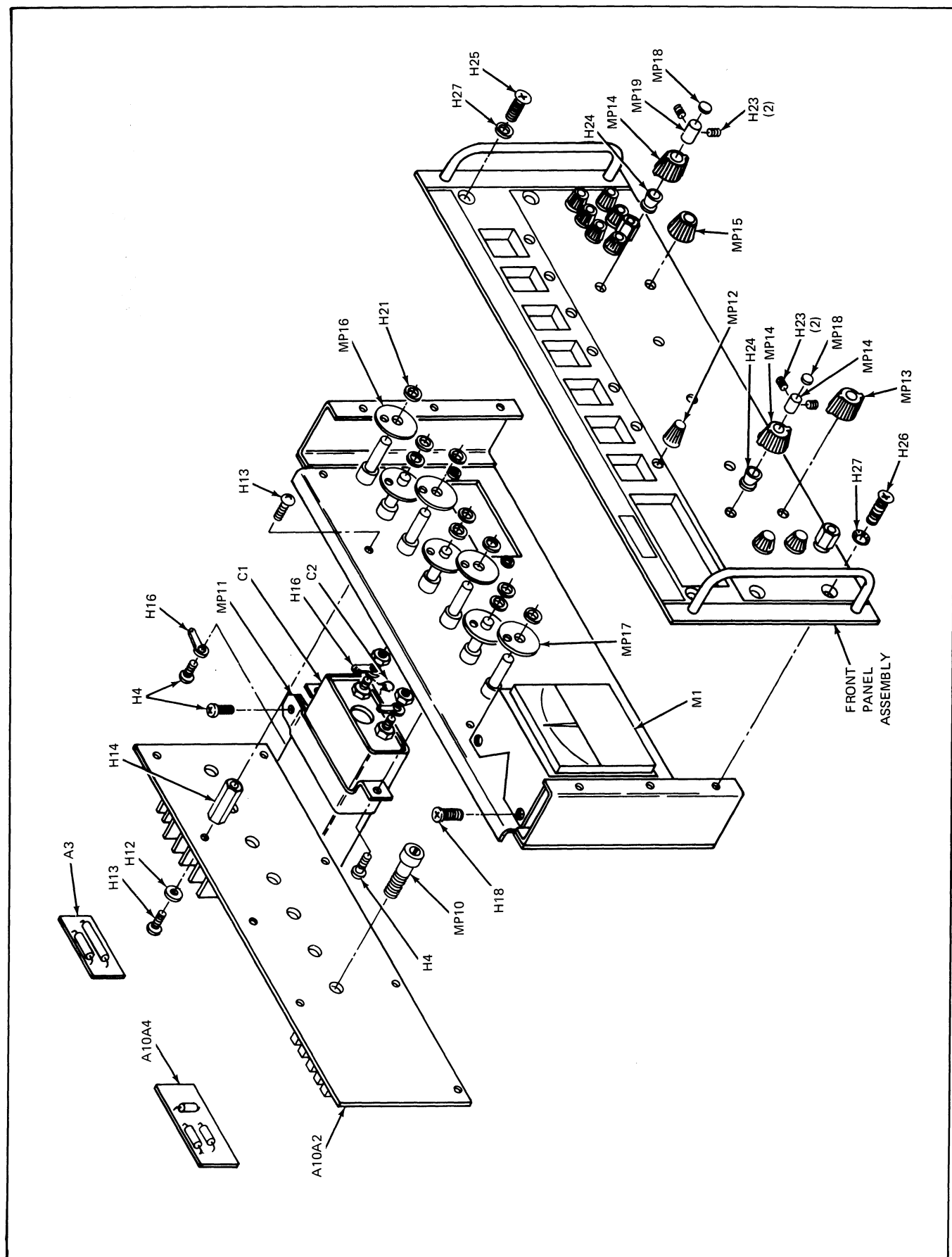


Figure 5-2. 335D Front End Assembly

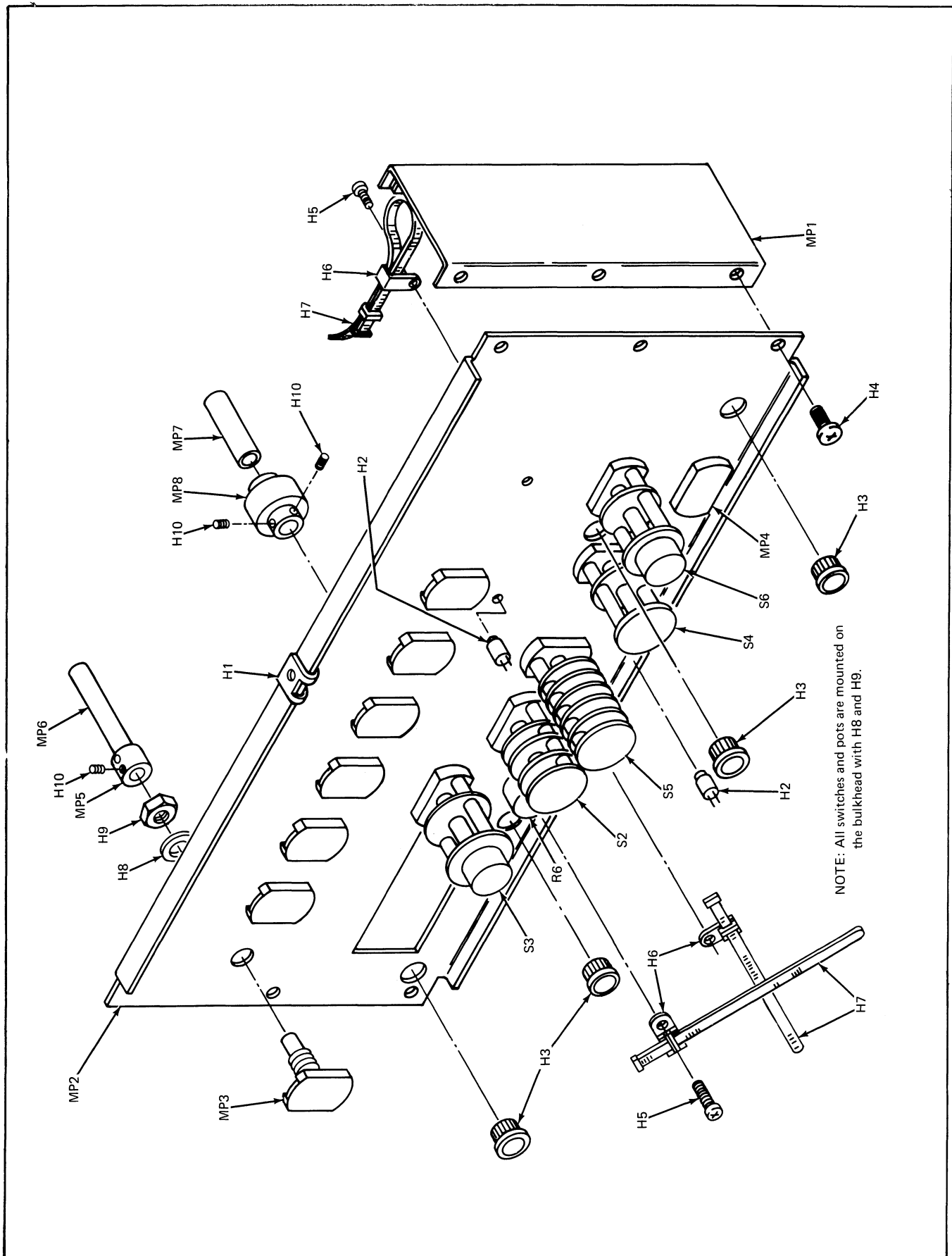


Figure 5-2. 335D Front End Assembly (cont)

Table 5-3. 335D Front Panel Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A12A1	FRONT PANEL ASSY FIGURE 5-3 (335A-4078)	ORDER	NEXT	HIGHER ASSY			
A1	CAPACITOR PCB ASSY	219212	89536	219212	1		
CR4	DIODE, LED	309617	07263	59NSL-5046NSC001	5		
CR5	DIODE, LED	309617	07263	59NSL-5046NSC001	REF		
CR6	DIODE, LED	309617	07263	59NSL-5046NSC001	REF		
CR7	DIODE, LED	309617	07263	59NSL-5046NSC001	REF		
CR8	DIODE, LED	309617	07263	59NSL-5046NSC001	REF		
H1	WASHER, LOICK, #10	201152	73734	30-151	2		
H2	WASHER, FLAT, #10	110262	81349	AN960-10L	3		
H3	WASHER, LOCK, #10	110312	89536	110312	3		
H4	NUT, HEX, 10-32	110536	89536	110536	1		
H6	WASHER, MYLAR, #10	197418	89536	197418	4		
H7	SCREW, FHP, 10-32X1 1/2	114520	89536	114520	4		
H8	LUG, SOLDER	101048	79963	46	1		
H9	HOLDER, CLIP	309625	07263	FUC001T	5		
J1	POST, BINDING, RED	149856	58474	BHB-10208-G22	4		
J2	POST, BINDING, BLACK	149864	58474	BHB-10208G21	2		
J3	POST, BINDING, RED	149856	58474	BHB-10208-G22	REF		
J4	POST, BINDING, BLACK	149864	58474	BHB-10208G21	REF		
J6	POST, BINDING, BLUE	233833	58474	DF3BLC	2		
J7	POST, BINDING, METALLIC	155911	58474	GP30NC	2		
J8	POST, BINDING, BLUE	233833	58474	DF3BLC	REF		
J9	POST, BINDING, METALLIC	155911	58474	GP30NC	REF		
J10	POST, BINDING, RED	149856	58474	BHB-10208-G22	REF		
J11	POST, BINDING, RED	149856	58474	BHB-10208-G22	REF		
MP1	PANEL, FRONT	ORDER	NEXT	HIGHER ASSY			
MP2	BEZEL, METER	222075	89536	222075	1		
MP3	BEZEL, READOUT	222042	89536	222042	7		
MP4	LINK, SENSE	101220	24655	0938-0712	1		
MP5	LINK, SENSE	190728	24655	0938-9503	2		
MP6	LINK, SENSE	190728	24655	0938-9503	REF		
MP7	HANDLE	101717	98278	1207	2		

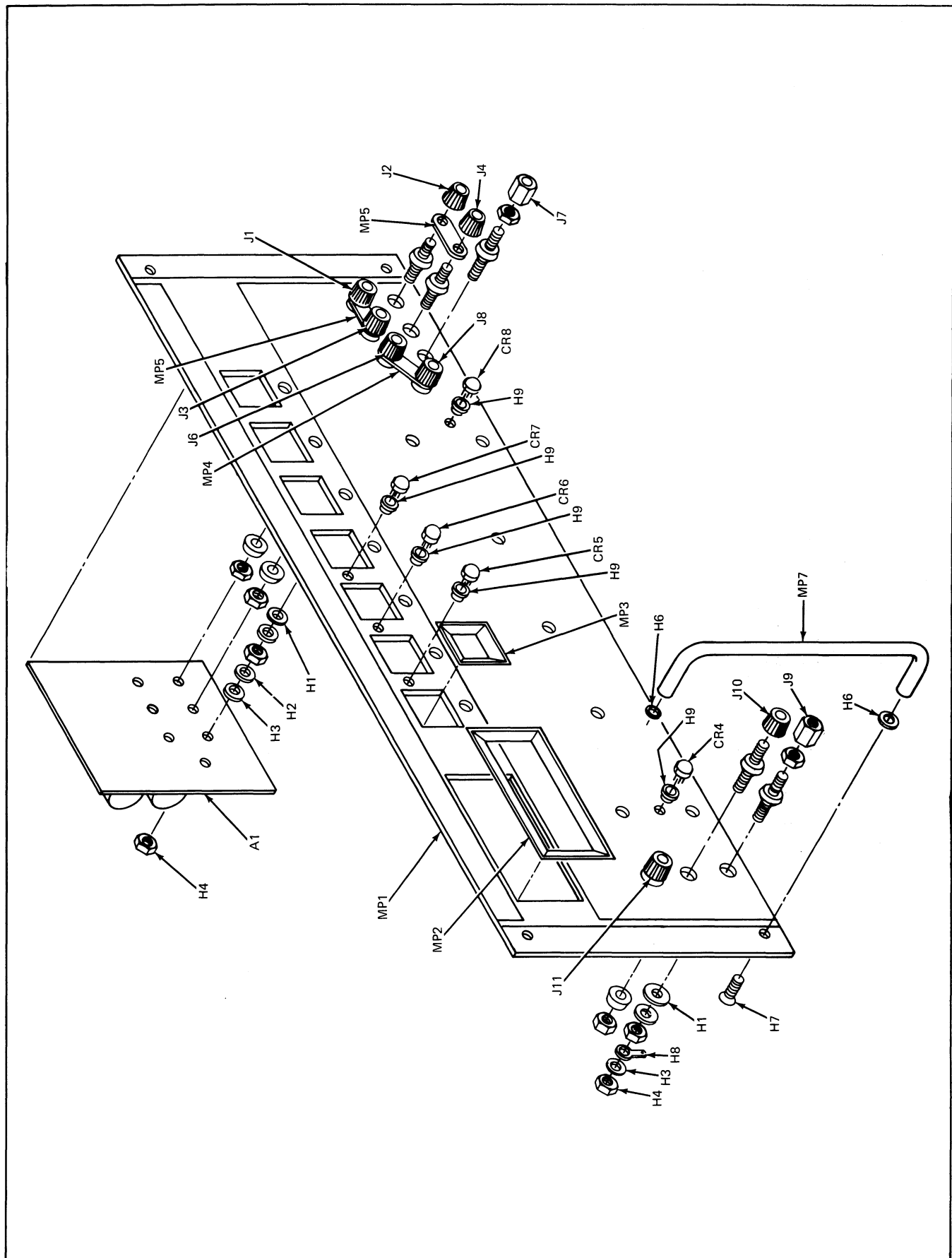


Figure 5-3. Front Panel Assembly

Table 5-4. 335D Outer Cover Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A13	OUTER COVER ASSY FIGURE 5-1 (COMPONENT LOCATORS CIRCLED)	ORDER	NEXT	HIGHER ASSY			
H1	RIVET	103606	12014	R3647X7-32	62		
H2	STUD, DZUS, 1/4 TURN	185447	72794	AJ5-70	2		
H3	RET, RING, DZUS	185454	72794	WA-516	2		
H4	SCREW, RHP, 8-32 X 3/8	114124	73734	19064	4		
H5	STUD, DZUS, 1/4 TURN	170563	72794	AJ3-25	4		
H6	RET, RING, DZUS	160770	89536	160770	4		
H7	EYELET	233664	61957	SE-35	8		
MP1	COVER, OUTER, TOP	ORDER	NEXT	HIGHER ASSY			
MP2	COVER, OUTER, REAR	ORDER	NEXT	HIGHER ASSY			
MP3	COVER, OUTER, BOTTOM	ORDER	NEXT	HIGHER ASSY			
MP4	COVER, OUTER, SIDE	ORDER	NEXT	HIGHER ASSY			
MP5	GUARD, LEFT SIDE	ORDER	NEXT	HIGHER ASSY			
MP6	GUARD, RIGHT SIDE	ORDER	NEXT	HIGHER ASSY			
MP7	GUARD, TOP	ORDER	NEXT	HIGHER ASSY			
MP8	GUARD, BOTTOM	ORDER	NEXT	HIGHER ASSY			
MP9	GUARD, REAR	ORDER	NEXT	HIGHER ASSY			
MP10	COVER, ACCESS	ORDER	NEXT	HIGHER ASSY			
MP11	FOOT, RUBBER	103309	77969	9102-W	4		
MP12	SPRING, DZUS	160788	72794	S3-175	4		

Table 5-5. A1 Capacitor PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	CAPACITOR PCB ASSY FIGURE 5-4 (335A-4062)	219212	89536	219212	REF		
C1	CAP, PLSTC, 1UF +/-20%, 200V	106450	89536	106450	2		
C2	CAP, PLSTC, 1UF +/-20%, 200V	106450	89536	106450	REF		
C3	CAP, PLSTC, 0.25UF +/-10%, 1200V	183616	89536	183616	2		
C4	CAP, PLSTC, 0.25UF +/-10%, 1200V	183616	89536	183616	REF		
CR1	DIODE, SI, 1 AMP, 100PIV	116111	05277	1N4817	2		
CR2	DIODE, SI, 1 AMP, 100PIV	116111	05277	1N4817	REF		
MP1	HOLDER, RUBBER, COMPONENT	104794	89536	104794	2		
MP2	TERMINAL	161976	89536	161976	3		

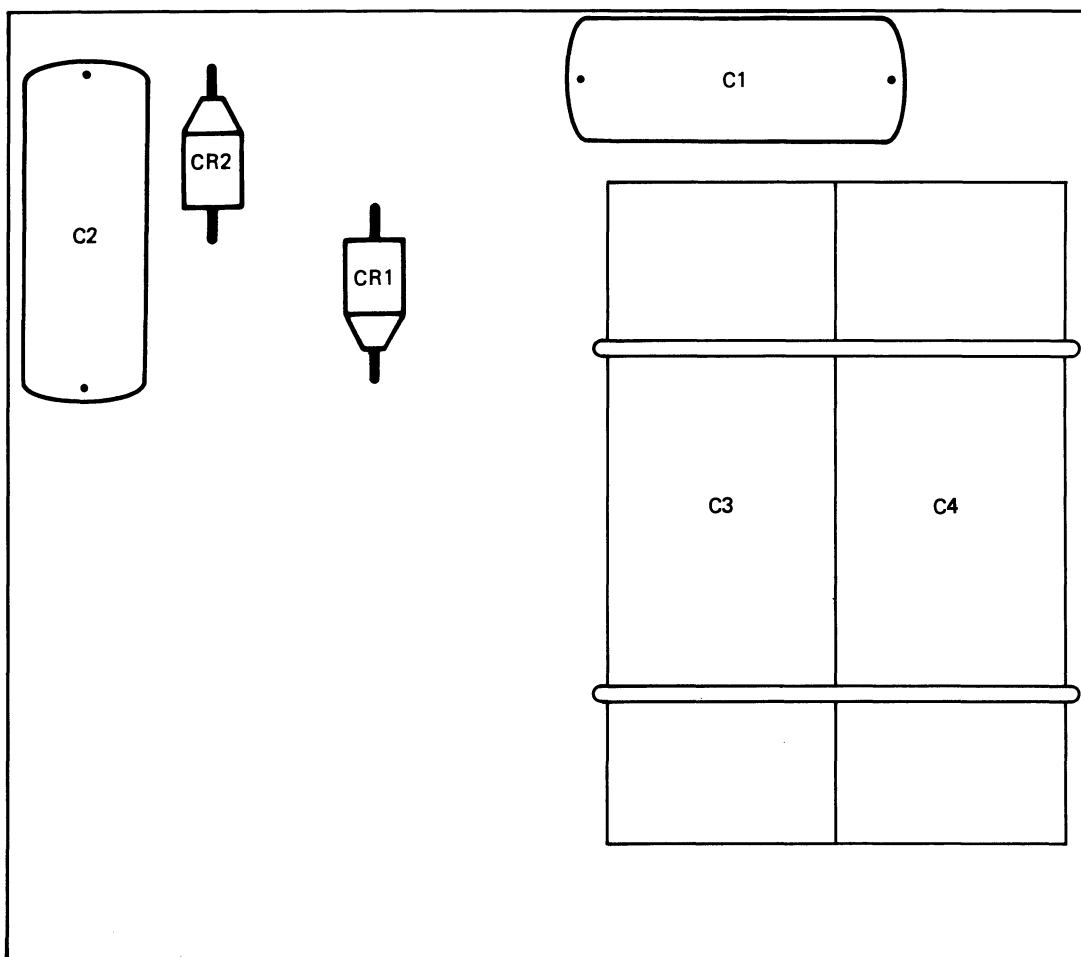


Figure 5-4. A1 Capacitor PCB Assembly

Table 5-6. A3 Capacitor Switch PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	CAPACITOR SWITCH PCB ASSY FIGURE 5-5 (335A-4092)	227603	89536	227603	REF		
C1	CAP, ELECT, 470UF +50/-10%, 25V	168153	80031	ET471X025A01	1		
CR1	DIODE, SILICON, 1 AMP, 100PIV	116111	05277	1N4817	1		
K1-1	RELAY, REED, 1000V	233916	89536	233916	1		
K1-2	COIL, REED, RELAY, 24V	186155	71707	SP-24-P	1		
Q1	XSTR, SI, NPN	203489	07910	CDQ10656	1		
R1	RES, COMP, 100 +/-10%, 1/2W	108100	01121	EB1011	2		
R2	RES, COMP, 15K +/-10%, 1/2W	108530	01121	EB1531	1		
R3	RES, COMP, 470 +/-10%, 1/2W	108415	01121	EB4711	1		
R4	RES, COMP, 10K +/-10%, 1/2W	108118	01121	EB1031	1		
R5	RES, COMP, 1K +/-10%, 1/2W	108563	01121	EB1021	1		
R6	RES, COMP, 100 +/-10%, 1/2W	108100	01121	EB1011	REF		
R7	RES, COMP, 39K +/-5%, 1W	236729	01121	GB3935	1		
XQ1	SOCKET, XSTR	104315	82305	14-47	1		

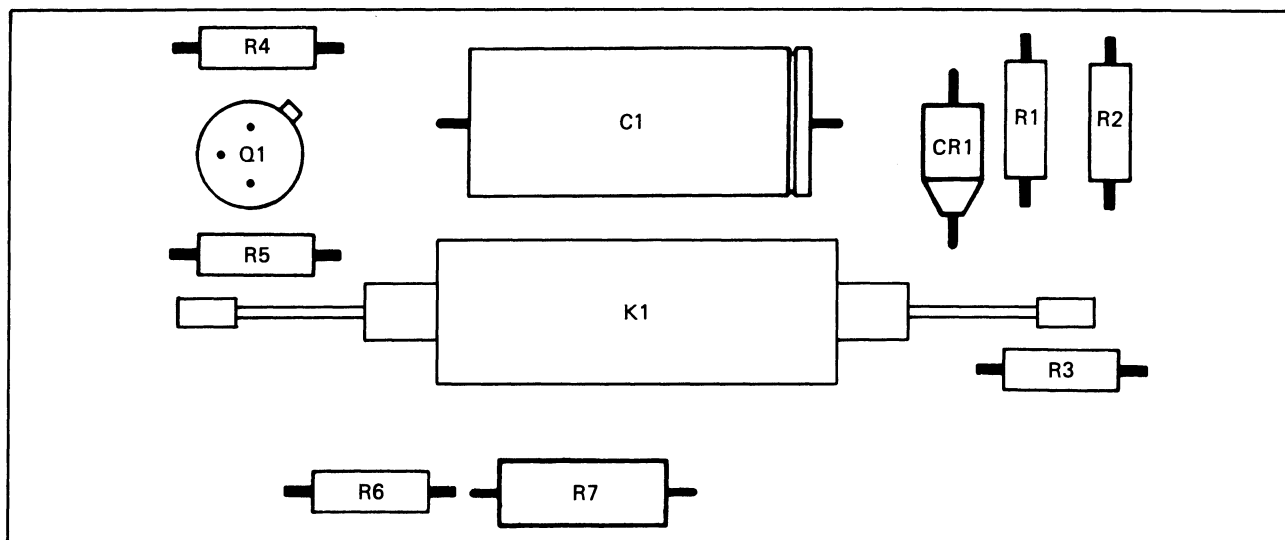


Figure 5-5. A3 Capacitor Switch PCB Assembly

Table 5-7. A5 Main Mother Board PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	MAIN MOTHER BOARD PCB ASSY FIGURE 5-6 (335A-4064)	219238	89536	219238	REF		
A5A1	REFERENCE SUPPLY PCB ASSY	314864	89536	314864	1		
A5A2	SERIES PASS DRIVER PCB ASSY	354258	89536	354258	1		
A5A3	DIFFERENTIAL AMP PCB ASSY	219162	89536	219162	1		
A5A4	CHOPPER AMP PCB ASSY	251918	89536	251918	1		
A5A5	AUXILIARY PS PCB ASSY	219188	89536	219188	1		
A5A6	CURRENT LIMITER PCB ASSY	354266	89536	354266	1		
C1	CAP, PLSTC, 0.1UF +/-20%, 200V	106435	56289	192P10402	1		
DS1	LAMP, NEON	185017	74276	NE-7	2	5	
DS2	LAMP, NEON	185017	74276	NE-7	REF		
H1	SCREW, PHP, 6-32	115063	89536	115063	12		
H2	WASHER, FLAT, #6	147728	89536	147728	12		
H3	WASHER, LOCK, #6	110395	89536	110395	12		
H4	NUT, HEX, 6-32	184044	89536	184044	12		
H5	WASHER, FIBER,	412809	76854	2-1185-119	6		
J1	CONNECTOR, FEMALE, 16 CONTACT	285015	91662	00-5009-016-141-001	4		
J2	CONNECTOR, FEMALE, 16 CONTACT	285015	91662	00-5009-016-141-001	REF		
J3	CONNECTOR, FEMALE, 16 CONTACT	187732	91662	00-5009-016-153-001	2		
J4	CONNECTOR, FEMALE, 16 CONTACT	187732	91662	00-5009-016-153-001	REF		
J5	CONNECTOR, FEMALE, 16 CONTACT	285015	91662	00-5009-016-141-001	REF		
J6	CONNECTOR, FEMALE, 16 CONTACT	285015	91662	00-5009-016-141-001	REF		
MP1	HOLDER, COMPNENT	104794	98159	28 29-115-3	2		
R1	RES, MTL FILM, 23.7K +/-1%, 1/2W	169383	91637	QMF652372F	1		
R2	RES, MTL FILM, 25.5K +/-1%, 1/2W	219006	91637	QMF652552F	1		
R3	RES, MTL FILM, 267K +/-1%, 1/2W	218990	91637	QMF652673F	1		
R4	RES, MTL FILM, 274K +/-1%, 1/2W	218982	91637	QMF652743F	1		
R5	RES, CAR FILM, 1.82M +/-1%, 1/2W	219089	89536	219089	3		
R6	RES, CAR FILM, 1.82M +/-1%, 1/2W	219089	89536	219089	REF		
R7	RES, CAR FILM, 1.82M +/-1%, 1/2W	219089	89536	219089	REF		
R8	RES, COMP, 1K +/-10%, 1W	109371	01121	GB1021	1		
R9	RES, COMP, 470 +/-10%, 1W	109710	01121	GB4711	1		
W1	CABLE, SHIELDED	135772	70903	8451	1		

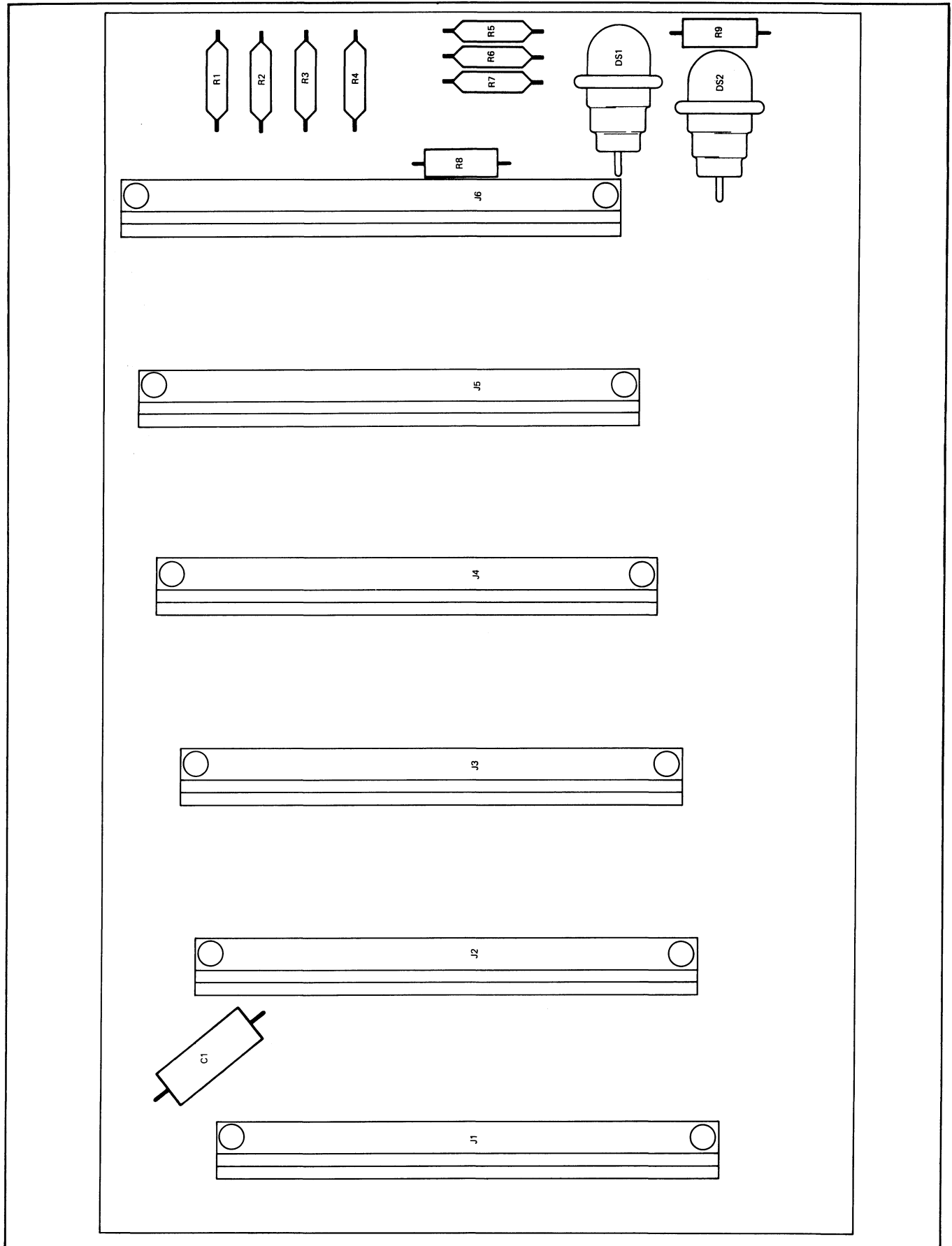






Figure 5-6. A5 Main Mother Board PCB Assembly

Table 5-8. A5A1 Reference Supply PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A1	REFERENCE SUPPLY PCB ASSY FIGURE 5-7 (332B/AF-4089T)	314864	89536	314864	REF		
A1	IC, VOLTAGE REG.	313106	04713	MC1723CG	1	1	
A2	IC, OP AMP	271502	12040	SH29466	1	1	
A3	REF AMP AND MATCHED RES SET 	314906	89536	314906	1		
A4	REF AMP OVEN	248914	01295	4ST1-2	1		
C1	CAP, MICA, 510PF +/-5%, 500V	148411	72136	DM19F511J	1		
C2	CAP, MICA, 68PF +/-5%, 500V	148510	72136	DM680	1		
C3	CAP, PLSTC, 0.1UF +/-10%, 50V	271866	06001	75F2R5A104	1		
MP1	HEAT SINK	104562	05820	MF209	1		
MP2	PAD, INSULATING	449371	89536	449371	1		
P1	CONNECTOR, 16 PIN	187724	91662	02-016-013-5-200	1		
Q1	XSTR, SI, NPN	203489	07910	CDQ10656	1	1	
R2	RES, VAR, CER MET, 10K +/-20%, 1/2W	267880	75378	190PC103B	3		
R4	RES, VAR, CER MET, 10K +/-20%, 1/2W	267880	75378	190PC103B	REF		
R6	RES, VAR, CER MET, 10K +/-20%, 1/2W	267880	75378	190PC103B	REF		
R7A							
R7B					REF		
R8	RES, MTL FILM, 16.5 +/-1%, 1/8W	238493	91637	QMF5516R5F	2		
R9	RES, VAR, 50 +/-20%, 1/2W	267815	71450	190PC500B	1		
R10	RES, MTL FILM, 16.5 +/-1%, 1/8W	238493	91637	QMF5516R5F	REF		
R12	RES, MTL FILM, 2.94K +/-1%, 1/8W	247528	91637	QMF652941F	1		
R13	1				REF		
R14	RES, MTL FILM, 6.34K +/-1%, 1/2W	218636	91637	QMF656341F	1		
R15	RES, MTL FILM, 8.66K +/-1%, 1/2W	247957	91637	QMF658661F	1		
R16	RES, MTL FILM, 16.9K +/-1%, 1/2W	198275	91637	QMF651691F	1		
R17	RES, MTL FILM, 7.5K +/-1%, 1/2W	186072	91637	QMF657501F	1		
R18	RES, MTL FILM, 4.99K +/-1%, 1/2W	148890	91637	QMF654991F	1		
R19	RES, COMP, 33 +/-5%, 2W	161497	01121	HB3305	1		
R20	RES, COMP, 2.7 +/-5%, 1/2W	246793	01121	EBR75	1		
XQ1	SOCKET, XSTR	152207	07047	10123-DAP	1		
							
	REF AMP AND MATCHED RES SET ASSY A3-1, R7A, R7E, AND R13						

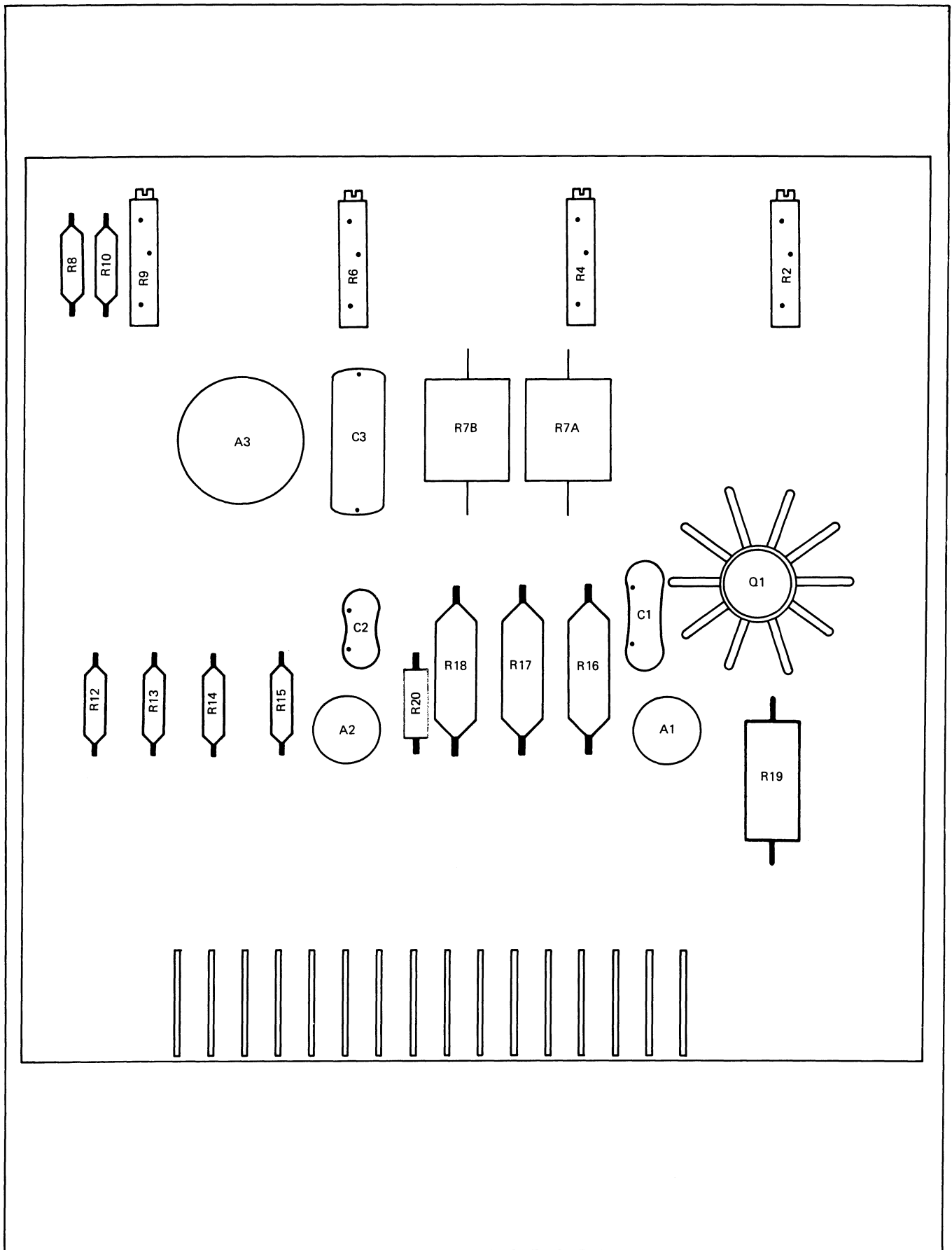


Figure 5-7. A5A1 Reference Supply PCB Assembly

Table 5-9. Series Pass Driver PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A2	SERIES PASS DRIVER PCB ASSY FIGURE 5-8 (335B-4094)	354258	89536	354258	REF		
C1	CAP, PLSTC, 0.47 UF +/-10%, 250V	184366	73445	C280AE/P470K	1		
C2	CAP, TA, 2.2 UF +/-10%, 20V	160226	56289	150D222X9020A2	1		
C3	CAP, PLSTC, 0.1 UF +/-20%, 200V	106435	56289	192P10402	1		
C4	CAP, PLSTC, 0.22 UF +/-10%, 80V	159392	56289	192P2249R8	1		
C5	CAP, ELECT, TA, 15 UF +/-10%, 20V	153056	56289	150D156X9020B2	1	1	
CR1	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	9	2	
CR2	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR3	DIODE, ZENER, 10V	113324	07910	1N961A	2	1	
CR4	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR5	DIODE, ZENER, 10V	113324	07910	1N961A	REF		
CR6	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR7	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR8	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR9	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR10	DIODE, SI, 150 MA, 6 PIV	113308	07910	CD13161	3	1	
CR11	DIODE, SI, 150 MA, 6 PIV	113308	07910	CD13161	REF		
CR12	DIODE, SI, 150 MA, 6 PIV	113308	07910	CD13161	REF		
CR13	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR14	DIODE, ZENER, 4.3V	180455	07910	1N749A	1	1	
CR15	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
H1	SPACER, #6	102616	89536	102616	1		
H2	SCREW, RHP, 6-32 X 3/4	114223	89536	114223	1		
H3	NUT, HEX #6	110569	73734	70206	3		
H4	WASHER, FLAT #6	111005	89536	111005	3		
H5	WASHER, SPLIT LK #6	110692	89536	110692	3		
H6	SPACER, .188 LONG	103499	89536	103499	2		
H7	SCREW, RHP, 6-32 X 5/8	152181	89536	152181	2		
MP1	HEAT SINK, XSTR	186759	89536	186759	1		
P1	CONNECTOR, MALE, 16-CONTACT	187724	91662	02-016-013-5-200	1		
Q1	XSTR, TESTED, SI, PNP	159491	89536	159491	4	1	
Q2	XSTR, SI, NPN	203489	07910	CDQ10656	3	1	
Q3	XSTR, SI, NPN	183004	95303	40250	1	1	
Q4	XSTR, TESTED, SI, PNP	159491	89536	159491	REF		
Q5	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
Q6	XSTR, TESTED, SI, PNP	159491	89536	159491	REF		
Q7	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
Q8	XSTR, TESTED, SI, PNP	159491	89536	159491	REF		
R1	RES, MET FLM, 4.02K +/-1%, 1/2W	167478	91637	QMF654021F	2		
R2	RES, VAR, WW 2K +/-10%, 1-1/4W	198416	89536	198416	1	1	
R3	RES, COMP, 2.7K +/-10%, 1W	109496	01121	GB2721	1		
R4	RES, MET FLM, 4.02K +/-1%, 1/2W	167478	91637	QMF654021F	REF		
R5	RES, VAR, WW 3K +/-20%, 1-1/4W	149781	89536	149781	2	1	
R6	RES, MET FLM, 5.62K +/-1%, 1/2W	219014	91637	QMF655621F	1		
R7	RES, COMP, 100K +/-10%, 1/2W	108126	01121	EB1041	1		
R9	RES, COMP, 2.4K +/-5%, 1/2W	108902	01121	EB2425	1		
R10	RES, COMP, 47 +/-10%, 2W	144352	01121	HB4701	2		
R11	RES, COMP, 47 +/-10%, 2W	144352	01121	HB4701	REF		
R12	RES, COMP, 36K +/-5%, 1/2W	185991	01121	EB3635	1		
R13	RES, VAR, WW 3K +/-20%, 1-1/4W	149781	89536	149781	REF		
R14	RES, MET FLM, 1K +/-1%, 1/2W	151324	91637	QMF651001F	1		
R15	RES, MET FLM, 221K +/-1%, 1/2W	182527	91637	QMF652213F	1		
R16	RES, COMP, 3.9K, 10%, 1/2W	161406	01121	EB3921	1		
R17	RES, COMP, 20K +/-5%, 1/2W	109041	01121	EB2035	1		
R18	RES, COMP, 16K +/-5%, 1/2W	159632	01121	EB1635	1		
R19	RES, COMP, 10K +/-10%, 1/2W	108118	01121	EB1031	1		

Table 5-9. Series Pass Driver PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R20	RES, COMP, 27K +/-5%, 1/2W	186023	01121	EB2735	1		
R21	RES, COMP, 27 +/-5%, 1/2W	260984	01121	EB2705	1		
R22	RES, MET FLN, 10 +/-1%, 1/2W	151043	91637	QMF65A100F	1		
R23	RES, COMP, 47K +/-5%, 1/2W	108738	01121	EB4735	2		
R24	RES, COMP, 620 +/-5%, 1/2W	108704	01121	EB6215	1		
R25	RES, COMP, 47K +/-5%, 1/2W	108738	01121	EB4735	REF		
R26	RES, COMP, 1.5K +/-10%, 1W	109413	01121	GB1521	1		
R27	RES, COMP, 2K +/-5%, 1/2W	169854	01121	EB2025	1		
R28	RES, COMP, 8.2K +/-5%, 1/2W	147777	01121	EB8225	1		
XQ1	SOCKET, XSTR	104315	22784	14-47	1		

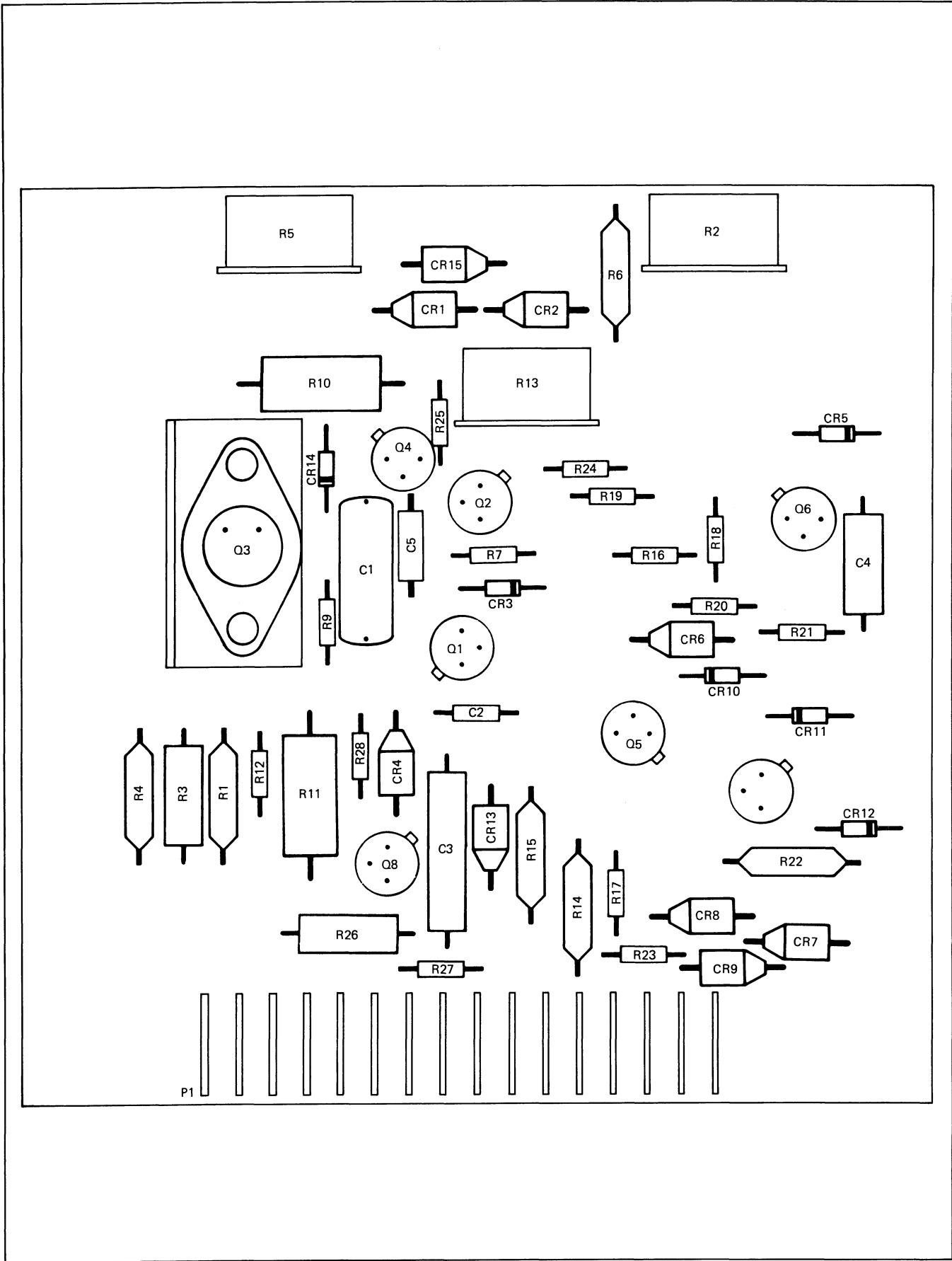


Figure 5-8. A5A2 Series Pass Driver PCB Assembly

Table 5-10. A5A3 Differential Amplifier PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A3	DIFF AMP PCB ASSY (335A-4057T) FIGURE 5-9 (335A-4057)	219162	89536	219162	REF		
C1	CAP, PLSTC, 0.1 UF +/-10%, 50V	150318	56289	194P1049R5	1		
C2	CAP, MICA, 510 PF +/-5%, 500V	148411	72136	DM19F511J	1		
C3	CAP, ELECT, TA, 15 UF +/-10%, 20V	153056	56289	150D156X902B2	1	1	
C4	CAP, ELECT, 220 UF +/-50/-10%, 40V	178616	80031	ET221X040A01	1	1	
CR1	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	14	3	
CR2	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR3	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR4	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR5	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR6	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR7	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR8	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR9	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR10	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR11	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR12	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR13	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
CR14	DIODE, ZENER, 10V	113324	07910	1N961A	1	1	
CR15	DIODE, SI, 1 AMP, 100 PIV	116111	05277	1N4817	REF		
H1	NUT, HEX	110569	73734	70206	1		
H2	SCREW, PHF	114223	89536	114223	1		
H3	WASHER, FLAT	111054	89536	111054	1		
H4	WASHER, LOCK	110692	89536	110692	1		
H5	SPACER	102616	89536	102616	1		
P1	CONNECTOR, MALE, 16-CONTACT	187724	91662	02-016-013-5-200	1		
Q1	XSTR, SI, NPN, SELECTED	437723	89536	437723	2	1	
Q2	XSTR, FET, SI, N-CHANNEL	271924	89536	271924	1	1	
Q3	XSTR, SI, PNP	190389	89536	190389	3	1	
Q4	XSTR, TESTED, SI, NPN	168716	89536	168716	2	1	
Q5	XSTR, SI, PNP	190389	89536	190389	REF		
Q6	XSTR, TESTED, SI, NPN	168716	89536	168716	REF		
Q7	XSTR, SI, PNP	190389	89536	190389	REF		
Q8	XSTR, SI, NPN	203489	07910	CDQ10656	1	1	
Q9	XSTR, SI, PNP	183558	89536	183558	3	1	
Q10	XSTR, SI, PNP	183558	89536	183558	REF		
Q11	XSTR, SI, PNP	183558	89536	183558	REF		
Q12	XSTR, SI, NPN, SELECTED	437723	89536	437723	REF		
R1	RES, COMP, 22K +/-5%, 1/2W	186064	01121	EB2235	1		
R2	RES, COMP, 100 +/-5%, 1/2W	188508	01121	EB1015	4		
R3	RES, COMP, 100 +/-5%, 1/2W	188508	01121	EB1015	REF		
R4	RES, WW, 10K +/-0.2%, 1/4W	112177	89536	112177	1	1	
R5	RES, COMP, 100 +/-5%, 1/2W	188508	01121	EB1015	REF		
R6	RES, COMP, 100 +/-5%, 1/2W	188508	01121	EB1015	REF		
R7	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	1		
R8	RES, COMP, 3.3K +/-5%, 1/2W	165761	01121	EB3325	1		
R9	RES, COMP, 3K +/-5%, 1/2W	109090	01121	EB3025	1		
R10	RES, COMP, 510, +/-5%, 1/2W	108951	01121	EB5115	1		
R11	RES, COMP, 22M +/-10%, 1/2W	108233	01121	EB2261	1		
R12	RES, COMP, 6.2K +/-5%, 1/2W	108621	01121	EB6225	1		
R13	RES, COMP, 2.2K +/-5%, 1/2W	108506	01121	EB2225	1		
R14	RES, COMP, 1.2K +/-10%, 1/2W	108803	01121	EB1221	1		
R15	RES, MET FLM, 100K +/-1%, 1/2W	151316	91637	QM651003F	1		
R16	RES, MET FLM, 221K +/-1%, 1/2W	182527	91637	QM652213F	2		
R17	RES, MET FLM, 40.2K +/-1%, 1/2W	161059	91637	QM654022F	2		
R18	RES, MET FLM, 75 +/-1%, 1/2W	150870	91637	QM650750F	2		

Table 5-10. A5A3 Differential Amplifier PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R19	RES, MET FLM, 75 +/-1%, 1/2W	150870	91637	QMF650750F	REF		
R20	RES, MET FLM, 221K +/-1%, 1/2W	182527	91637	QMF652213F	REF		
R21	RES, MET FLM, 40.2K +/-1%, 1/2W	161059	91637	QMF654022F	REF		
R22	RES, MET FLM, 6.04K +/-1%, 1/2W	162586	91637	QMF656041F	1		
R23	RES, MET FLM, 42.2K +/-1%, 1/2W	182501	91637	QMF654222F	1		
R24	RES, MET FLM, 9.09K +/-1%, 1/2W	151258	91637	QMF659091F	1		
R25	RES, MET FLM, 15K +/-1%, 1/2W	151498	91637	QMF651502F	1		
R26	RES, MET FLM, 1.58K +/-1%, 1/2W	182543	91637	QMF651581F	2		
R27	RES, MET FLM, 1.58K +/-1%, 1/2W	182543	91637	QMF651581F	REF		
R28	RES, MET FLM, 9.76K +/-1%, 1/2W	182485	91637	QMF659761F	1		
R29	RES, COMP, 10K +/-5%, 1/2W	109165	01121	EB1035	1		
R30	RES, COMP, 2.7K +/-10%, 1/2W	108837	01121	EB2721	1		
R31	RES, COMP, 2K +/-5%, 1/2W	169854	01121	EB2025	1		
XQ1	SOCKET, XSTR	104315	82305	14-47	12		
XQ2	SOCKET, XSTR	104315	82305	14-47	REF		
XQ3	SOCKET, XSTR	104315	82305	14-47	REF		
XQ4	SOCKET, XSTR	104315	82305	14-47	REF		
XQ5	SOCKET, XSTR	104315	82305	14-47	REF		
XQ6	SOCKET, XSTR	104315	82305	14-47	REF		
XQ7	SOCKET, XSTR	104315	82305	14-47	REF		
XQ8	SOCKET, XSTR	104315	82305	14-47	REF		
XQ9	SOCKET, XSTR	104315	82305	14-47	REF		
XQ10	SOCKET, XSTR	104315	82305	14-47	REF		
XQ11	SOCKET, XSTR	104315	82305	14-47	REF		
XQ12	SOCKET, XSTR	104315	82305	14-47	REF		

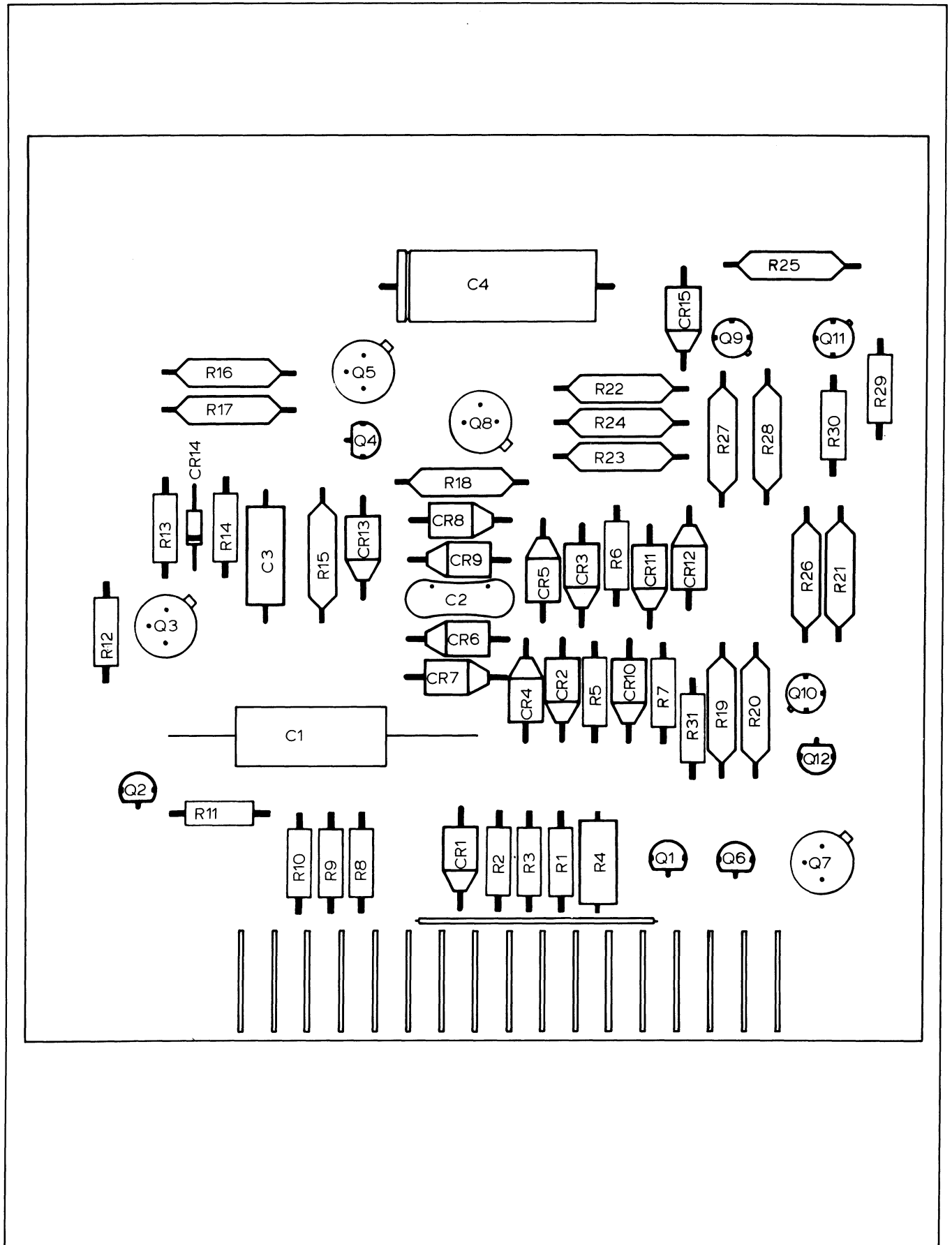


Figure 5-9. A5A3 Differential Amplifier PCB Assembly

Table 5-11. A5A4 Chopper Amplifier PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A4	CHOPPER AMP PCB ASSY FIGURE 5-10 (333A-4004)	251918	89536	251918	REF		
C1	CAP, PLSTC, 0.1UF +/-10%, 250V	161992	89536	161992	1		
C2	CAP, PLSTC, 0.0068UF +/-20%, 200V	106070	56289	192P68202	2		
C3	CAP, PLSTC, 0.0068UF +/-20%, 200V	106070	56289	192P68202	REF		
C4	CAP, PLSTC, 0.047UF +/-10%, 250V	162008	73445	C280AE/A47K	1		
C5	CAP, MICA, 4PF +/-5%, 500V	190397	72136	DM15C040K	1		
C6	CAP, MICA, 640PF +/-5%, 500V	215251	72136	DM19F6405	1		
C7	CAP, ELECT, 5UF +75/-10%, 25V	152009	56289	30D505G025BA4	2	1	
C8	CAP, ELECT, 47UF +50/-10%, 25V	168823	80031	ET470X025A4	2	1	
C9	CAP, ELECT, 100UF +75/-10%, 3V	106534	56289	30D107G003CB4	2	1	
C10	CAP, MICA, 220PF +/-5%, 500V	170423	72136	DM15F221J	1		
C11	CAP, CER, 100PF +/-10%, 1KV	105593	71590	DD-101	1		
C12	CAP, MICA, 5PF +/-10%, 500V	148577	72136	DM15C050K	1		
C13	CAP, ELECT, 5UF +75/-10%, 25V	152009	56289	30D505G025BA4	REF		
C14	CAP, ELECT, TA, 33UF +/-10%, 10V	182832	56289	150D336X9010B2	2	1	
C15	CAP, ELECT, 15UF +75/-10%, 6V	105700	56289	30D156G006BA4	2	1	
C16	CAP, ELECT, TA, 33UF +/-10%, 10V	182832	56289	150D336X9010B2	REF		
C17	CAP, ELECT, 15UF +75/-10%, 6V	105700	56289	30D156G006BA4	REF		
C18	CAP, ELECT, TA, 100UF +/-10%, 10V	170456	56289	150D107X9010R2	1	1	
C19	CAP, PLSTC, 0.015UF +/-2%, 100V	233577	02799	1PC-153-G	2		
C20	CAP, PLSTC, 0.015UF +/-2%, 100V	233577	02799	1PC-153-G	REF		
C21	CAP, ELECT, 47UF +50/-10%, 25V	168823	80031	ET470X025A4	REF		
C22	CAP, TA, 0.47UF +/-20%, 35V	161349	56289	196D474X0035HA1	1		
C23	CAP, ELECT, 100UF, 3V	106534	56289	30D107G003CB4	1	1	
CR1	DIODE, ZENER, SI	266601	07910	1N965B	1	1	
CR2	DIODE, SI, 150MA	203323	07910	1N4448	8	2	
CR3	DIODE, SI, 150MA	203323	07910	1N4448	REF		
CR4	DIODE, SI, 150MA	203323	07910	1N4448	REF		
CR5	DIODE, SI, 150MA	203323	07910	1N4448	REF		
CR6	DIODE, SI, 150MA	203323	07910	1N4448	REF		
CR7	DIODE, SI, 150MA	203323	07910	1N4448	REF		
CR8	DIODE, SI, 150MA	203323	07910	1N4448	REF		
CR9	DIODE, SI, 150MA	203323	07910	1N4448	REF		
H1	SCREW, PHP	114918	89536	114918	1		
H2	WASHER, FLAT	110775	89536	110775	1		
H3	WASHER, SPLIT	110395	89536	110395	1		
H4	NUT, HEX	110635	89536	110635	1		
MP1	COVER, CHOPPER	251751	89536	251751	1		
Q1	⊗ XSTR, MOS FET, P-CHANNEL	226043	89536	226043	1	1	
Q2	XSTR, FET, N-CHANNEL	271924	89536	271924	1	1	
Q3	XSTR, SI, PNP	195974	04713	2N3906	1	1	
Q4	XSTR, SI, PNP	288761	01295	SKA6808	1	1	
Q5	XSTR, SI, NPN	218396	04713	2N3904	3	1	
Q6	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q7	XSTR, SI, NPN	218396	04713	2N3904	REF		
R1	RES, COMP, 51K +/-5%, 1/4W	193334	01121	CB5135	1		
R2	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	3		
R3	RES, MTL FILM, 402K +/-1%, 1/2W	262121	91637	CMF654023F	1		
R4	RES, COMP, 10 +/-5%, 1/4W	147868	01121	CB1005	1		
R5	RES, MTL FILM, 604K +/-1%, 1/2W	182493	91637	CMF656043F	1		
R6	RES, COMP, 3.3M +/-5%, 1/4W	208389	01121	CB3355	1		
R7	RES, COMP, 13K +/-5%, 1/4W	221598	01121	CB1335	1		
R8	RES, COMP, 200 +/-5%, 1/4W	193482	01121	CB2015	3		
R9	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	5		
R10	RES, MTL FILM, 34K +/-1%, 1/2W	151241	91637	CMF653402F	2		
R11	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		

Table 5-11. A5A4 Chopper Amplifier PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12	RES, MTL FILM, 34K+/-1%, 1/2W	151241	91637	QMF653402F	REF		
R13	RES, COMP, 1.5K +/-5%, 1/4W	148031	01121	CB1525	1		
R14	RES, MTL FILM, 301 +/-1%, 1/2W	167494	91637	QMF653010F	1		
R15	RES, MTL FILM, 8.06K +/-1%, 1/2W	159467	91637	QMF658061F	1		
R16	RES, MTL FILM, 68.1K +/-1%, 1/2W	161083	91637	QMF656812F	1		
R17	RES, COMP, 68K +/-5%, 1/4W	148171	01121	CB6835	1		
R18	RES, COMP, 24K +/-5%, 1/4W	193425	01121	CB2435	1		
R19	RES, MTL FILM, 10K +/-1%, 1/2W	151274	91637	QMF651002F	2		
R20	RES, MTL FILM, 10K +/-1%, 1/2W	151274	91637	QMF651002F	REF		
R21	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R22	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R23	RES, COMP, 33K +/-5%, 1/4W	148155	01121	CB3335	1		
R24	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	1		
R25	RES, COMP, 36K +/-5%, 1/4W	221929	01121	CB3635	1		
R26	RES, COMP, 18K +/-5%, 1/4W	148122	01121	CB1835	1		
R27	RES, COMP, 560 +/-5%, 1/4W	147991	01121	CB5615	1		
R28	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	1		
R29	RES, COMP, 180K +/-5%, 1/4W	193441	01121	CB1845	1		
R30	RES, COMP, 8.2K +/-5%, 1/4W	160796	01121	CB8225	1		
R31	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	1		
R32	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	REF		
R33	RES, MTL FILM, 4.22K +/-1%, 1/2W	223396	91637	QMF654221F	1		
R34	RES, VAR, CER MET, 5K +/-20%, 3/4W	159905	73138	78PR5K	1	1	
R35	RES, MTL FILM, 24.3K +/-1%, 1/2W	217430	91637	QMF652432F	1		
R36	RES, MTL FILM, 187K +/-1%, 1/8W	289462	91637	QMF551873F	2		
R37	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	REF		
R38	RES, MTL FILM, 187K +/-1%, 1/8W	289462	91637	QMF551873F	REF		
R39	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	REF		
R40	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	REF		
R41	RES, COMP, 200 +/-5%, 1/4W	193482	01121	CB2015	REF		
R42	RES, COMP, 200 +/-5%, 1/4W	193482	01121	CB2015	REF		
R43	RES, VAR, COMP, 10K +/-30%, 1/4W	223131	89536	223131	1	1	
U1	IC, OP AMP	246603	07263	U5B770939X	1	1	
XQ2	SOCKET, XSTR	104315	82305	14-47	6		
XQ3	SOCKET, XSTR	104315	82305	14-47	REF		
XQ4	SOCKET, XSTR	104315	82305	14-47	REF		
XQ5	SOCKET, XSTR	104315	82305	14-47	REF		
XQ6	SOCKET, XSTR	104315	82305	14-47	REF		
XQ7	SOCKET, XSTR	104315	82305	14-47	REF		

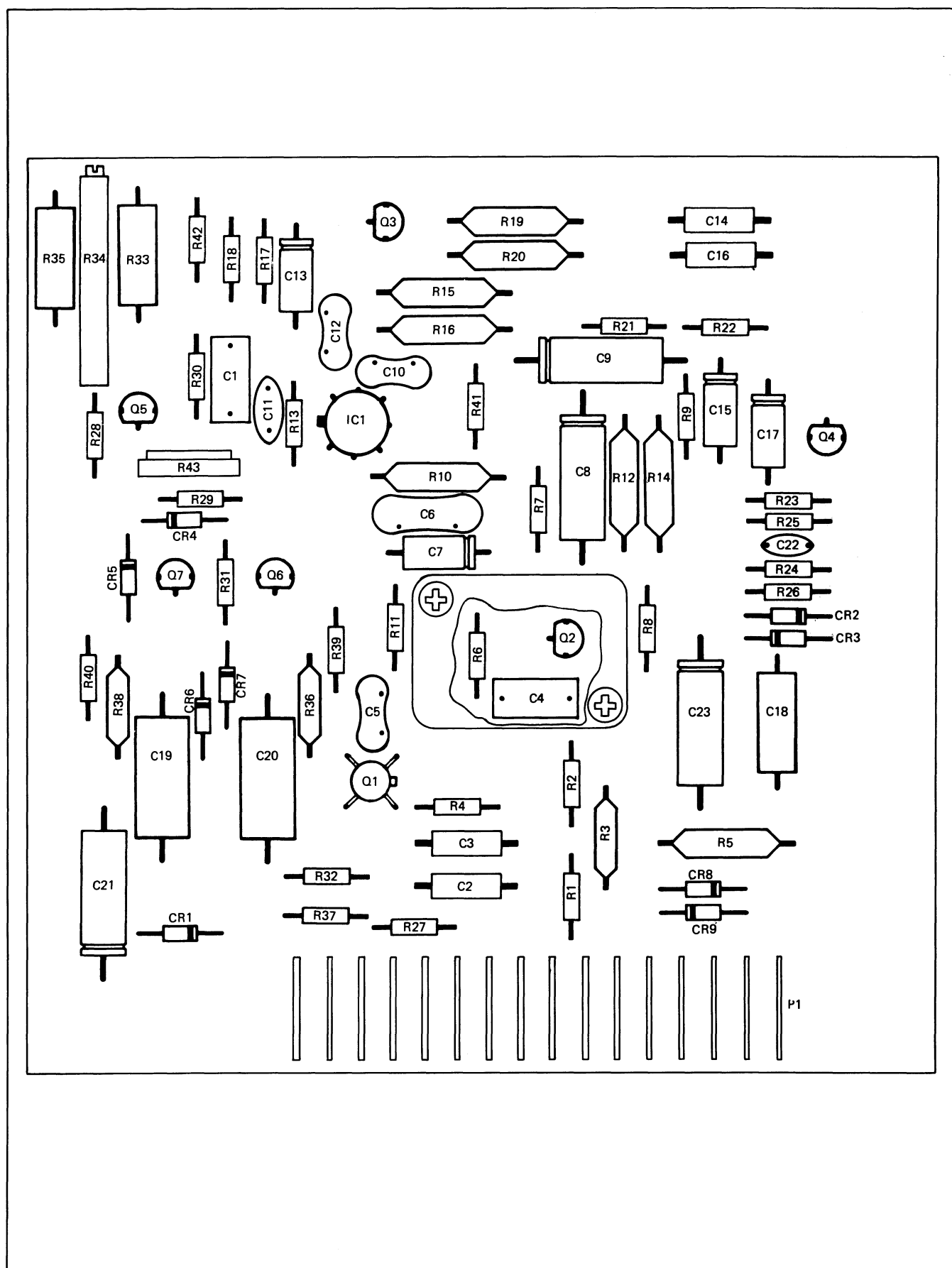


Figure 5-10. A5A4 Chopper Amplifier PCB Assembly

Table 5-12. A5A5 Auxiliary Power Supply PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A5	AUXILIARY POWER SUPPLY PCB ASSY FIGURE 5-11 (335A-4059)	219188	89536	219188	REF		
C1	CAP, TA, 680F +/-10%, 15V	182824	56289	150D683X9R2	1		
C2	CAP, ELECT, 220UF +50/-10%, 63V	185850	80031	ET221X063A02	1	1	
C3	CAP, ELECT, 50UF +75/-10%, 50V	105122	56289	30D506G050DD4	2	1	
C4	CAP, PLSTC, 0.1UF +/-20%, 200V	106435	56289	192P10402	2		
C5	CAP, PLSTC, 2UF +/-20%, 100V	106963	89536	106963	2		
C6	CAP, PLSTC, 0.1UF +/-20%, 200V	106435	56289	192P10402	REF		
C7	CAP, ELECT, 20UF +75/-10%, 50V	106229	56289	30D206G050	2	1	
C8	CAP, ELECT, 50UF +75/-10%, 50V	105122	56289	30D506G050DD4	REF		
C9	CAP, PLSTC, 0.0012UF +/-10%, 200V	106088	56289	192P12292	1		
C10	CAP, PLSTC, 2UF +/-20%, 100V	106963	89536	106963	REF		
C11	CAP, ELECT, 20UF +75/-10%, 50V	106229	56289	30D206G050	REF		
CR1	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	8	2	
CR2	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR3	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR4	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR5	DIODE, ZENER, 3.9V	113316	07910	1N748	1	1	
CR6	DIODE, ZENER, 6.3V	172148	03877	1N3496	1	1	
CR7	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR8	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR9	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR10	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
H1	SPACER	102616	89536	102616	1		
H2	SCREW, PHP	114223	89536	114223	1		
H3	NUT, HEX	110569	73734	70206	5		
H4	WASHER, FLAT	111054	89536	111054	5		
H5	WASHER, SPLIT	110692	89536	110692	5		
H6	SCREW, PHP	152181	89536	152181	4		
H7	SPACER	153155	89536	153155	4		
P1	CONNECTOR, MALE, 16 CONTACT	187724	91662	02-016-013-5-200	1		
Q1	XSTR, THYRISTOR	192567	03508	C-6F	1	1	
Q2	XSTR, SELECTED, SI, PNP	159491	89536	159491	1	1	
Q3	XSTR, SI, NPN	203489	07910	CDQ10656	5	1	
Q4	XSTR, SI, NPN	183004	95303	40250	2	1	
Q5	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
Q6	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
Q7	XSTR, SI, NPN	183004	95303	40250	REF		
Q8	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
Q9	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
R1	RES, COMP, 10K +/-5%, 1/2W	109165	01121	EB1035	1		
R2	RES, COMP, 390 +/-5%, 1/2W	109082	01121	EB3915	1		
R3	RES, COMP, 5.6k +/-5%, 1/2W	187880	01121	EB5625	1		
R4	RES, COMP, 15 +/-10%, 2W	155549	01121	HB1501	1		
R5	RES, COMP, 15K +/-10%, 1/2W	108530	01121	EB1531	1		
R6	RES, COMP, 3K +/-5%, 1/2W	109090	01121	EB3025	1		
R7	RES, COMP, 33K +/-10%, 1/2W	178541	01121	EB3331	1		
R8	RES, MTL FILM, 7.15K +/-1%, 1/2W	186072	91637	QMF657151F	1		
R9	RES, VAR, WW, 1K +/- 20%, 1-1/4W	113266	89536	113266	1	1	
R10	RES, MTL FILM, 2.55K +/-1%, 1/2W	176362	91637	QMF652551F	1		
R11	RES, COMP, 6.2K +/-5%, 1/2W	108621	01121	EB6225	1		
R12	RES, MTL FILM, 2.37K +/-1%, 1/2W	182519	91637	QMF652371F	1		
R13	RES, COMP, 12K +/-10%, 1/2W	108977	01121	EB1231	1		
R14	RES, COMP, 82 +/-10%, 2W	110239	01121	EB8201	1		
R15	RES, COMP, 8.2K +/-5%, 1/2W	147777	01121	EB8225	1		
R16	RES, COMP, 3.3K +/-10%, 1/2W	108373	01121	EB3321	1		
R17	RES, COMP, 4.7K +/-10%, 1/2W	108381	01121	EB4721	1		

Table 5-12. A5A5 Auxiliary Power Supply PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R18	RES, MTL FILM, 8.45K +/-10%, 1/2w	159475	91637	QMF658451F	1		
R19	RES, MTL FILM, 4.99K +/-1%, 1/2w	148890	91637	QMF654991F	1		
R20	RES, COMP, 2.0K +/-5%, 1/2w	169854	01121	EB2025	1		
XQ1	SOCKET, XSTR	104315	82305	14-47	7		
XQ2	SOCKET, XSTR	104315	82305	14-47		REF	
XQ3	SOCKET, XSTR	104315	82305	14-47		REF	
XQ5	SOCKET, XSTR	104315	82305	14-47		REF	
XQ6	SOCKET, XSTR	104315	82305	14-47		REF	
XQ8	SOCKET, XSTR	104315	82305	14-47		REF	
XQ9	SOCKET, XSTR	104315	82305	14-47		REF	

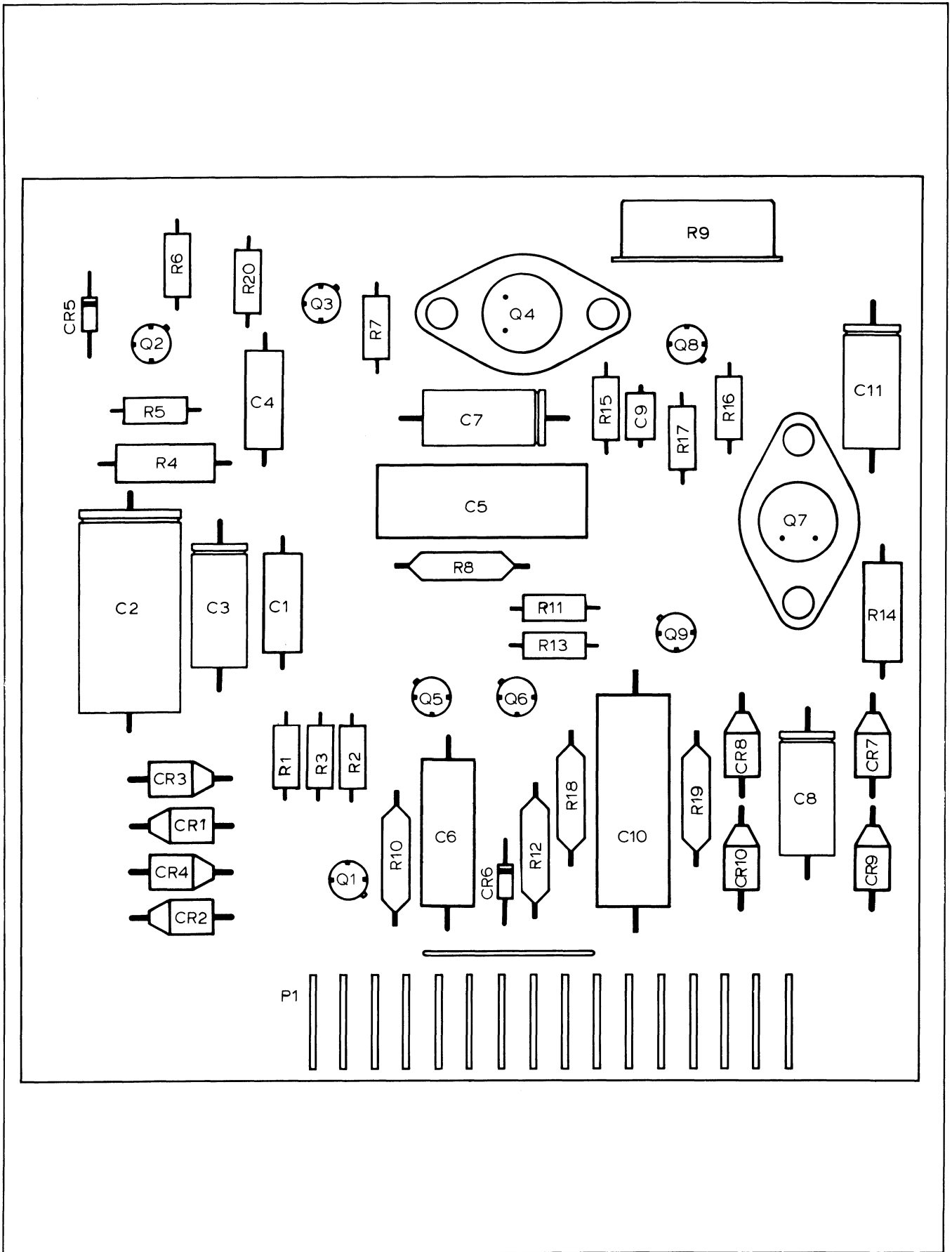


Figure 5-11. A5A5 Auxiliary Power Supply PCB Assembly

Table 5-13. A5A6 Current Limiter PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A6	CURRENT LIMITER PCB ASSY FIGURE 5-12 (335B-4095)	354266	89536	354266	REF		
C1	CAP, ELECT, 350 UF +75/-10%, 75V	292862	80031	3044BT351U075	3	1	
C2	CAP, ELECT 20UF +75/-10%, 50V	106229	56289	30D206G050CC4	3	1	
C3	CAP, ELECT 20UF +75/-10%, 50V	106229	56289	30D206G050CC4	REF		
C4	CAP, ELECT, 350 UF +75/-10%, 75V	292862	80031	3044BT351U075	REF		
C5	CAP, ELECT 20UF +75/-10%, 50V	106229	56289	30D206G050CC4	REF		
C6	CAP, ELECT, 350 UF +75/-10%, 75V	292862	80031	3044BT351U075	REF		
C7	CAP, PLSTC, 1UF +/-10%, 50V	271866	06001	75F3R5A104	1		
C9	CAP, ELECT, 2UF +75/-10%, 50V	105197	56289	30D2040G050BA4	1	1	
C10	CAP, ELECT, 150UF +50/-10%, 63V	170274	80031	ET151X063A01	1	1	
CR1	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	5	1	
CR2	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR3	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR4	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR5	DIODE, ZENER, 36V	186163	07910	1N974B	1	1	
CR6	DIODE, ZENER, 3.9V	113316	07910	1N748	1	1	
CR7	DIODE, ZENER, 36V	237354	04713	1N3033A	1	1	
CR8	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR9	DIODE, ZENER, 12V	159780	07910	1N759	1	1	
CR10	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	2	1	
CR11	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR12	DIODE, SI, 150MA, 6PIV	113308	07910	CD13161	1		
H1	SCREW, PHP, 6-32 X 5/8	152181	89536	152181	4		
H2	SCREW, PHP, 6-32 X 3/4	114223	89536	114223	1		
H3	NUT, HEX, 6-32	110569	73734	70206	5		
H4	WASHER, FLAT, #6	111054	89536	111054	5		
P1	CONNECTOR, MALE, 16 CONTACT	187724	91662	02-016-013-5-200	1		
Q1	XSTR, SI, NPN	183004	95303	40250	1	1	
Q2	XSTR, GE, PNP	180315	04713	2N297A	1	1	
Q3	XSTR, SELECTED, SI, PNP	159491	89536	159491	3	1	
Q4	XSTR, SI, NPN	203489	07910	CDQ10656	2	1	
Q5	XSTR, SELECTED, SI, PNP	159491	89536	159491	REF		
Q6	XSTR, SELECTED, SI, PNP	159491	89536	159491	REF		
Q7	XSTR, SI, NPN	203489	07910	CDQ10656	REF		
R1	RES, COMP, 10 +/-10%, 2W	110163	01121	HB1001	2		
R2	RES, COMP, 3.3K +/-5%, 1/2W	165761	01121	EB3325	2		
R3	RES, COMP, 2.4K +/-5%, 2W	218834	01121	HB2425	2		
R4	RES, COMP, 10 +/-10%, 2W	110163	01121	HB1001	REF		
R5	RES, COMP, 3.3K +/-5%, 1/2W	165761	01121	EB3325	REF		
R6	RES, COMP, 7.5K +/-5%, 1/2W	108910	01121	EB7525	3		
R7	RES, COMP, 100K +/-10%, 1/2W	108126	01121	EB1041	2		
R8	RES, COMP, 2.4K +/-5%, 2W	218834	01121	HB2425	REF		
R10	RES, COMP, 4.7K +/-10%, 1/2W	108381	01121	EB4721	1		
R11	RES, COMP, 10K +/-10%, 1/2W	108118	01121	EB1031	2		
R12	RES, COMP, 10K +/-10%, 1/2W	108118	01121	EB1031	REF		
R13	RES, COMP, 16K +/-5%, 1/2W	159632	01121	EB1635	1		
R14	RES, COMP, 1K +/-10%, 1/2W	108563	01121	EB1021	2		
R15	RES, COMP, 2.2K +/-10%, 1/2W	108605	01121	EB2221	1		
R16	RES, COMP, 100K +/-10%, 1/2W	108126	01121	EB1041	REF		
R17	RES, COMP, 36K +/-5%, 1/2W	185991	01121	EB3635	1		
R18	RES, COMP, 330K +/-5%, 1/2W	150201	01121	EB3345	1		
R19	RES, COMP, 7.5K +/-5%, 1/2W	108910	01121	EB7525	REF		
R20	RES, COMP, 7.5K +/-5%, 1/2W	108910	01121	EB7525	REF		
R21	RES, COMP, 1K +/-10%, 1/2W	108563	01121	EB1021	REF		
R22	RES, MTL FILM, 12.1K +/-1%, 1/2W	182535	91637	CMF651212F	1		
R23	RES, VAR, 10K +/-10%, 1-1/4W	162115	89536	162115	1	1	

Table 5-12 Table 5-13. A5A6 Current Limiter PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R24	RES, VAR, WW, 150 +/-10%, 1-1/4 w	113092	89536	113092	1	1	
XQ1	HEAT SINK	186759	89536	186759	1		
XQ2	HEAT SINK	186742	89536	186742	1		
XQ3	SOCKET, XSTR	104315	82305	14-47	5		
XQ4	SOCKET, XSTR	104315	82305	14-47	REF		
XQ5	SOCKET, XSTR	104315	82305	14-47	REF		
XQ6	SOCKET, XSTR	104315	82305	14-47	REF		
XQ7	SOCKET, XSTR	104315	82305	14-47	REF		

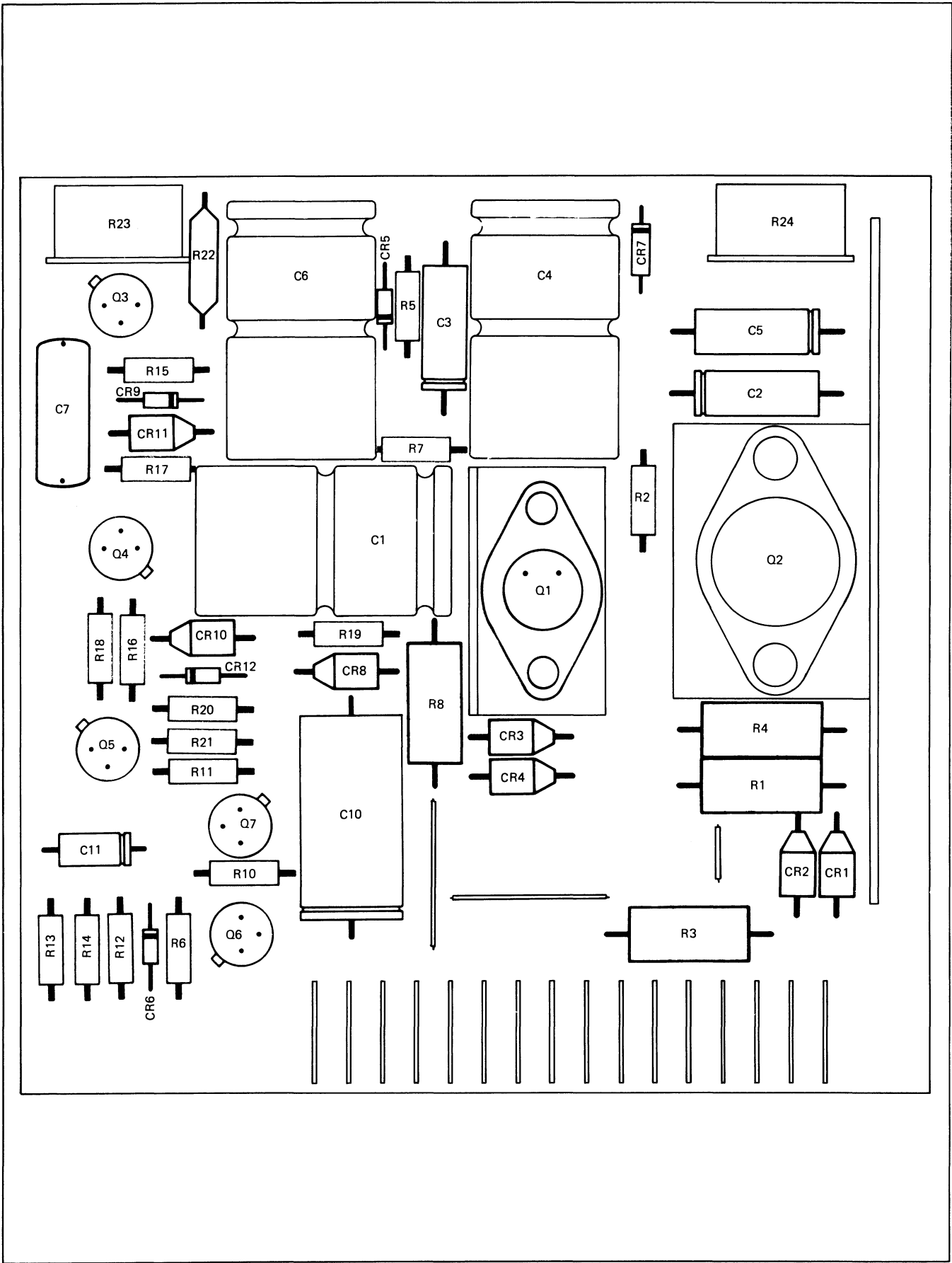


Figure 5-12. A5A6 Current Limiter PCB Assembly

Table 5-14. A6 Isolated Mother Board PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6	ISOLATED MOTHER BOARD PCB ASSY FIGURE 5-13 (335A-4055)	219147	89536	219147	REF		
A6A1	NULL DETECTOR POWER SUPPLY PCB ASSY	219121	89536	219121	1		
A6A2	NULL DETECTOR AMP PCB ASSY	219139	89536	219139	1		
J1	CONNECTOR, FEMALE 16 CONTACT	285015	91662	00-5009-016-141-001	2		
J2	CONNECTOR, FEMALE 16 CONTACT	285015	91662	00-5009-016-141-001	REF		
MP1	GROMMET	162131	31827	6-41	4		
MP2	SPACER	190454	89536	190454	4		

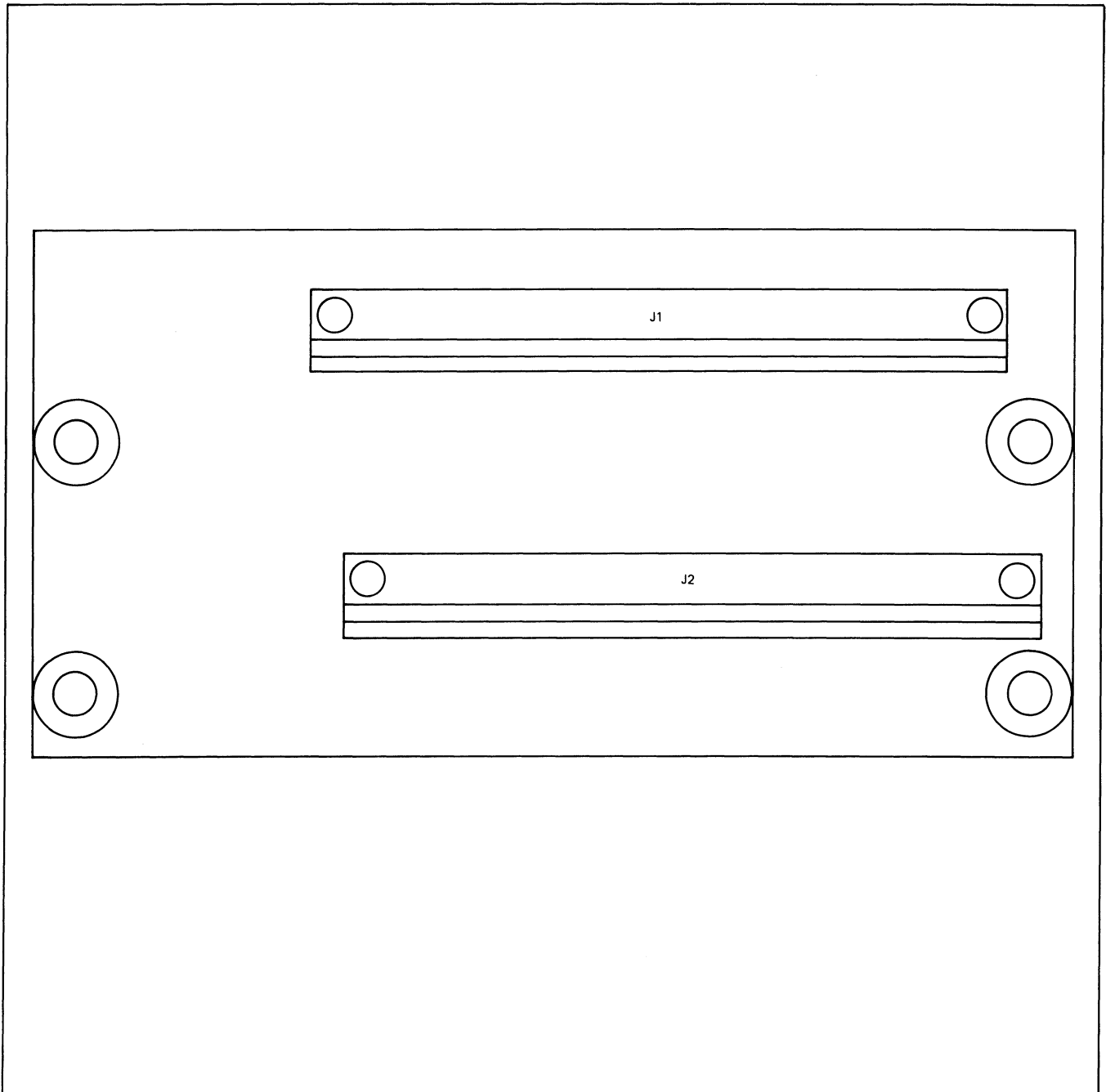


Figure 5-13. A6 Isolated Mother Board PCB Assembly

Table 5-15. A6A1 Null Detector Power Supply PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CODE
A6A1	NULL DET P S PCB ASSY (335A-4053) FIGURE 5-14 (335A-4053)	219121	89536	219121	REF		
C1	CAP, ELECT, 1,000 UF, +50/-10%, 16V	193896	80031	ET102X016A02	3	1	
C2	CAP, PLSTC, 1 UF, +/-20%, 200V	106450	89536	106450	1		
C3	CAP, ELECT, 1,000 UF, +50/-10%, 16V	193896	80031	ET102X016A02	REF		
C4	CAP, ELECT, 1,000 UF, +50/-10%, 16V	193896	80031	ET102X016A02	REF		
C5	CAP, ELECT, 470 UF, +50/-10%, 4V	187773	80031	ET471X6P3A6	2	1	
C6	CAP, ELECT, 47 UF, +50/-10%, 25V	168823	80031	ET470X025A4	1	1	
CR1	DIODE, SI, LAMP, 600 PIV	112383	05277	1N4822	6	2	
CR2	DIODE, SI, LAMP, 600 PIV	112383	05277	1N4822	REF		
CR3	DIODE, SI, LAMP, 600 PIV	112383	05277	1N4822	REF		
CR4	DIODE, SI, LAMP, 600 PIV	112383	05277	1N4822	REF		
CR5	DIODE, ZENER, 10V	113324	07910	1N961A	1	1	
CR6	DIODE, SI, LAMP, 600 PIV	112383	05277	1N4822	REF		
CR7	DIODE, SI, LAMP, 600 PIV	112383	05277	1N4822	REF		
H1	SPACER, #6	102616	89536	102616	1		
H2	WASHER, FLAT #6	111054	89536	111054	1		
H3	WASHER, SPLIT #6	110692	89536	110692	1		
H4	NUT, 6-32	110569	73734	70206	1		
H5	SCREW, PH, 6-32 X 3/4	114223	89536	114223	1		
P1	CONNECTOR, MALE, 16-CONTACT	187724	91662	02-016-013 5-200	1		
Q1	XSTR, SI, PNP	380394	89536	380394	2	1	
Q2	XSTR, SI, PNP	380394	89536	380394	REF		
Q3	XSTR, SI, PNP	321398	89536	321398	1	1	
Q4	XSTR, SI, NPN	454843	89536	454843	3	1	
Q5	XSTR, SI, NPN	454843	89536	454843	REF		
Q6	XSTR, SI, NPN	454843	89536	454843	REF		
R1	RES, COMP, 150 +/-5%, 1/2W	186056	01121	EB1515	1		
R2	RES, COMP, 5.1K +/-5%, 1/2W	109108	01121	EB5125	2		
R3	RES, COMP, 5.1K +/-5%, 1/2W	109108	01121	EB5125	REF		
R4	RES, VAR, WW, 2K +/-10%, 1-1/4W	198416	89536	198416	1	1	
R5	RES, COMP, 22K +/-5%, 1/2W	186064	01121	EB2235	4		
R6	RES, COMP, 22K +/-5%, 1/2W	186064	01121	EB2235	REF		
R7	RES, COMP, 22K +/-5%, 1/2W	186064	01121	EB2235	REF		
R8	RES, COMP, 22K +/-5%, 1/2W	186064	01121	EB2235	REF		
R9	RES, VAR, WW, 3K +/-20%, 1-1/4W	149781	89536	149781	1	1	
R10	RES, COMP, 10K +/-10%, 1/2W	108118	01121	EB1031	1		
R11	RES, COMP, 1K +/-10%, 1/2W	108563	01121	EB1021	1		
T1	XFMR, DRIVER	227207	89536	227207	1		
T2	XFMR, OUTPUT	227215	89536	227215	1		
XQ1	SOCKET, XSTR	104315	22784	14-47	6		
XQ2	SOCKET, XSTR	104315	22784	14-47	REF		
XQ3	SOCKET, XSTR	104315	22784	14-47	REF		
XQ4	SOCKET, XSTR	104315	22784	14-47	REF		
XQ5	SOCKET, XSTR	104315	22784	14-47	REF		
XQ6	SOCKET, XSTR	104315	22784	14-47	REF		



IF ANY OF THESE TRANSISTORS ARE REPLACED AND ARE OF THE TYPE GA2817, GA2875, OR GA2877, ALL 6 TRANSISTORS MUST BE REPLACED BY TRANSISTOR TYPES IN THIS PARTS LIST.

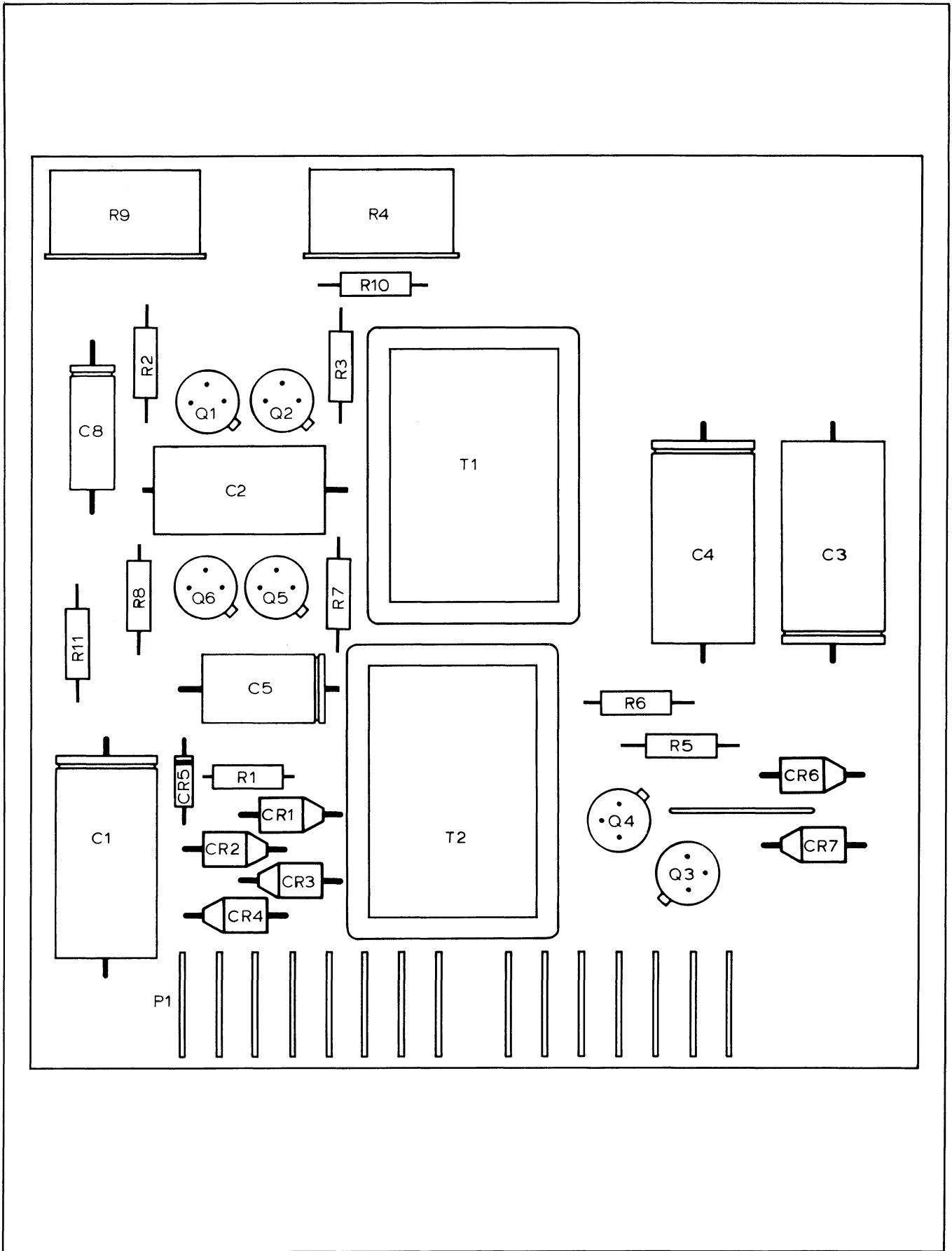


Figure 5-14. A6A1 Null Detector Power Supply PCB Assembly

Table 5-16. A6A2 Null Detector Amplifier PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6A2	NULL DET AMP PCB ASSY (335A-4054) FIGURE 5-15 (335A-4052)	299139	89536	299139	1		
C1	CAP, PLSTC, 0.22 UF +/-20%, 250V	194803	73445	C280MAE/220K	1		
C2	CAP, PLSTC, 0.22 UF +/-20%, 120V	167452	89536	167452	1		
C3	CAP, PLSTC, 0.47 UF +/-20%, 120V	190553	89536	190553	2		
C4	CAP, PLSTC, 0.47 UF +/-20%, 120V	190553	89536	190553	REF		
C5	CAP, PLSTC, 0.1 UF +/-20%, 200V	271973	84411	X601PE10492	3		
C6	CAP, CER, 300 PF +/-10%, 500V	105734	71590	BB60301KW7W	2		
C7	CAP, ELECT, 330 UF +/-10%, 16V	187765	80031	ET331X016A00	1	1	
C8	CAP, CER, 300 PF +/-10%, 500V	105734	71590	BB60301KW7W	REF		
C9	CAP, TA, 10 UF +/-10%, 20V	160259	56289	150D103X9020B2	4		
C10	CAP, PLSTC, 0.1 UF +/-20%, 200V	271973	84411	X601PE10492	REF		
C11	CAP, PLSTC, 0.0047 UF +/-20%, 200V	106054	56289	192P47202	1		
C12	CAP, TA, 10 UF +/-10%, 20V	160259	56289	150D103X9020B2	REF		
C13	CAP, ELECT, 470 UF +/-10%, 4V	187773	80031	ET471X6P3A6	1	1	
C14	CAP, ELECT, 1500 UF +/-10%, 4V	166330	80031	ET152X6P3A01	1	1	
C15	CAP, TA, 10 UF +/-10%, 20V	160259	56289	150D103X9020B2	REF		
C16	CAP, PLSTC, 0.1 UF +/-20%, 200V	271973	84411	X601PE10492	REF		
C17	CAP, TA, 22 UF +/-10%, 15V	182816	56289	150D223X9015B	1		
C18	CAP, TA, 10 UF +/-10%, 20V	160259	56289	150D103X9020B2	REF		
CR1	DIODE, TREATED, SI, 10 MA, 2 PIV	180885	89536	180885	2	1	
CR2	DIODE, TREATED, SI, 10 MA, 2 PIV	180885	89536	180885	REF		
CR3	DIODE, SI, 1 AMP, 600 PIV	112383	05277	1N4822	2	1	
CR4	DIODE, SI, 1 AMP, 600 PIV	112383	05277	1N4822	REF		
CR5	DIODE, ZENER, 10V	113324	07910	1N961A	1	1	
DS1	LAMP, NEON	162602	89536	N5K750120	2	1	
DS2	LAMP, NEON	162602	89536	N5K750120	REF		
H1	WASHER, SHOULDER #6	110387	86928	5604-47	4		
H2	WASHER, LOCK #6	110692	89536	110692	5		
H3	WASHER, FLAT #6	111054	89536	111054	5		
H5	SCREW, 6-32 X 3/8	152165	89536	152165	5		
H6	WASHER, FLAT #6	111310	89536	111310	2		
H7	TIE POINT	172080	06383	SST-1M	1		
H8	TERMINAL, TEFLON	218297	98291	FTE15	2		
H9	TERMINAL, STAND-OFF	161976	98291	013-3013-000-689	6		
MP1	PHOTOCELL SUPPORT	194613	89536	194613	1		
MP2	ROD, LIGHT	237362	89536	237362	2		
MP3	SHIELD, INPUT (NOT ILLUSTRATED)	226886	89536	226886	1		
MP4	BLOCK, CHOPPER	167569	89536	167569	2		
P1	CONNECTOR, MALE, 16-CONTACT	187724	91662	02-016-013 5-200	1		
Q1	XSTR, SELECTED, SI, NPN	242065	04713	2N5089	1	1	
Q2	XSTR, SI, NPN	168716	07263	S19254	1	1	
Q3	XSTR, SI, NPN	168708	03508	2N3391	1	1	
Q4	XSTR, SI, NPN	177105	07263	2N3565	4	1	
Q5	XSTR, SI, NPN	177105	07263	2N3565	REF		
Q6	XSTR, GE, PNP	182709	01295	GA3938	1	1	
Q7	XSTR, SI, NPN	177105	07263	2N3565	REF		
Q8	XSTR, SI, NPN	177105	07263	2N3565	REF		
Q9	XSTR, SI, PNP	169375	04713	MPS3638	2	1	
Q10	XSTR, SI, PNP	169375	04713	MPS3638	REF		
Q11	XSTR, GE, NPN	117127	01295	2N1304	1	1	
Q12	XSTR, GE, PNP	190298	01295	2N1305	1	1	
R1	RES, COMP, 150K +/-5%, 2W	110122	01121	HB1545	2		
R1A	RES, COMP, 150K +/-5%, 2W	110122	01121	HB1545	REF		
R2	RES, COMP, 33K +/-5%, 1/2W	108761	01121	EB3335	1		
R3	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	2		
R4	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	4		

Table 5-16. A6A2 Null Detector Amplifier PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R5	RES, COMP, 470 +/-5%, 1/4W	147983	01121	CB4715	1		
R6	RES, COMP, 200K +/-5%, 1/4W	248781	01121	CB2045	1		
R7	RES, WW 10 +/-1%, 1/2W	193946	89536	193946	1	1	
R8	RES, COMP, 1.2M +/-10%, 1/2W	108407	01121	EB1251	1		
R9	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	2		
R10	RES, COMP, 10M +/-10%, 1/2W	108142	01121	EB1061	1		
R11	RES, COMP, 1.2M +/-5%, 1/4W	188425	01121	CB1255	1		
R12	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	REF		
R13	RES, COMP, 68K +/-5%, 1/4W	148171	01121	CB6835	1		
R14	RES, COMP, 82K +/-5%, 1/4W	188458	01121	CB8235	1		
R15	RES, COMP, 39 +/-5%, 1/4W	193391	01121	CB3805	1		
R16	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R17	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	3		
R18	RES, COMP, 39K +/-5%, 1/4W	188466	01121	CB3935	1		
R19	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R20	RES, COMP, 100 +/-5%, 1/4W	147926	01121	CB1015	1		
R21	RES, COMP, 750K +/-5%, 1/4W	221937	01121	CB2545	1		
R22	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R23	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	REF		
R24	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	2		
R25	RES, COMP, 150K +/-5%, 1/4W	182212	01121	CB1545	2		
R26	RES, COMP, 68K +/-5%, 1/4W	148171	01121	CB6835	REF		
R27	RES, COMP, 150K +/-5%, 1/4W	182212	01121	CB1545	REF		
R28	RES, COMP, 22K +/-5%, 1/4W	148130	01121	CB2235	REF		
R29	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R30	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	REF		
R31	RES, COMP, 3.9M +/-5%, 1/4W	188417	01121	CB3955	1		
R32	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	2		
R33	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	REF		
V1	PHOTOCELL ASSEMBLY	194449	89536	194449	1	1	
V2	PHOTOCELL ASSEMBLY	194449	89536	194449	REF		
XQ4	SOCKET, XSTR	104315	82305	14847	9		
XQ5	SOCKET, XSTR	104315	82305	14847	REF		
XQ6	SOCKET, XSTR	104315	82305	14847	REF		
XQ7	SOCKET, XSTR	104315	82305	14847	REF		
XQ8	SOCKET, XSTR	104315	82305	14847	REF		
XQ9	SOCKET, XSTR	104315	82305	14847	REF		
XQ10	SOCKET, XSTR	104315	82305	14847	REF		
XQ11	SOCKET, XSTR	104315	82305	14847	REF		
XQ12	SOCKET, XSTR	104315	82305	14847	REF		

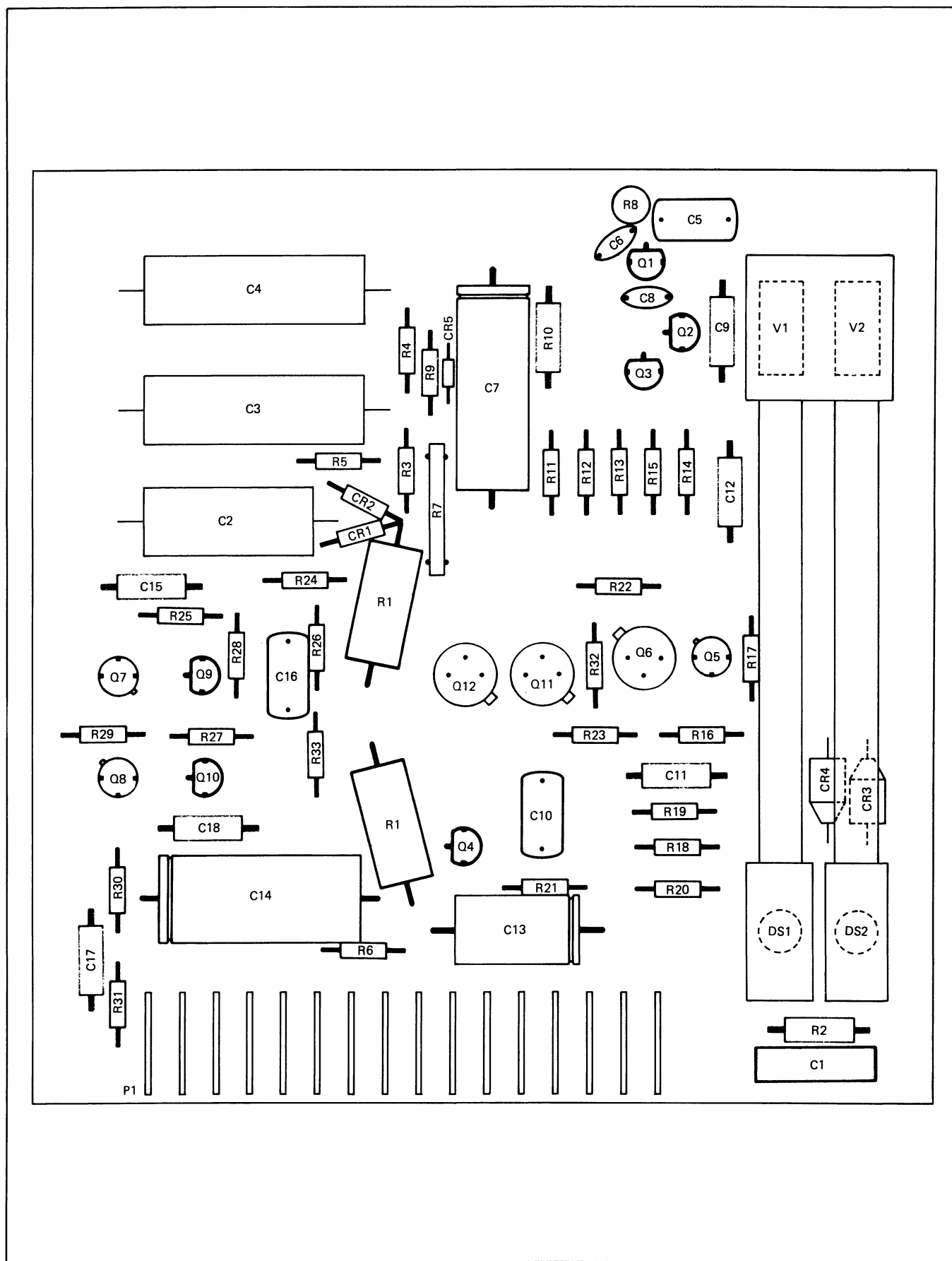


Figure 5-15. A6A2 Null Detector Amplifier PCB Assembly

Table 5-17. A7 Time Delay PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7	TIME DELAY PCB ASSY FIGURE 5-16 (332A-420)	192260	89536	192260	REF		
C2001	CAP, ELECT, 4700F +50/-10%, 40V	185868	80031	ET471X040A2	1	1	
CR2001	DIODE, SI, 1 AMP, 100PIV	116111	05277	1N4817	3		
CR2002	DIODE, SI, 1 AMP, 100PIV	116111	05277	1N4817	REF		
CR2003	DIODE, SI, 1 AMP, 100PIV	116111	05277	1N4817	REF		
H1	WASHER	110395	89536	110395	2		
H2	SCREW, PHP	114124	73734	19022	2		
H3	WASHER, FLAT	110775	89536	110775	2		
K2001	RELAY, ARMATURE, DPDT, 12VDC	176347	80089	62-760	1		
Q2001	XSTR, THYRISTOR, 1.6A, 50V	192567	03508	C-6F	1	1	
R2001	RES, COMP, 2.2K +/-10%, 2W	109967	01121	HE2221	2		
R2002	RES, COMP, 5.6K +/-10%, 1/2W	108324	01121	EB5621	1		
R2003	RES, COMP, 390 +/-10%, 1/2W	108365	01211	EB3911	1		
R2004	RES, COMP, 10K +/-10%, 1/2W	108118	01211	EB1031	1		
XQ2001	SOCKET, XSTR	104315	82305	14-47	1		

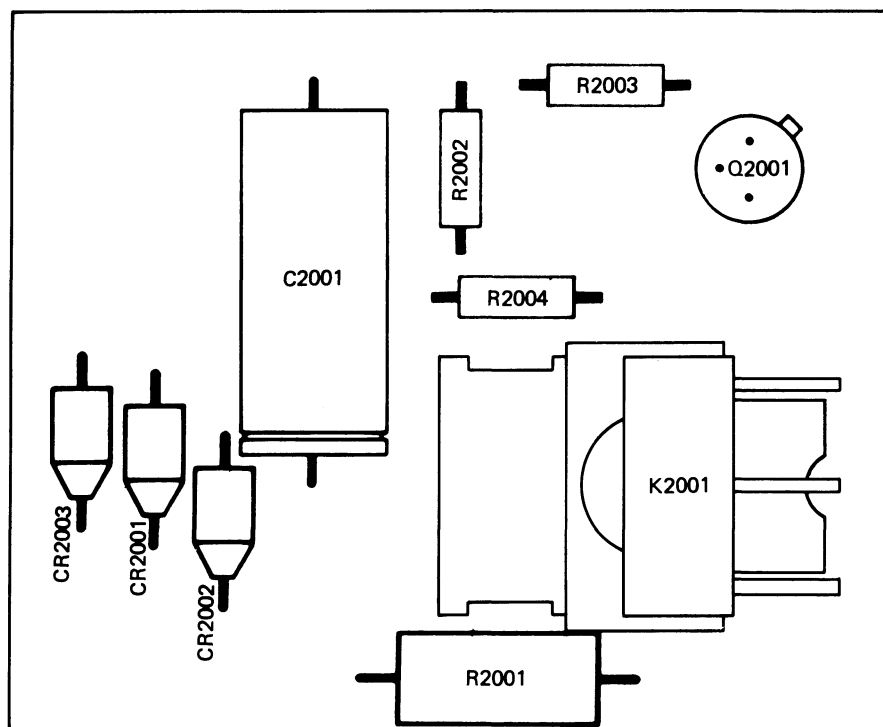


Figure 5-16. A7 Time Delay PCB Assembly

Table 5-18. A8 High Voltage Mother Board PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8	HIGH VOLTAGE MOTHER BOARD PCB ASSY FIGURE 5-17 (335A-4063)	219220	89536	219220	REF		
A8A1	SERIES PASS ELEMENT PCB ASSY	219204	89536	219204	REF		
A8A2	PRE-REGULATOR PCB ASSY	222000	89536	222000	REF		
C1	CAP, ELECT, 125UF +50/-10%, 450V	106336	89536	106336	3	1	
C2	CAP, ELECT, 125UF +50/-10%, 450V	106336	89536	106336	REF		
C3	CAP, ELECT, 125UF +50/-10%, 450V	106336	89536	106336	REF		
C4	CAP, ELECT, 8UF +50/-10%, 450V	194068	56289	39D805F450-H-E4	2	1	
C5	CAP, ELECT, 8UF +50/-10%, 450V	194068	56289	39D805F450-H-E4	REF		
C6	CAP, PLSTC, 1UF +/-20%, 200V	106450	89536	106450	1		
C7	CAP, ELECT, 50UF +75/-10%, 50V	105122	56289	30D506G050DD4	1	1	
C8	CAP, CER, 0.001UF +/-20%, 3KV	105635	80183	29C300	1		
C9	CAP, CER, 0.01UF, GMV, 1600V	106930	71590	DD16-103	1		
C10	CAP, OIL, 3UF +/-20%, 230V	185962	56289	200P1640	1		
CR1	DIODE, SI, IA, 600PIV	112383	05277	1N4822	20		
CR2	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR3	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR4	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR5	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR6	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR7	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR8	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR9	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR10	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR11	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR12	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR13	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR14	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR15	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR16	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR17	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR18	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR19	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR20	DIODE, SI, IA, 600PIV	112383	05277	1N4822	REF		
CR21	DIODE, SI, IA, 100PIV	116111	05277	1N4817	2		
CR22	DIODE, SI, IA, 100PIV	116111	05277	1N4817	REF		
H1	WASHER, SPLIT, #6	110395	89536	110395	1		
H2	NUT, HEX, 6-32	110635	89536	110635	1		
H3	WASHER, FLAT, #6	110775	89536	110775	1		
H4	SCREW, PHP, 6-32	115063	89536	115063	1		
H5	SCREW, 6-32	115022	89536	115022	2		
H6	SCREW, RHS, 6-32	114421	89536	114421	1		
H7	WASHER, FIBER, #6	110387	86928	5604-47	2		
H8	NUT, HEX, 6-32	110569	73734	70206	1		
H9	TUBE, CAP	135111	89536	135111	3		
J1	CONN, FEMALE, 16 CONTACT	187732	91662	00-5009-016-153-001	2		
J2	CONN, FEMALE, 16 CONTACT	187732	91662	00-5009-016-153-001	REF		
K1A	SWITCH, DRY REED, HIGH VOLTAGE	184440	12617	DRYT-10	2		
K1B	COIL, REED RELAY, 24V	186155	71707	SP-24-P	2		
MP1	CAP, PLATE	226845	89536	226845	1		
R1	RES, COMP, 220K +/-10%, 2W	110197	01121	HB2241	6		
R2	RES, COMP, 220K +/-10%, 2W	110197	01121	HB2241	REF		
R3	RES, COMP, 220K +/-10%, 2W	110197	01121	HB2241	REF		
R4	RES, COMP, 470K +/-5%, 1W	109819	01121	GB4745	2		
R5	RES, COMP, 470K +/-5%, 1W	109819	01121	GB4745	REF		

Table 5-18. A8 High Voltage Mother Board PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R6	RES, COMP, 10 +/-10%, 2W	110163	01121	HB1001	2		
R7	RES, COMP, 470 +/-10%, 1/2W	108415	01121	EB4711	1		
R8	RES, COMP, 5.1 +/-5%, 1W	219071	01121	GB5105	1		
R9	RES, COMP, 10 +/-10%, 2W	110163	01121	HB1001	REF		
R10	RES, COMP, 270 +/-10%, 2W	110189	01121	HB2711	1		
R11	RES, COMP, 2.2K +/-10%, 2W	109967	01121	HB2221	1		
R12	RES, COMP, 220K +/-10%, 2W	110197	01121	HB2241	REF		
R13	RES, COMP, 220K +/-10%, 2W	110197	01121	HB2241	REF		
R14	RES, COMP, 220K +/-10%, 2W	110197	01121	HB2241	REF		
R15	RES, WW, 2K +/-5%, 10W	155416	89536	155416	1		
T1	XFMR, PULSE	185827	89536	155416	1		
W1	HARNESS, REAR (NOT SHOWN)	225110	89536	225110	1		

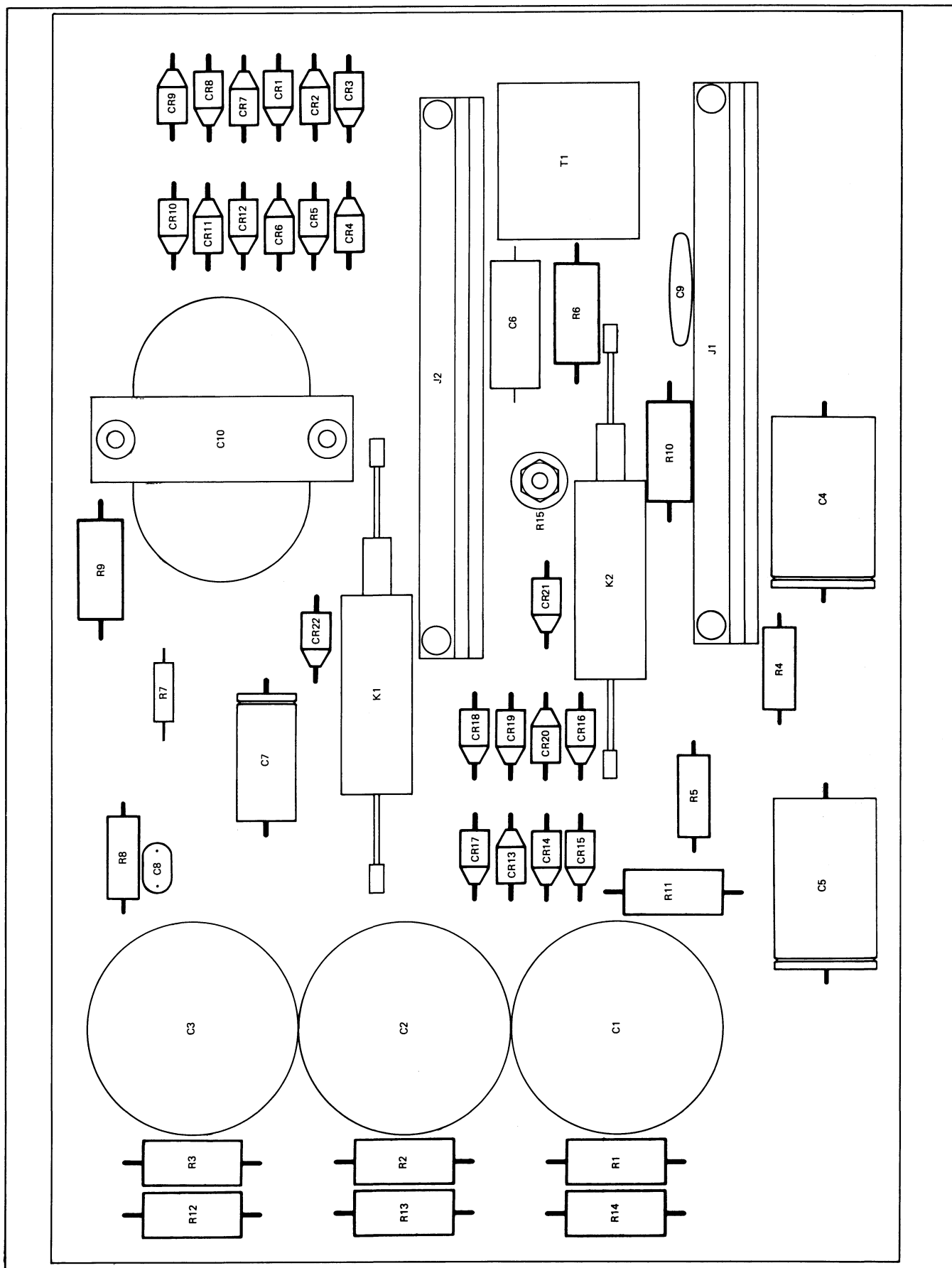


Figure 5-17. A8 High Voltage Mother Board PCB Assembly

Table 5-19. A8A1 Series Pass Element PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A1	SERIES PASS ELEMENT PCB ASSY FIGURE 5-18 (332B/AF-4061)	314823	89536	314823	REF		
C1	CAP, CER, 0.05UF +80/-10%, 500V	105676	56389	33C58B	1		
C2	CAP, ELECT, 8UF +50/-10%, 450V	194068	56289	39D805F450HE4	1	1	
C3	CAP, MYLAR, 0.0022UF +/-10%, 50V	313239	06001	75FIR5A224	1		
C4	CAP, CER, 0.005UF +/-20%, 100V	175232	56289	C023B101E802M	1		
C5	CAP, ELECT, 22UF +50/-10%, 25V	241356	80031	ET220X025A7	1	1	
CR1	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	17	4	
CR2	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR3	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR4	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR5	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR6	DIODE, ZENER, 16V +/-5%	313221	12969	UZ8716	1	1	
CR7	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR8	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR9	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR10	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR11	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR12	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR13	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR14	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR15	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR16	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR17	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR18	DIODE, ZENER, 20V	113340	07910	1N968A	1	1	
CR19	DIODE, ZENER, 36V	186163	07910	1N974E	1	1	
CR20	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	3	1	
CR21	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR22	DIODE, ZENER, 6.2V	180497	07910	1N753	1	1	
CR23	DIODE, ZENER, 200V	217422	04713	1N3051A	8	2	
CR24	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR25	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR26	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR27	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR28	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR29	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR30	DIODE, ZENER, 200V	217422	04713	1N3051A	REF		
CR31	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR32	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
H1	SPACER	153155	89536	153155	14		
H2	SCREW	152181	89536	152181	16		
H3	WASHER, SPLIT	110692	89536	110692	16		
H4	NUT, HEX	110569	73734	70206	16		
H5	WASHER, FLAT	111054	89536	111054	16		
H6	SPACER	103499	89536	103499	2		
J1	CONNECTOR, 16 PIN	187724	91662	02-016-013-5-200	1		
L1	CHOKE, RF, 2.2MH	147801	72259	WEE-2,200	2		
L2	CHOKE, RF, 2.2MH	147801	72259	WEE-2,200	REF		
L3	CHOKE, RF, 220UH	147835	72259	WEE-220	1		
Q1	XSTR, SI, NPN	190710	04713	2N3739	8	2	
Q2	XSTR, SI, NPN	190710	04713	2N3739	REF		
Q3	XSTR, SI, NPN	190710	04713	2N3739	REF		
Q4	XSTR, SI, NPN	190710	04713	2N3739	REF		
Q5	XSTR, SI, NPN	190710	04713	2N3739	REF		
Q6	XSTR, SI, NPN	190710	04713	2N3739	REF		
Q7	XSTR, SI, NPN	190710	04713	2N3739	REF		
Q8	XSTR, SI, NPN	190710	04713	2N3739	REF		

Table 5-19. A8A1 Series Pass Element PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q9	XSTR, SI, PNP	117176	03508	2N1671A	1	1	
Q10	XSTR, SI, NPN	203489	07910	CDQ10656	1	1	
Q11	XSTR, SI, NPN	218396	04713	2N3904	1	1	
Q12	XSTR, SI, NPN	177105	07263	2N3565	1	1	
R1	RES, COMP, 1.8K +/-10%, 2W	185983	01121	HB1821	3		
R2	RES, COMP, 1.8K +/-10%, 2W	185983	01121	HB1821	REF		
R3	RES, COMP, 1.8K +/-10%, 2W	185983	01121	HB1821	REF		
R4	RES, COMP, 62K +/-5%, 1/2W	108522	01121	EB6235	2		
R5	RES, COMP, 100K +/-10%, 2W	158659	01121	HB1041	1		
R6	RES, COMP, 56K +/-5%, 1/2W	219048	01121	EB5635	1		
R7	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	8		
R8	RES, COMP, 62K +/-5%, 1/2W	108522	01121	EB6235	REF		
R9	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R10	RES, COMP, 68K +/-5%, 1/2W	159624	01121	EB6835	1		
R11	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R12	RES, COMP, 75K +/-5%, 1/2W	108928	-1121	EB7535	2		
R13	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R14	RES, COMP, 82K +/-5%, 1/2W	195966	01121	EB8235	1		
R15	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R16	RES, COMP, 91K +/-5%, 1/2W	219030	01121	EB9135	1		
R17	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R18	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	9		
R19	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R20	RES, COMP, 1.1K +/-5%, 1/2W	163717	01121	EB1105	1		
R21	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R22	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R23	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R24	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R25	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R26	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R27	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R28	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	7		
R29	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	REF		
R30	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	REF		
R31	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	REF		
R32	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	REF		
R33	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	REF		
R34	RES, COMP, 22K +/-10%, 2W	109975	01121	HB2231	REF		
R35	RES, COMP, 75K +/-5%, 1/2W	108928	-1121	EB7535	REF		
R36	RES, COMP, 5.1K +/-5%, 1/4W	193342	01121	CB5125	3		
R37	RES, COMP, 36K +/-5%, 1/2W	185991	01121	EB3635	1		
R38	RES, COMP, 180 +/-5%, 1/2W	108944	01121	EB1815	1		
R39	RES, COMP, 5.1K +/-5%, 1/4W	193342	01121	CB5125	1		
R40	RES, COMP, 100K +/-5%, 1/2W	168054	01121	EB1045	REF		
R41	RES, COMP, 5.1K +/-5%, 1/4W	193342	01121	CB5125	REF		
R42	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R43	RES, COMP, 5.1K +/-5%, 1/4W	193342	01121	CB5125	REF		
XQ8	HEAT SINK	192245	89536	192245	1		
XQ9	SOCKET, XSTR	104315	82305	14-47	4		
XQ10	SOCKET, XSTR	104315	82305	14-47	REF		
XQ11	SOCKET, XSTR	104315	82305	14-47	REF		
XQ12	SOCKET, XSTR	104315	82305	14-47	REF		

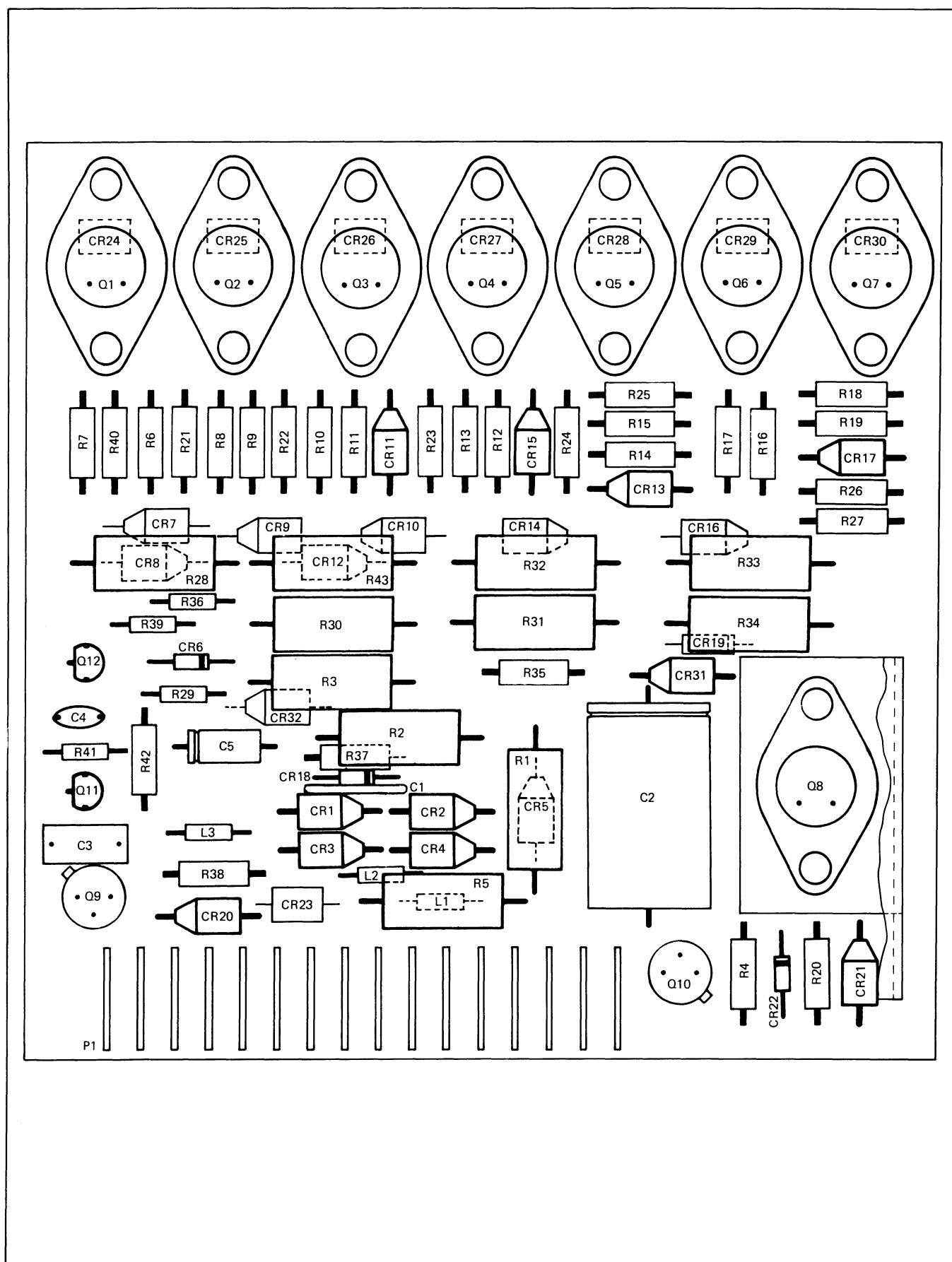


Table 5-20. A8A2 Pre-Regulator PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A2	PRE-REGULATOR PCB ASSY	314815	89536	314815	REF		
	FIGURE 5-19 (332B/AF-4082)						
A8A2A1	HEAT SINK ASSY (332B/AF-4099)	314807	89536	314807	1		
C1	CAP, CER,0.05UF +80/-10%, 500V	105676	56289	33C58B	4		
C2	CAP, CER,0.05UF +80/-10%, 500V	105676	56289	33C58B	REF		
C3	CAP, ELECT, 330UF +50/-10%, 16V	187765	80031	ET331X016A00	2	1	
C4	CAP, ELECT, 330UF +50/-10%, 16V	187765	80031	ET331X016A00	REF		
C5	CAP, MYLAR, 1.0UF, +/-20%, 200V	106450	89536	106450	1		
C6	CAP, CER,0.05UF +80/-10%, 500V	105676	56289	33C58B	REF		
C7	CAP, MYLAR, .001UF +/-10%,200V	159582	56289	192P10292	1		
C8	CAP, CER,0.05UF +80/-10%, 500V	105676	56289	33C58B	REF		
CR1	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	8		
CR2	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR3	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR4	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR5	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR6	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	4	1	
CR7	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR8	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR9	DIODE, SI, 1A, 600PIV	112383	05277	1N4822	REF		
CR10	DIODE, SI, 3A, 200PIV	187716	04713	1N4999	4	1	
CR11	DIODE, SI, 3A, 200PIV	187716	04713	1N4999	REF		
CR12	DIODE, SI, 3A, 200PIV	187716	04713	1N4999	REF		
CR13	DIODE, SI, 3A, 200PIV	187716	04713	1N4999	REF		
CR15	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR16	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
CR17	DIODE, SI, 1A, 100PIV	116111	05277	1N4817	REF		
H1	WASHER, FIBER, #6 (NOT SHOWN)	110387	86928	5604-47	2		
H2	WASHER, SPLIT, #6(NOT SHOWN)	110692	89536	110692	4		
H3	SCREW, 6-32 X 1-3/8 (NOT SHOWN)	114926	89536	114926	1		
H4	NUT, HEX, 6-32 (NOT SHOWN)	110569	73734	70206	2		
H5	SPACER, #6	144311	89536	144311	2		
H6	SCREW, 6-32 X 3/4	114223	89536	114223	2		
H7	WASHER, FLAT, #6	111054	89536	111054	3		
K1	RELAY, ARMATURE, 115VAC, DPDT	106864	16332	100-DPDT	1		
K2	RELAY, REED, 500V	136630	89536	136630	1		
	COIL, REED RELAY, 24V	186155	71707	SP-24-P	1		
P1	CONNECTOR, MALE, 16 CONTACT	187724	91662	02-016-013-5-200	1		
Q3	XSTR, TESTED, SI, NPN	203489	07910	CDQ10656	3	1	
Q4	XSTR, TESTED, SI, PNP	159491	89536	159491	4	1	
Q5	XSTR, TESTED, SI, NPN	203489	07910	CDQ10656	REF		
Q6	XSTR, TESTED, SI, PNP	159491	89536	159491	REF		
Q7	XSTR, TESTED, SI, NPN	203489	07910	CDQ10656	REF		
Q8	XSTR, TESTED, SI, PNP	159491	89536	159491	REF		
Q9	XSTR, TESTED, SI, PNP	159491	89536	159491	REF		
R1	RES, COMP, 68 +/-10%, 2W	110205	01121	EB6801	1		
R2	RES, WW, 0.192 +/-1%,3W	238741	89536	238741	1	1	
R4	RES, WW, 1K +/-5%, 5W	113282	44655	1532	1	1	
R5	RES, COMP, 22K +/-5%,1/2W	186064	01121	EB2235	1		
R7	RES, COMP, 220 +/-10%, 1/2W	108191	01121	EB2211	1		
R8	RES, COMP, 430 +/-5%, 1/2W	109058	01121	EB4315	1		
R9	RES, COMP, 100, +/-5%, 1/2W	188508	01121	EB1015	2		
R10	RES, COMP, 2.2K +/-5%, 1/2W	108506	01121	EB2225	1		
R11	RES, COMP, 100, +/-5%, 1/2W	188508	01121	EB1015	REF		
R12	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	4		
R13	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R14	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R15	RES, COMP, 4.7K +/-5%, 1/2W	108886	01121	EB4725	1		

Table 5-20. A8A2 Pre-Regulator PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R16	RES, COMP, 3.3K +/-5%, 1/2W	165761	01121	EB3325	1		
R17	RES, COMP, 1K +/-5%, 1/2W	108597	01121	EB1025	REF		
R18	RES, COMP, 560 +/-5%, 1/2W	109124	01121	EB5615	1		
R19	RES, COMP, 68 +/-5%, 1/2W	178384	01121	EB6805	1		
XQ3	SOCKET, XSTR	285262	71785	133-23-92-045	7		
XQ4	SOCKET, XSTR	285262	71785	133-23-92-045	REF		
XQ5	SOCKET, XSTR	285262	71785	133-23-92-045	REF		
XQ6	SOCKET, XSTR	285262	71785	133-23-92-045	REF		
XQ7	SOCKET, XSTR	285262	71785	133-23-92-045	REF		
XQ8	SOCKET, XSTR	285262	71785	133-23-92-045	REF		
XQ9	SOCKET, XSTR	285262	71785	133-23-92-045	REF		

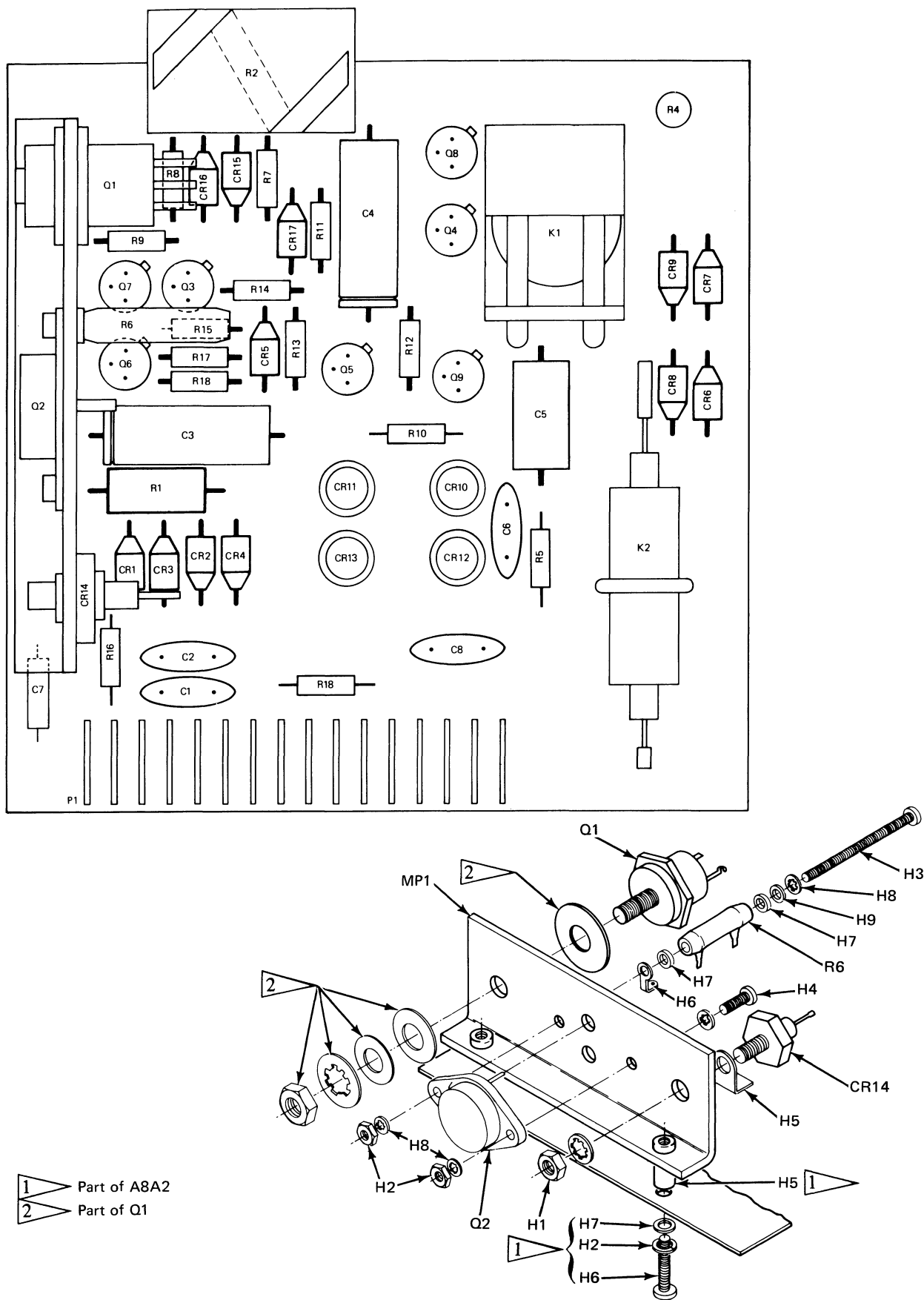


Figure 5-19. A8A2 Pre-Regulator PCB Assembly

Table 5-21. A8A2A1 Heat Sink Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A2A1	HEAT SINK ASSY INSET OF FIGURE 5-19 (332B/AF-4065)	314807	89536	314807	1		
CR14	DIODE, ZENER, 200V	187617	89536	187617	1		
H1	NUT, HEX	110619	89536	110619	1		
H2	NUT, HEX, 6-32	110569	73734	70206	2		
H3	SCREW, PHP, 6-32 X 1-3/4	114413	89536	114413	1		
H4	SCREW, SEMS, 6-32 X 3/8	177022	89536	177022	1		
H5	LUG, SOLDER	101501	79963	327	1		
H6	LUG, SOLDER	101055	89536	101055	1		
H7	WASHER, FIBER, #6	110387	89536	110387	2		
H8	WASHER, LOCK, #6	110338	89536	110338	1		
H9	WASHER, FLAT, #6	111054	89536	111054	1		
MP1	HEAT SINK(332 B/AF 2043)	314898	89536	314898	1		
Q1	XSTR, SI, NPN, 200W	193953	05277	320C034431	1		
Q2	XSTR, SI, NPN, 80W	261347	89536	261347	1		
R6	RES, PWR, 1.0 +/-5%, 8W	112425	44655	1D48F	1		

Table 5-22. A9 Extender PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9	EXTENDER PCB ASSY NOT SHOWN (335B-415)	325415	89536	325415	REF		

Table 5-23. A10 Matched PCB Set Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10	MATCHED PCB SET ASSY FIGURE 5-20 (332B/AF-4065)	314997	89536	314997	1		
A10A2	SAMPLE STRING PCB ASSY	ORDER	NEXT	HIGHER ASSY			
A10A4	RANGE CAL PCB ASSY	ORDER	NEXT	HIGHER ASSY			
A10A10	MATCHED RESISTOR SET ASSY	322420	89536	322420	1		
H1	WASHER, FIBER, #4	145391	76854	2-1185-119	4		
H2	WASHER, SPLI, #4	110395	89536	110395	4		
H3	NUT, HEX, 4-40	184044	89536	184044	4		
R47	RES, VAR, 100 +/-20%, 1/2W	267823	11236	190PC101B	1		
R48	RES, VAR, 200 +/-20%, 1/2W	284711	11236	190PC201B	1		
R49	RES, VAR, 500 +/-20%, 1/2W	267849	11236	190PC501B	2		
R50	RES, VAR, 500 +/-20%, 1/2W	267849	11236	190PC501B	REF		
R51	RES, MF, 100 +/-1%, 1/8W	168195	91637	MFF1-81000F	1		
R52	RES, MF, 200 +/-1%, 1/8W	245340	91637	MFF182000F	1		
R53	RES, MF, 348 +/-1%, 1/8W	236778	91637	MFF1-83480F	2		
R54	RES, MF, 348 +/-1%, 1/8W	236778	91637	MFF1-83480F	REF		
S6	SWITCH, 332D-8010	313023	89536	313023	1		
S7	SWITCH ASSY, 335A-4050	291021	89536	291021	1		
	R67, 0.1						
	R68, 0.1						
	R69, 0.1						
	R70, 0.1						
	R71, 0.1						
	R72, 0.1						
	R73, 0.1						
	R74, 0.1						
	R75, 0.1						
	R76, 0.1						

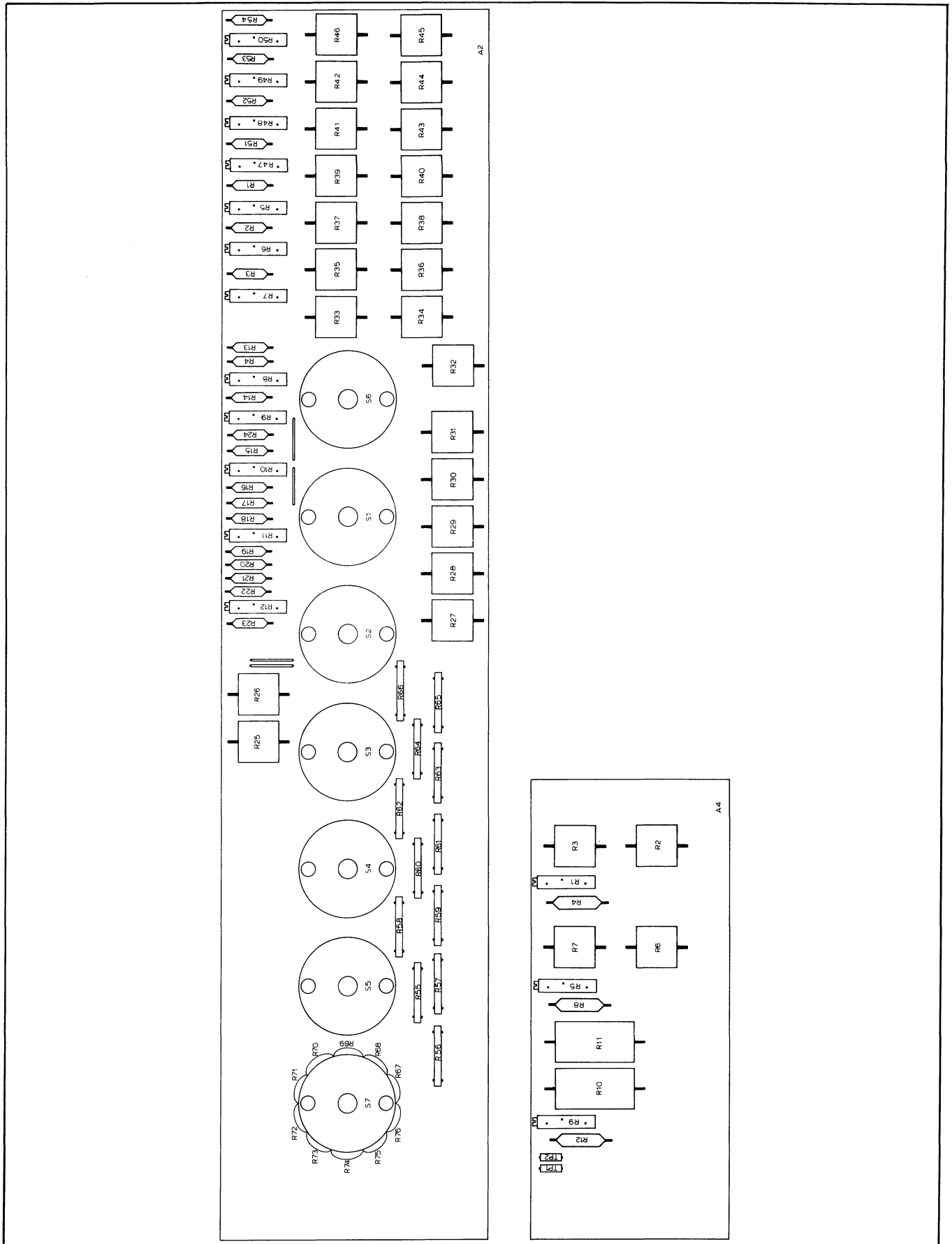


Figure 5-20. A10 Matched PCB Set Assembly

Table 5-24. A10A2 Sample String PCB Assembly



ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A2	SAMPLE STRING PCB ASSY (A2) NOT SHOWN AS ASSY FIGURE 5-20 SHOWS COMPONENTS MOUNTED	ORDER	NEXT	HIGHER ASSY			
H1	NUT, HEX, 4-40	184044	89536	184044	10		
H2	WASHER, SPLIT, #4	110395	89536	110395	10		
H3	WASHER, FIBER, #4	145391	89536	145391	10		
R1	RES, MF, 34 +/-1%, 1/8W	296699	91637	MFF1-8R340F	2		
R2	RES, MF, 34 +/-1%, 1/8W	296699	91637	MFF1-8R340F	REF		
R3	RES, MF, 20 +/-1%, 1/8W	236844	91637	MFF1-8R200F	2		
R4	RES, MF, 20 +/-1%, 1/8W	236844	91637	MFF1-8R200F	REF		
R5	RES, VAR, 50 +/-20%, 1/2W	267815	11236	190PC500B	2	1	
R6	RES, VAR, 50 +/-20%, 1/2W	267815	11236	190PC500B	REF		
R7	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	6	1	
R8	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	REF		
R9	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	REF		
R10	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	REF		
R11	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	REF		
R12	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	REF		
R13	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	12		
R14	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R15	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R16	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R17	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R18	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R19	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R20	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R21	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R22	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R23	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R24	RES, MF, 10 +/-1%, 1/8W	268789	91637	MFF1-8R100F	REF		
R47							
R48							
R49							
R50							
R51							
R52							
R53							
R54							
S1	SWITCH, 332D-8010	313023	89536	313023	5		
S2	SWITCH, 332D-8010	313023	89536	313023	REF		
S3	SWITCH, 332D-8010	313023	89536	313023	REF		
S4	SWITCH, 332D-8010	313023	89536	313023	REF		
S5	SWITCH, 332D-8010	313023	89536	313023	REF		
							
	R47 THROUGH R54 ARE LISTED ON THE A10 MATCHED PCE SET ASSY						
	NOTE:						
	ALL OTHER RESISTORS BELONG TO THE A10A10 MATCHED RESISTOR SET ASSY						

Table 5-25. A10A4 Range Cal PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A4	RANGE CAL PCB ASSY (A4) NOT SHOWN AS ASSY FIGURE 5-20 SHOWS COMPONENTS MOUNTED						
H1	SPACER, HEX, SWAGED	181735	89536	181735	2		
R1	RES, VAR, 20 +/-20%, 1/2W	261180	11236	190PC200B	1	1	
R4	RES, MF, 20 +/-1%, 1/2W	296350	91637	MFF1-2R200F	1		
R5	RES, VAR, 200 +/-20%, 1/2W	284711	71450	190PC201B	1	1	
R8	RES, MF, 200 +/-1%, 1/2W	151480	91637	MFF1-22000F	1		
R9	RES, VAR, 2K +/-20%, 1/2W	267864	71450	190PC202B	1	1	
R12	RES, MF, 2K +/-1%, 1/2W	151266	91637	MFF1-22001F	1		
TP1	CONN, TEST JACK, RED	170480	74970	105-752	1		
TP2	CONN, TEST JACK, BLACK	149112	74970	105-0753	1		
NOTE:							
ALL OTHER RESISTORS BELONG TO THE A10A10 MATCHED RESISTOR SET ASSY							

Table 5-26. A10A10 Matched Resistor Set Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A10	MATCHED RESISTOR SET ASSY NOT SHOWN AS ASSY FIGURE 5-20 SHOWS COMPONENTS MOUNTED	322420	89536	322420	1		
	A2R25, 997.5						
	A2R26, 1996.5						
	A2R27, 3.995K						
	A2R28, 3.995K						
	A2R29, 19.985K						
	A2R30, 19.985K						
	A2R31, 19.985K						
	A2R32,, 19.985K						
	A2R33, 19.985K						
	A2R34, 19.985K						
	A2R35, 19.985K						
	A2R36, 99.925K						
	A2R37, 99.925K						
	A2R38, 99.925K						
	A2R39, 99.925K						
	A2R40, 99.925K						
	A2R41, 99.925K						
	A2R42, 99.925K						
	A2R43, 99.925K						
	A2R44, 99.925K						
	A2R45, 99.925K						
	A2R46, 99.925K						
	A2R55, 2						
	A2R56, 1						
	A2R57, 4						
	A2R58, 4						
	A2R59, 10						
	A2R60, 20						
	A2R61, 40						
	A2R62, 40						
	A2R63, 100						
	A2R64, 200						
	A2R65, 400						
	A2R66, 400						
	A4R2, 7492.5						
	A4R3, 7492.5						
	A4R6, 74.925K						
	A4R7, 74.925K						
	A4R10, 749.250K						
	A4R11, 749.250K						

Section 6
Option & Accessory Information

This instrument has no options or accessories.

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Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

Federal Supply Codes for Manufacturers

D9816 Westermann Wilhelm Augusta-Anlage Mannheim-Nackarau Germany	01101 Wabash Inc (Formerly Wabash Magnetics) Wabash, IN	02697 Parker-Hannifin Corp. O-Ring Div Lexington, KY	04423 Telonic Berkley Inc. Laguna Beach, CA
S0482 Sony Corp. Tokyo, Japan	01121 Allen Bradley Co. Milwaukee, WI	02735 RCA-Solid State Div. Somerville, NJ	04713 Motorola Inc. Semiconductor Group Phoenix, AZ
S3774 Oshino Electric Lamp Works Tokoyo, Japan	01281 TRW Electronics & Defense Sector R F Devices Lawndale, CA	02768 ITW (IL Tool Works) Fastex Division Des Plaines, IL	04946 Standard Wire and Cable Rancho Dominguez, CA
0AD86 IN General El Paso, TX	01295 TX Instruments Inc. Semiconductor Group Dallas, TX	02799 Arco Electronics Inc. Chatsworth, CA	05173 General Radio NY,NY. Replaced by:
0AE89 Autosplce Inc. Woodside, NY	01526 Genicom Waynesboro, VA	03296 Nylon Molding Corp. Monrovia, CA	24655 Genrad,INC. Concord, MA
0BW21 Noritake Co. Inc. Burlington, MA	01537 Motorola Communications & Electronics Inc. Franklin Park, IL	03445 Lercon Electronics Inc Burbank, CA	05236 Jonathan Mfg. Co. Fullerton, CA
0ANF0 Topaz Semiconductor Inc San Jose, CA	01686 RCL Electronics/Shallcross Inc. Electro Components Div. Manchester, NH	03508 General Electric Co. Semiconductor Products & Batteries Auburn, NY	05245 Corcom Inc. Libertyville, IL
0DSM7 Conductive (Pkg) Containers Inc. Brookfield, WI	01884 Sprague Electric Co. (Now 56289)	03797 Genisco Technology Corp. Eltronics Div. Rancho Dominguez, CA	05276 ITT Pomona Electronics Div. Pomona, CA
0CLN7 Ernhart Fastening Group Shelton, CT	01961 Varian Associates Inc. Pulse Engineering Div. Convoy, CT	03877 Gilbert Engineering Co.Inc Incon Sub of Transitron Electronic Corp. Glendale, AZ	05277 Westinghouse Elec. Corp. Semiconductor Div. Youngwood, PA
0FB81 S-Mos Systems Inc. San Jose, CA	01963 Cherry Electrical Products Corp Waukegan, IL	03888 KDI Electronics Inc. Pyrofilm Div. Whippany, NJ	05347 Ultronix Inc Grand Junction, CO
0FFP1 Eveready LTD Ever Ready Special Battery Div. Dawley Telford Salop UK	02111 Spectrol Electronics Corp. City of Industry, CA	03911 Clairex Corp. Clairex Electronics Div. Mount Vernon, NY	05397 Union Carbide Corp. Materials Systems Div. Cleveland. OH
00199 Marcon Electronics Corp Kearny, NJ	02114 Amperex Electronic Corp. Ferrox Cube Div. Saugerties, NY	03980 Muirhead Inc. Mountainside, NJ	05571 Sprague Electric Co. (Now 56289)
00213 Nytronics Comp. Group Inc. Darrington, NC	02131 General Instrument Corp. Government Systems Div. Westwood, MA	04009 Cooper Industries, Inc. Arrow Hart Div. Hartford, CT	05574 Viking Connectors Inc Sub of Criton Corp. Chatsworth, CA
00327 Welwyn International Inc. Westlake, OH	02395 Sonar Radio Corp. Hollywood, FL	04217 Essex International Inc. Wire & Cable Div. Anaheim, CA	05791 LYN-TRON Burbank, CA
00656 Aerovox Corp. New Bedford, MA	02533 Leigh Instruments Ltd. Frequency Control Div. Don Mills, Ontario, Canada	04221 Midland-Ross Corp. Midtex Div. N. Mankato, MN	05820 EG & G Wakefield Engineering Wakefield, MA
00686 Film Capacitors Inc. Passaic, NJ	02606 Fenwal Labs Division of Travenal Labs Morton Grove, IL	04222 AVX Corp. AVX Ceramics Div. Myrtle Beach, SC	05839 Advance Electrical Chicago, IL
00779 AMP, Inc. Harrisburg, Pennsylvania	02660 Bunker Ramo-Eltra Corp. Amphenol NA Div. Broadview, IL		05972 Loctite Corp. Newington, CT

Federal Supply Codes for Manufacturers (cont)

06001 General Electric Co. Electric Capacitor Product Section Columbia, SC	07047 Ross Milton Co., The Southampton, PA	08111 MF Electronics New Rochelle, NY	1B715 (United Shoe & Nylock Corp) -Nylock Fastener Corp.- Paramus, NJ
06141 Fairchild Weston Systems Inc. Data Systems Div. Sarasota, FL	07138 Westinghouse Electric Corp. Industrial & Government Tube Div. Horseheads, NY	08235 Industro Transistor Corp. Long Island City, NY	10059 Barker Engineering Corp. Kenilworth, NJ
06192 La Deau Mfg. Co. Glendale, CA	07233 Benchmark Technology Inc. City of Industry, CA	08261 Spectra-Strip An Eltra Co. Garden Grove, CA	10389 IL Tool Works Inc. Licon Div. Chicago, IL
06229 Electrovert Inc. Elmsford, NY	07239 Biddle Instruments Blue Bell, PA	08445 Electri-Cord Mfg., Inc Westfield, PA	11236 CTS Corp. Resistor Products Div. Beme, IN
06383 Panduit Corp. Tinley Park, IL	07256 Silicon Transistor Corp. Sub of BBF Inc. Chelmsford, MA	08530 Reliance Mica Corp. Brooklyn, NY	11237 CTS Corp of CA Electro Mechanical Div. Paso Robles, CA
06473 Bunker Ramo Corp. Amphenol NA Div. SAMS Operation Chatsworth, CA	07261 Avnet Corp. Culver City, CA	08718 ITT Cannon Electric Phoenix Div. Phoenix, AZ	11295 ECM Motor Co. Schaumburg, IL
06540 Mite Corp Amatom-Electrical Div	07263 Fairchild Semiconductor North American Sales Ridgeview, CT	08806 General Electric Co. Minature Lamp Products Cleveland, OH	11358 Columbia Broadcasting System CBS Electronic Div. Newburyport, MA
06555 Beede Electrical Instrument Penacook, NH	07344 Bircher Co. Inc., The Rochester, NY	08863 Nylomatic Fallsington, PA	11403 Vacuum Can Co. Best Coffee Maker Div. Chicago, IL
06665 Precision Monolithics Sub of Bouns Inc. Santa Clara, CA	07374 Optron Corp Woodbridge, CT	08988 Skottie Electronics Inc. Archbald, PA	11502 (can also use 35009) TRW Inc. TRW Resistive Products Div. Boone, NC
06666 General Devices Co. Inc. INpolis, IN	07557 Campion Co. Inc. Philadelphia, PA	09021 Airco Inc. Airco Electronics Bradford, PA	11503 Keystone Columbia Inc. Freemont, IN
06739 Electron Corp. Littleton, CO	07597 Bumdy Corp. Tape/Cable Div. Rochester, NY	09023 Cornell-Dublier Electronics Fuquay-Varina, NC	11532 Teledyne Relays Teledyne Industries Inc. Hawthorne, CA
06743 Gould Inc. Foil Div. Eastlake, OH	07716 TRW Inc. (Can use 11502) IRC Fixed Resistors/ Burlington Burlington, VT	09214 General Electric Co. Semiconductor Products Dept. Auburn, NY	11711 General Instrument Corp. Rectifier Div. Hicksville, NY
06751 Components Inc. Semcor Div. Phoenix, AZ	07792 Lerma Engineering Corp. Northampton, MA	09353 C and K Components Inc. Newton, MA	11726 Qualidyne Corp. Santa Clara, CA
06776 Robinson Nugent Inc. New Albany, IN	07810 Bock Corp. Madison, WI	09423 Scientific Components Inc. Santa Barbara, CA	12014 Chicago Rivet & Machine Co. Naperville, IL
06915 Richco Plastic Co. Chicago, IL	07910 Teledyne Semiconductor Mtn. View, CA	09922 Bumdy Corp. Norwalk, CT	12020 Ovenaire Div. of Electronic Technologies Charlottesville, VA
06961 Vemitron Corp. Piezo Electric Div. Bedford, OH	07933 Raytheon Co. Semiconductor Div. Mountain View, CA	09969 Dale Electronics Inc. Yankton, SD	12038 Simco (Div of Ransburg Corp) Hatfield, PA
06980 EIMAC (See Varian) San Carlos, CA	08FG6 Calmos Systems Inc. Kanata, Ont. Canada	09975 Burroughs Corp. Electronics Components Detroit, MI	12040 National Semiconductor Corp. Danbury, CT
	080A9 Dallas Semiconductor Dallas, TX	1A791 LFE Electronics Danvers, MA	

Federal Supply Codes for Manufacturers (cont)

12060 Diodes Inc. Northridge, CA	13050 Potter Co. Wesson, MS	14704 Crydom Controls (Division of Int Rectifier) El Segundo, CA	16473 Cambridge Scientific Industries Div. of Chemed Corp. Cambridge, MD
12136 PHC Industries Inc. Formerly Philadelphia Handle Co. Camden, NJ	13103 Thermalloy Co., Inc. Dallas, TX	14752 Electro Cube Inc. San Gabriel, CA	16733 Cablewave Systems Inc. North Haven, CT
12300 AMF Canada Ltd. Potter-Brumfield Guelph, Ontario, Canada	13327 Solitron Devices Inc. Tappan, NY	14936 General Instrument Corp. Discrete Semi Conductor Div. Hicksville, NY	16742 Paramount Plastics Fabricators Inc. Downey, CA
12323 Practical Automation Inc. Shelton, CT	13511 Bunker-Ramo Corp. Amphenol Cadre Div. Los Gatos, CA	14949 Trompeter Electronics Chatsworth, CA	16758 General Motors Corp. Delco Electronics Div. Kokomo, IN
12327 Freeway Corp. Cleveland, OH	13606 Sprague Electric Co. (Use 56289)	15412 Amtron Midlothian, IL	17069 Circuit Structures Lab Burbank, CA
12406 Elpac Electronics Inc. Santa Ana, CA	13689 SPS Technologies Inc. Hatfield, NJ	15542 Scientific Components Corp. Mini-Circuits Laboratory Div. Brooklyn, NY	17117 Electronic Molding Corp. Woonsocket, RI
12443 Budd Co.,The Plastics Products Div. Phoenixville, PA	13764 Micro Plastics Flippin, AZ	15636 Elec-Trol Inc. Saugus, CA	17338 High Pressure Eng. Co. Inc. OK City, OK
12581 Hitachi Metals International Ltd. Hitachi Magna-Lock Div. Big Rapids, MO	13919 Burr-Brown Research Corp. Tucson, AZ	15782 Bausch & Lomb Inc. Graphics & Control Div. Austin, TX	17504 Aluminum Filter Co. Carpinteria, CA
12615 US Terminals Inc. Cincinnati, OH	14099 Semtech Corp. Newbury Park, CA	15801 Fenwal Electronics Inc. Div. of Kidde Inc. Framingham, MA	17545 Atlantic Semiconductors Inc. Asbury Park, NJ
12617 Hamlin Inc. LaKe Mills, WI	14140 McGray-Edison Co. Commercial Development Div. Manchester, NH	15818 Teledyne Inc. Co. Teledyne Semiconductor Div. Mountain View, CA	17745 Angstrom Precision, Inc. Hagerstown, MD
12673 Wesco Electrical Greenfield, MA	14189 Ortronics, Inc. Orlando, FL	15849 Usecu Inc. (Now 88245)	17856 Siliconix Inc. Santa Clara, CA
12697 Clarostat Mfg. Co. Inc. Dover, NH	14193 Cal-R-Inc. Santa Monica, CA	15898 International Business Machines Corp. Essex Junction, VT	18178 E G & Gvactee Inc. St. Louis, MO
12749 James Electronic Inc. Chicago, IL	14301 Anderson Electronics Hollidaysburg, PA	16068 International Diode Div. Harrison, NJ	18235 KRL/Bantry Components Inc. Manchester, NH
12856 MicroMetals Inc. Anaheim, CA	14329 Wells Electronics Inc. South Bend, IN	16162 MMI Southfield, MI	18310 Concord Electronics New York, NY
12881 Metex Corp. Edison, NJ	14482 Watkins-Johnson Co. Palo Alto, CA	16245 Conap Inc. Olean, NY	18324 Signetics Corp. Sacramento, CA
12895 Cleveland Electric Motor Co. Cleveland, OH	14552 Microsemi Corp. (Formerly Micro-Semiconductor) Santa Ana, CA	16258 Space-Lok Inc. Burbank, CA	18377 Parlex Corp. Methuen, MA
12954 Microsemi Corp. Components Group Scottsdale, AZ	14604 Elmwood Sensors, Inc Pawtucket, RI	16352 Codi Corp. Linden, NJ	18520 Sharp Electronics Corp. Paramus, NJ
12969 Unitrode Corp. Lexington, MA	14655 Cornell-Dublier Electronics Div. of Federal Pacific Electric Co. Govt Cont Dept. Newark, NJ	16469 MCL Inc. LaGrange, IL	18542 Wabash Inc. Wabash Relay & Electronics Div. Wabash, IN

Federal Supply Codes for Manufacturers (cont)

18565 Chomerics Inc. Woburn, MA	2Y384 North American Philips Lighting Corp. Van Wert, OH	23732 Tracor Applied Sciences Inc. Rockville, MD	26402 Lumex, Inc. Bayshore, NY
18612 Vishay Intertechnology Inc. Vishay Resistor Products Group Malvern, PA	20584 Enochs Mfg. Inc. INpolis, IN	23880 Stanford Applied Engineering Santa Clara, CA	26629 Frequency Sources Inc. Sources Div. Chelmsford, MA
18632 Norton-Chemplast Santa Monica, CA	20891 Cosar Corp. Dallas, TX	23936 William J. Purdy Co. Pamotor Div. Burlingame, CA	26806 American Zettler Inc. Irvine, CA
18677 Scanbe Mfg. Co. Div. of Zero Corp. El Monte, CA	21317 Electronics Applications Co. El Monte, CA	24347 Penn Engineering Co. S. El Monte, CA	27014 National Semiconductor Corp. Santa Clara, CA
18736 Voltronics Corp. East Hanover, NJ	21604 Buckeye Stamping Co. Columbus, OH	24355 Analog Devices Inc. Norwood, MA	27167 Coming Glass Works Coming Electronics Wilmington, NC
18786 Micro-Power Long Island City, NY	21845 Solitron Devices Inc. Semiconductor Group Riviera Beach, FL	24444 General Semiconductor Industries, Inc. Tempe, AZ	27264 Molex Inc. Lisle, IL
18927 GTE Products Corp. Precision Material Products Business Parts Div. Titusville, PA	21847 Aertech Now TRW Microwave Inc. Sunnyvale, CA	24546 Bradford Electronics Bradford, PA	27440 Industrial Screw Products Los Angeles, CA
19080 Robinson Electronics Inc. San Luis Obispo, CA	21962 Vectron Corp. Replaced by: S.W. Electronics	24618 Transcon Mfg. Now: D.J. Associates Inc.	27494 Staffall, Inc. Providence, RI
19112 Garry Corp. Langhorne, PA	22526 DuPont, EI DeNemours & Co. Inc. DuPont Connector Systems Advanced Products Div. New Cumberland, PA	24655 Genrad Inc. (Replaced General Radio 05173) Concord, MA	27745 Associated Spring Bames Group Inc. Syracuse, NY
19315 Bendix Corp., The Navigation & Control Group Terboro, NJ	22626 Micro Semiconductor (Now 14552)	24759 Lenox-Fugle Electronics Inc. South Plainfield, NJ	27918 Component Parts Corp. Bellmore, NY
19451 Perine Machine Tool Corp. Kent, WA	22670 GM Nameplate Seattle, WA	24796 AMF Inc. Potter & Brumfield Div. San Juan Capistrano, CA	27956 Relcom (Now 14482)
19482 Delta Electronics Alexandria, VA	22767 ITT Semiconductors Palo Alto, CA	24931 Specialty Connector Co. Greenwood, IN	28175 Alpha Metals Chicago, IL
19613 MN Mining & Mfg. Co. Textool Products Dept. Electronic Product Div. Irving, TX	22784 Palmer Inc. Cleveland, OH	24995 ECS Grants Pass, OR	28198 Positronic Industries Springfield, MO
19647 Caddock Electronics Inc. Riverside, CA	23050 Product Comp. Corp. Mount Vernon, NY	25088 Siemen Corp. Isilen, NJ	28213 MN Mining & Mfg. Co. Consumer Products Div. 3M Center Saint Paul, MN
19701 Mepco/Centralab Inc. A N. American Philips Co. Mineral Wells, TX	23223 CTS Microelectronics Lafayette, NY	25099 Cascade Gasket Kent, WA	28309 Kaiser Minette, AL
2B178 Wire Products Cleveland, OH	23237 I.R.C., Inc. Microcircuits Division Philadelphia, PA	25403 Amperex Electronic Corp. Semiconductor & Micro-Circuit Div. Slatersville, RI	28425 Serv-O-Link Eulless, TX
2K262 Boyd Corporation Portland, OR	23302 S.W. Electronics & Mfg. Corp. Cherry Hill, NJ	25435 Moldtronics, Inc Downers Grove, IL	28478 Deltrol Corporation Deltrol Controls Div. Milwaukee, WI
	23730 Mark Eyelet and Stamping Inc. Wolcott, CT	25706 Dabum Electronic & Cable Corp. Norwood, NJ	28480 Hewlett Packard Co. Corporate HQ Palo Alto, CA

Federal Supply Codes for Manufacturers (cont)

28484 Emerson Electric Co. Gearmaster Div. McHenry, IL	31433 Kemet Electronics Corp. Simpsonville, NC	33246 Epoxy Technology Inc. Billerica, MA	36701 Van Waters & Rogers Valley Field, Quebec, Canada
28520 Heyco Molded Products Kenilworth, NJ	31448 Army Safeguard Logistics Command Huntsville, AL	33292 Pioneer Sterilized Wiping Cloth Co. Portland, OR	37942 Mallory Capacitor Corp. Sub of Emhart Industries INpolis, IN
28932 Lumax Industrials, Inc Altoona, PA	31471 Gould Inc Semiconductor Div Santa Clara, CA	33297 NEC Electronics USA Inc. Electronic Arrays Inc. Div. Mountain View, CA	39003 Maxim Industries Middleboro, MA
29083 Monsanto Co. Santa Clara, CA	31522 Metal Masters Inc. Baldwin, MS	33919 Nortek Inc. Cranston, RI	4F434 Plastic Sales Los Angeles, CA
29604 Stackpole Components Co. Raleigh, NC	31746 Cannon Electric Woodbury, TN	34114 Oak Industries Rancho Bernardo, CA	40402 Roderstein Electronics Inc. Statesville, NC
29907 Omega Engineering Inc. Stamford, CT	31827 Budwig Ramona, CA	34263 CTS Electronics Corp. Brownsville, TX	42498 National Radio Melrose, MA
3D536 Aimsco Inc. Seattle, WA	31918 ITT-Schadow Eden Prairie, MN	34333 Silicon General Inc. Garden Grove, CA	43543 Nytronics Inc.(Now 53342)
30035 Jolo Industries Inc. Garden Grove, CA	32293 Intersil Cupertino, CA	34335 Advanced Micro Devices (AMD) Sunnyvale, CA	43744 Panasonic Industrial Co. San Antonio, TX
30045 Solid Power Corp. Farmingdale, NY	32539 Mura Corp. Westbury, Long Island, N.Y.	34359 MN Mining & Mfg. Co. Commercial Office Supply Div. Saint Paul, MN	43791 Datron Systems Wilkes Barre, PA
30146 Symbex Corp. Painesville, OH	32559 Bivar Santa Ana, CA	34371 Harris Corp. Harris Semiconductor Products Group Melbourne, FL	44655 Ohmite Mfg. Co. Skokie, IL
30148 AB Enterprise Inc. Ahoskie, NC	32719 Siltronics Santa Ana, CA	34576 Rockwell International Corp. Newport Beach, CA	47001 Lumberg Inc. Richmond, VA
30161 Aavid Engineering Inc. Laconia, NH	32767 Griffith Plastics Corp. Burlingame, CA	34641 Instrument Specialties Euless, TX	47379 ISOCOM Campbell, CA
30315 Itron Corp. San Diego, CA	32879 Advanced Mechanical Components Northridge, CA	34649 Intel Corp. Santa Clara, CA	49569 IDT (International Development & Trade) Dallas, TX
30323 IL Tool Works Inc. Chicago, IL	32897 Murata Erie North America Inc. Carlisle Operations Carlisle, Pennsylvania	34802 Electromotive Inc. Kenilworth, NJ	49671 RCA Corp. New York, NY
30800 General Instrument Corp. Capacitor Div. Hicksville, NY	32997 Bourns Inc. Trimpot Div. Riverside, CA	34848 Hartwell Special Products Placentia, CA	49956 Raytheon Company Executive Offices Lexington, MA
30838 Fastec Chicago, ILL	33025 M/A ComOmni Spectra, Inc. (Replacing Omni Spectra) Microwave Subsystems Div. Tempe, AZ	35009 Renfrew Electric Co. Ltd. IRC Div. Toronto, Ontario, Canada	5D590 Mostek Corp. Replaced by: SGS Thompson Microelec- tronics
31019 Solid State Scientific Inc. Willow Grove, PA	33096 CO Crystal Corp. Loveland, CO	35986 Amrad Melrose Park, IL	5F520 Panel Components Corp. Santa Rosa, CA
31091 Alpha Industries Inc. Microelectronics Div. Hatfield, PA	33173 General Electric Co. Owensboro, KY	36665 Mitel Corp. Kanata, Ontario, Canada	5P575 Nobel Electronics Suffern, NY
31323 Metro Supply Company Sacramento, CA			5W664 NDK Div. of Nihon Dempa Kogyo LTD Lynchburg, VA

Federal Supply Codes for Manufacturers (cont)

5U802 Dennison Mfg. Co. Framingham, MA	51499 Amtron Corp. Boston, MA	52840 Western Digital Corp. Costa Mesa, CA	54937 DeYoung Mfg. Bellevue, WA
50088 SGS - Thomson Microelectronics Inc. Carrollton, TX	51506 Accurate Screw Machine Co. (ASMCO) Nutley, NJ	53021 Sangamo Weston Inc. (See 06141)	54590 RCA Corp. Electronic Components Div. Cherry Hill, NJ
50120 Eagle-Picher Industries Inc. Electronics Div. CO Springs, CO	51605 CODI Semiconductor Inc. Kenilworth, NJ	53036 Textool Co. Houston, TX	55026 American Gage & Machine Co. Simpson Electric Co. Div. Elgin, IL
50157 Midwest Components Inc. Muskegon, MS	51642 Centre Engineering Inc. State College, PA	53184 Xciton Corp. Lathan, NY	55112 Plessey Capacitors Inc. (Now 60935)
50356 Teac Corp. of America Industrial Products Div. Montebello, CA	51705 ICO/Rally Palo alto, CA	53217 Technical Wire Products Inc. Santa Barbara, CA	55261 LSI Computer Systems Inc. Melville, NY
50364 MMI, Inc.(Monolithic Memories Inc) Military Products Div. Santa Clara, CA	51791 Statek Corp. Orange, CA	53342 Opt Industries Inc. Phillipsburg, NJ	55285 Berequist Co. Minneapolis, MN
50472 Metal Masters, Inc. City of Industry, CA	51984 NEC America Inc. Falls Church, VA	53673 Thompson CSF Components Corp. (Semiconductor Div) Conaga Park, CA	55322 Samtech Inc. New Albany, IN
50541 Hypertronics Corp. Hudson, MA	52063 Exar Integrated Systems Sunnyvale, CA	53718 Airmold/W. R. Grese & Co. Roanoke Rapids, NC	55408 STI-CO Industries Co Buffalo, NY
50558 Electronic Concepts, Inc. Eatontown, NJ	52072 Circuit Assembly Corp. Irvine, CA	53848 Standard Microsystems Hauppauge, NY	55464 Central Semiconductor Corp. Hauppauge, NY
50579 Litronix Inc. Cupertino, CA	52152 MN Mining & Mfg. Saint Paul, MN	53894 AHAM Inc. RanchoCA, CA	55557 Microwave Diode Corp. W.Stewartstown, NH
50891 Semiconductor Technology Stuart, FL	52333 API Electronics Haugpauge,Long Island,NY	53944 Glow-Lite Pauls Valley, OK	55566 R A F Electronic Hardware Inc. Seymour, CT
50934 Tran-Tec Corp Columbus, NE	52361 Communication Systems Piscataway, NJ	54178 Plasmetex Industries Inc. San Marcos, CA	55576 Synertek Santa Clara, CA
51167 Aries Electronics Inc. Frenchtown, NJ	52500 Amphenol, RF Operations Burlington, MA	54294 Shallcross Inc. Smithfield, NC	55680 Nichicon/America/Corp. Schaumburg, IL
51284 Mos Technology Norristown, PA	52525 Space-Lok Inc. Lerco Div. Burbank, CA	54453 Sullins Electronic Corp. San Marcos, CA	55943 D J Associates, Inc (Replaced Transcon Mfg.-24618) Fort Smith, AZ
51249 Heyman Mfg. Co. Cleveland, OH	52531 Hitachi Magnetics Edmore, MO	54473 Matsushita Electric Corp. (Panasonic) Secaucus, NJ	56282 Utek Systems Inc. Olathe, KS
51372 Verbatim Corp. Sunnyvale, CA	52745 Timco Los Angeles, CA	54492 Cinch Clamp Co., Inc. Santa Rosa, CA	56289 Sprague Electric Co. North Adams, MA
51398 MUPAC Corp. Brockton, MA	52763 Stettner-Electronics Inc. Chattanooga, TN	54583 TDK Garden City, NY	56365 Square D Co. Corporate Offices Palatine, IL
51406 Murata Erie, No. America Inc. (Also see 72982) Marietta, GA	52769 Sprague-Goodman Electronics Inc. Garden City Park, NY	54590 RCA Corp Distribution & Special Products Cherry Hill, NY	56375 WESCORP Div. Dal Industries Inc Mountain View, CA
	52771 Monitem Corp. Amatrom Div. Santa Clara, CA	54869 Piher International Corp. Arlington Heights, IL	

Federal Supply Codes for Manufacturers (cont)

56481 Shugart Associates Sub of Xerox Corp. Sunnyvale, CA	59610 Souriau Inc Valencia, CA	60911 Inmos Corp. CO Springs, CO	64537 KDI Electronics Whippany, NJ
56637 RCD Components Inc. Manchester, NH	59635 HV Component Associates Howell, NJ	60935 Westlake Capacitor Inc. Tantalum Div. Greencastle, IN	64782 Precision Control Mfg. Inc. Bellevue, WA
56708 Zilog Inc. Campbell, CA	59640 Supertex Inc. Sunnyvale, CA	60958 ACIC Intercomp Wire & Cable Div. Hayesville, NC	64834 West M G Co. San Francisco, CA
56856 Vamistor Corp. of TN Sevierville, TN	59660 Tusonix Inc. Tucson, AZ	61271 Fujitsu Microelectronics Inc San Jose, CA	64961 Electronic Hardware LTD North Hollywood, CA
56880 Magnetics Inc. Baltimore, MD	59730 Thomas and Betts Corp. IA City, IA	61394 SEEQ Technology Inc. San Jose, CA	65092 Sangamo Weston Inc. Weston Instruments Div. Newark, NJ
57026 Endicott Coil Co. Inc. Binghamton, NY	59831 Semtronics Corp. Watchung, NJ	61429 Fox Electronics Cape Coral, FL	65786 Cypress Semi San Jose, CA
57053 Gates Energy Products Denver, CO	61053: American Components Inc. an Insilco Co. RPC Div. Hayesville, NC	61529 Aromat Corp. New Providence, NJ	65940 Rohm Corp & Whatney Irvine, CA
57170 Cambridge Thermionic Cambridge, MA Replaced by: 71279 Interconnection Products Inc.	6L611 Allen, Robert G. Inc. Van Nuys, CA	61752 IR-ONICS Inc Warwick, RI	65964 Evonx Inc. Bannockburn, IL
57668 R-ohm Corp Irvine, CA	6U850 Burgess Switch Co., Inc Northbrook, IL	61772 Integrated Device Technology Santa Clara, CA	66150 Entron Inc. Winslow Teltronics Div. Glendale, NY
57962 SGS - Thomson Microelectronics Inc Montgomeryville, PA	6U095 AMD Enterprises, Inc. Roswell, GA	61802 Toshiba Houston, TX	66302 VLSI Technology Inc. San Jose, CA
58014 Hitachi Magnalock Corp. (Now 12581)	6X403 SGS/ATES Semiconductor Corp. INpolis, IN	61857 SAN-O Industrial Corp. Bohemia, Long Island, NY	66419 Exel San Jose, CA
58104 Simco Atlanta, GA	6Y440 Micron Technology Inc. Boise, ID	61935 Schurter Inc. Petaluma, CA	66450 Dyna-Tech Electronics, Inc Walled Lake, MI
58364 BYCAP Inc. Chicago, IL	60046 Power Dynamics Inc West Orange, NJ	62351 Apple Rubber Lancaster, NY	66608 Bering Industries Freemont, CA
58451 Precision Lamp Cotat, CA	60197 Precicontact Inc. Langhome, PA	62643 United Chemicon Rosemont, IL	66891 BKC International Electronics Lawrence, MA
58474 Superior Electric Co. Bristol, CT	60386 Squires Electronics Inc Cornelius, OR	62712 Seiko Instruments Torrance, CA	66958 SGS Semiconductor Corp. Phoenix, AZ
58614 Communications Instruments Inc. Fairview, NC	60395 Xicor Inc. Milpitas, CA	62793 Lear Siegler Inc. Energy Products Div. Santa Ana, CA	66967 Powerex Inc Auburn, NY
59124 KOA-Speer Electronics Inc. Bradford, PA	60399 Torin Engineered Blowers Div. of Clevepak Corp. Torrington, CT	63743 Ward Leonard Electric Co.Inc. Mount Vernon, NY	67183 Altera Santa Clara, CA
59422 Holmberg Electronics Irvine, CA	60496 Micrel Inc. Sunnyvale, CA	64154 Lamb Industries Portland, OR	68919 WIMA % Harry Levinson Co. Seattle, WA
	60705 Cera-Mite Corp. (formerly Sprague) Grafton, WI	64155 Linear Technology Milpitas, CA	

Federal Supply Codes for Manufacturers (cont)

7F361 Richmond-Division of Dixico % Zellerbach Paper Co. Seattle, WA	71468 ITT Cannon Div. of ITT Fountain Valley, CA	73138 Beckman Industrial corp. Helipot Div. Fullerton, CA	75042 TRW Inc. IRC Fixed Resistors Philadelphia, PA
7F844 Moore Business Forms, Inc Seattle, WA	71482 General Instrument Corp. Clare Div. Chicago, IL	73168 Fenwal Inc. Ashland, MA	75297 Kester Solder Div. Litton Systems, Inc Des Plaines, IL
7G902 Textron Inc. Camcar Div. Rockford, IL	71590 Mopco/Centralab A North American Philips Co. Fort Dodge, IA	73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, CA	75376 Kurz-Kasch Inc. Dayton, OH
7J395 Universal Plastics Welshpool, WA	71707 Coto Corp. Providence, RI	73445 Amperex Electronic Corp. Hicksville, NY	75378 CTS Knights Inc. Sandwich, IL
7J696 AMD Plastics East Lake, OH	71744 General Instrument Corp. Lamp Div/Worldwide Chicago, IL	73559 Carlingswitch Inc. Hartford, CT	75382 Kulka Electric Corp. (Now 83330) Mount Vernon, NY
7K354 Omni Spectra Inc Los Altos, CA	71785 TRW Inc. Cinch Connector Div. Elk Grove Village, IL	73586 Circle F Industries Trenton, NJ	75569 Performance Semiconductor Corp. Sunnyvale, CA
7Z884 ALPS Seattle, WA	71984 Dow Coming Corp. Midland, MI	73734 Federal Screw Products Inc. Chicago, IL	75915 Litelfuse Tracor (Formerly: Tracor-Littelfuse) Des Plaines, IL
7X634 Duracell USA Div. of Dart & Kraft Inc. Valdese, NC	72005 AMAX Specialty Metals Corp. Newark, NJ	73743 Fischer Special Mfg. Co. Cold Spring, KY	76854 Oak Switch Systems Inc. Crystal Lake, IL
70290 Almetal Universal Joint Co. Cleveland, OH	72136 Electro Motive Mfg. Corp. Florence, NC	73893 Microdot Mt. Clemens, MS	77122 TRW Assemblies & Fasteners Group Fastener Div. Moutainside, NJ
70485 Atlantic India Rubber Works Inc. Chicago, IL	72228 AMCA International Corp. Continental Screw Div. New Bedford, MA	73899 JFD Electronic Components Div. of Murata Erie Oceanside, NY	77342 AMF Inc. Potter & Brumfield Div. Princeton, IN
70563 Amperite Company Union City, NJ	72259 Nytronics Inc. New York, NY	73905 FL Industries Inc. San Jose, CA	77542 Ray-O-Vac Corp Madison, WI
70903 Cooper-Belden Corp. Geneva, IL	72619 Amperex Electronic Corp. Dialight Div. Brooklyn, NY	73949 Guardian Electric Mfg. Co. Chicago, IL	77638 General Instrument Corp. Rectifier Div. Brooklyn, NY
71002 Bimbach Co. Inc. Farmingdale, NY	72653 G C Electronics Co. Div. of Hydrometals Inc. Rockford, IL	74199 Quam Nichols Co. Chicago, IL	77900 Shakeproof Lock Washer Co. (Now 78189)
71034 Bliley Electric Co. Erie, PA	72794 Dzus Fastner Co. Inc. West Islip, NY	74217 Radio Switch Co. Marlboro, NJ	77969 Rubbercraft Corp. of CA Ltd. Torrance, CA
71183 Westinghouse Electric Corp. Bryant Div. Bridgeport, CT	72928 Gulton Industries Inc. Gudeman Div. Chicago, IL	74306 Piezo Crystal Co. Div. of PPA Industries Inc. Carlisle, PA	78189 IL Tool Works Inc. Shakeproof Div. Elgin, IL
71279 Interconnection Products Inc. Formerly Midland-Ross Cambion Div. Santa Ana, CA	72962 Elastic Stop Nut Div. of Harrard Industries Union, NJ	74445 Holo-Krome Co. Elmwood, CT	78277 Sigma Instruments Inc. South Braintree, MA
71400 Bussman Manufacturing Div. McGraw-Edison Co. St. Louis, MO	72982 Erie Specialty Products, Inc Formerly: Murata Erie Erie, PA	74542 Hoyt Elect.Instr. Works Inc. Penacook, NH	78290 Struthers Dunn Inc. Pitman, NJ
71450 CTS Corp. Elkhart, IN		74840 IL Capacitor Inc. Lincolnwood, IL	78553 Eaton Corp. Engineered Fastener Div. Cleveland, OH
		74970 Johnson EF Co. Waseca, MN	

Federal Supply Codes for Manufacturers (cont)

78592 Stoeger Industries South Hackensack, NJ	81439 Therm-O-Disc Inc. Mansfield, OH	83315 Hubbell Corp. Mundelein, IL	87034 Illuminated Products Inc. (Now 76854)
79497 Western Rubber Co. Goshen, IN	81483 International Rectifier Corp. Los Angeles, CA	83330 Kulka Smith Inc. A North American Philips Co. Manasquan, NJ	87516 Standard Crystal KS City, KS
79727 C - W Industries Southampton, PA	81590 Korry Electronics Inc. Seattle, WA	83478 Rubbercraft Corp. of America West Haven, CT	88044 Aeronautical Standards Group Dept. of Navy & Air Force
79963 Zierick Mfg. Corp. Mount Kisco, NY	81741 Chicago Lock Co. Chicago, IL	83553 Associated Spring Bames Group Gardena, CA	88219 GNB Inc. Industrial Battery Div. Langhorne, PA
8C798 Ken-Tronics, Inc. Milan, IL	82227 Aipax Corp. Cheshire Div. Cheshire, CT	83740 Union Carbide Corp. Battery Products Div. Danbury, CT	88245 Winchester Electronics Litton Systems-Useco Div. Van Nuys, CA
8D528 Baumgartens Atlanta, GA	82240 Simmons Fastner Corp. Albany, NY	84171 Arco Electronics Commack, NY	88486 Triangle PWC Inc. Jewitt City, CT
8F330 Eaton Corp. Cutler Hammer Product Sales Office Mountain View, CA	82305 Palmer Electronics Corp. South Gate, CA	84411 American Shizuki TRW Capacitors Div. Ogallala, NE	88690 Essex Group Inc. Wire Assembly Div. Dearborn, MI
8T100 Tellabs Inc. Naperville, IL	82389 Switchcraft Inc. Sub of Raytheon Co. Chicago, IL	84613 FIC Corp. Rockville, MD	88786 Atlantic India Rubber Co. Goshen, IN
80009 Tektronix Beaverton, OR	82415 Aipax Corp. Frederick Div. Frederick, MD	84682 Essex Group Inc. Peabody, MA	88978 Phillips (Now Fluke) Mahwah, NJ
80031 Mepco/Electra Inc. Morristown, NJ	82872 Roanwell Corp. New York, NY	84830 Lee Spring Co. Inc. Brooklyn, NY	89020 Amerace Corp. Buchanan Crimp Tool Products Div. Union, NJ
80032 Ford Aerospace & Communications Corp. Western Development Laboratories Div. Palo Alto, CA	82877 Rotron Inc. Custom Div. Woodstock, NY	85367 Bearing Distributing Co. San Francisco, CA	89265 Potter-Brumfield (See 77342)
80145 LFE Corp. Process Control Div. Clinton, OH	82879 ITT Royal Electric Div. Pawtucket, RI	85372 Bearing Sales Co. Los Angeles, CA	89462 Waldes Truarc, Inc. Long Island, NY
80183 Sprague Products (Now 56289)	83003 Varo Inc. Garland, TX	85480 W. H. Brady Co. Industrial Product Milwaukee, WI	89536 John Fluke Mfg. Co., Inc. Everett, WA
80294 Boums Instruments Inc. Riverside, CA	83014 Hartwell Corp. Placentia, CA	85840 Brady WH Co Industrial Products Div Milwaukee, WI	89597 Fredericks Co. Huntingdon Valley, PA
80583 Hammerlund Mfg. Co. Inc. Paramus, NJ	83055 Signalite Fuse Co. (Now 71744)	85932 Electro Film Inc. Valencia, CA	89709 Bunker Ramo-Eltra Corp. Amphenol Div. Broadview, IL
80640 Computer Products Inc. Stevens-Arnold Div. South Boston, MA	83058 TRW Assemblies & Fasteners Group Fasteners Div. Cambridge, MA	86577 Precision Metal Products Co. Peabody, MA	89730 General Electric Lamp Div. Newark, NJ
81073 Grayhill Inc. La Grange, IL	83259 Parker-Hannifin Corp. O-Seal Div. Culver City, CA	86684 Radio Corp. of America (Now 54590)	9R216 Data Composition Svc, Inc Laurel, MD
81312 Litton Systems Inc. Winchester Electronics Div. Watertown, CT	83298 Bendix Corp. Electric & Fluid Power Div. Eatonville, NJ	86928 Seastrom Mfg. Co. Inc. Glendale, CA	9S171 Port Plastics Tukwila, WA

Federal Supply Codes for Manufacturers (cont)

9W423 Amatom El Mont, CA	91934 Miller Electric Co. Woonsocket, RI	95573 Campion Laboratories Inc. Detroit, MI	98278 Malco A Microdot Co. South Pasadena, CA
90201 Mallory Capacitor Co. Sub of Emhart Industries Inc. Indianapolis, IN	91967 National Tel-Tronics Div. of electro Audio Dynamics Inc Meadville, PA	95712 Bendix Corp. Electrical Comp. Div. Franklin, IN	98291 Sealectro Corp. BICC Electronics Trumbull, CT
90215 Best Stamp & Mfg. Co. KS City, MO	91984 Maida Development Co. Hampton, VA	95987 Weckesser Co. Inc. (Now 85480)	98372 Royal Industries Inc. (Now 62793)
90303 Duracell Inc. Technical Sales & Marketing Bethel, CT	91985 Norwalk Valve Co. S. Norwalk, CT	96733 SFE Technologies San Fernando, CA	98388 Lear Siegler Inc. Accurate Products Div. San Deigo, CA
91094 Essex Group Inc. Suflex/IWP Div. Newmarket, NH	92218 Wakefield Corp., The Wakefield, ME	96853 Gulton Industries Inc. Measurement & Controls Div. Manchester, NH	98978 IERC (International Electronic Research Corp.) Burbank, CA
91247 IL Transformer Co. Chicago, IL	92527 VTC Inc. Bloomington, MN	96881 Thomson Industries Inc. Port WA, NY	99120 Plastic Capacitors Inc. Chicago, IL
91293 Johanson Mfg. Co. Boonton, NJ	92607 Tensolite Co. Div. of Carlisle Corp. Buchanan, NY	97464 Industrial Retainer Ring Irvington, NJ	99217 Bell Industries Inc. Elect. Distributor Div. Sunnyvale, CA
91462 Alpha Industries Inc. Logansport, IN	92914 Alpha Wire Corp. Elizabeth, NJ	97525 EECO Inc. Santa Ana, CA	99378 ATLEE of DE Inc. N. Andover, MA
91502 Associated Machine Santa Clara, CA	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, MA	97540 Whitehall Electronics Corp. Master Mobile Mounts Div. Fort Meyers, FL	99392 Mepco/Electra Inc. Roxboro Div. Roxboro, NC
91506 Augat Alcoswitch N. Andover, MA	94144 Raytheon Co. Microwave & Power Tube Div. Quincy, MA	97913 Industrial Electronic Hardware Corp. NY, NY	99515 Electron Products Inc. Div. of American Capacitors Duarte, CA
91507 Froeliger Machine Tool Co. Stockton, CA	94222 Southco Inc. Concordville, PA	97945 Pennwalt Corp. SS White Industrial Products Piscataway, NJ	99779 Bunker Ramo- Eltra Corp. Barnes Div. Lansdown, PA
91637 Dale Electronics Inc. Columbus, NE	94988 Wagner Electric Corp. Sub of McGraw-Edison Co. Whippany, NJ	97966 CBS Electronic Div. Danvers, MA	99800 American Precision Industries Delevan Div. East Aurora, NY
91662 Elco Corp. A Gulf Western Mfg. Co. Connector Div. Huntingdon, PA	95146 Alco Electronic Products Inc. Switch Div. North Andover, MA	98094 Machlett Laboratories Inc. Santa Barbara, CA	99942 Mepco/Centralab A North American Philips Co. Milwaukee, WI
91737 ITT Cannon/Gremar (Now 08718)	95263 Leecraft Mfg. Co. Long Island City, NY	98159 Rubber-Teck Inc. Gardena, CA	
91802 Industrial Devices Inc. Edgewater, NJ	95275 Vitramon Inc. Bridgeport, CT		
91833 Keystone Electronics Corp. NY, NY	95303 RCA Corp. Receiving Tube Div. Cincinnati, OH		
91836 King's Electronics Co. Inc. Tuckahoe, NY	95348 Gordo's Corp. Bloomfield, NJ		
91929 Honeywell Inc. Micro Switch Div. Freeport, IL	95354 Methode Mfg. Corp. Rolling Meadows, IL		

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Appendix 7A

Manual Change Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual with an X.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table 7A-1.

CHANGES

There are no backdating changes at this printing. All pcb assemblies are documented at their original revision level.

Table 7A-1. Backdating

Ref Or Option No.	Assembly Name	Fluke Part No.	To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with change under desired rev letter																	
			2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	J	K
	Final Assembly													X						
	Front End Assembly													X						
	Front Panel Assembly														X					
	Outer Cover Assembly																			
A1	Capacitor PCB	219212											X							
A3	Capacitor Switch PCB	227603																		
A5	Main Mother Board PCB	219238										X								
A5A1	Reference Supply PCB	314864										X								
A5A2	Series Pass Driver PCB	354258											X							
A5A3	Differential Amp. PCB	219162										X								
A5A4	Chopper Amp. PCB	251918												X						
A5A5	Auxiliary PS PCB	219188		X																
A5A6	Current Limiter PCB	354266																X		
A6	Isolated Mother Board PCB	219147	X																	
A6A1	Null Detector Power Supply PCB	219121									X									
A6A2	Null Detector Amp. PCB	219139																		X
A7	Time Delay PCB	192260			X															
A8	High Voltage Mother Board PCB	219220										X								
A8A1	Series Pass Element PCB	314823										X								
A8A2	Pre-Regulator PCB	314815											X							
A8 A2A1	Heat Sink Assy	314807									X									
A9	Extender PCB	187344			X															
A10	Matched PCB Set Assy (A2 and A4 PCBs)	314997			X															

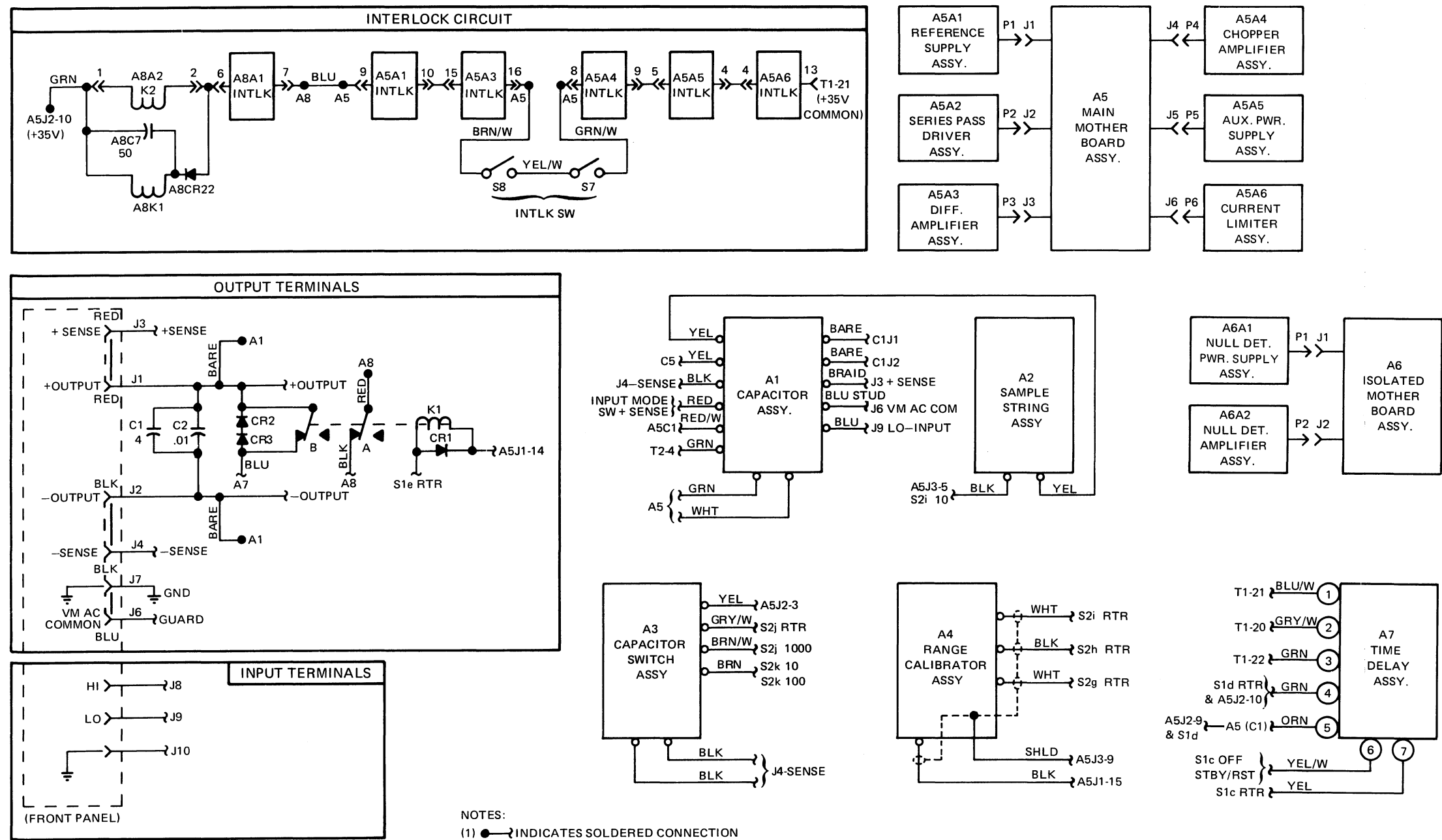
Section 8

Schematic Diagrams

FIGURE NO.	TITLE	DRAWING NO.	PAGE
8-1.	Wiring Diagrams		8-3
8-2.	A5 Main Mother Board	335A-1064	8-5
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8-5.	DC Voltage Standard Support Modules	335A-1002	8-10
8-6.	A2 Sample String	335A-1003	8-13
8-7.	Voltmeter	335A-1005	8-14
8-8.	Power Distribution	335A-1004	8-16

Table 8-1. Mnemonics

ACK	— acknowledge
ACK LAT	— acknowledge late
AR	— analog return
DB	— data bus
DBIN	— data bus input signal (from μP)
DLD ACK	— delayed ACK
EN INT	— enable interrupt
HLDA	— hold acknowledge
IB ADX	— interbus address
IBIN	— interbus input signal
IC	— interbus control
ID	— interbus data
IINT	— internal interrupt
INA	— interrupt acknowledge (from controller)
INT	— interrupt
INTA	— Interrupt acknowledge (status word from μP)
INTE	— interrupt enable (from μP)
MEM RD	— memory read
MS ADDR BYTE	— memory select address byte
$\phi 1$	— clock pulse
$\phi 2$	— clock pulse
ϕLL	— phase-locked loop
RAM	— random access memory
ROM	— read only memory
RRDY	— reset ready
RST	— reset
RT	— real time
R/W	— read/write
μP	— microprocessor
VA	— analog supply voltage
$V_{CC} \phi 2$	— 5V clock pulse
$V_{DD} \phi 2$	— 12V clock pulse
SRDY	— set ready
SYN IINT	— synchronized internal interrupt
TTL PU	— TTL pull-up
WO	— write out
WR	— write



NOTES:
(1) ●→ INDICATES SOLDERED CONNECTION
(2) ALL RESISTANCE IN OHMS AND ALL CAPACITANCE IN MICROFARADS

Figure 8-1. Wiring Diagrams

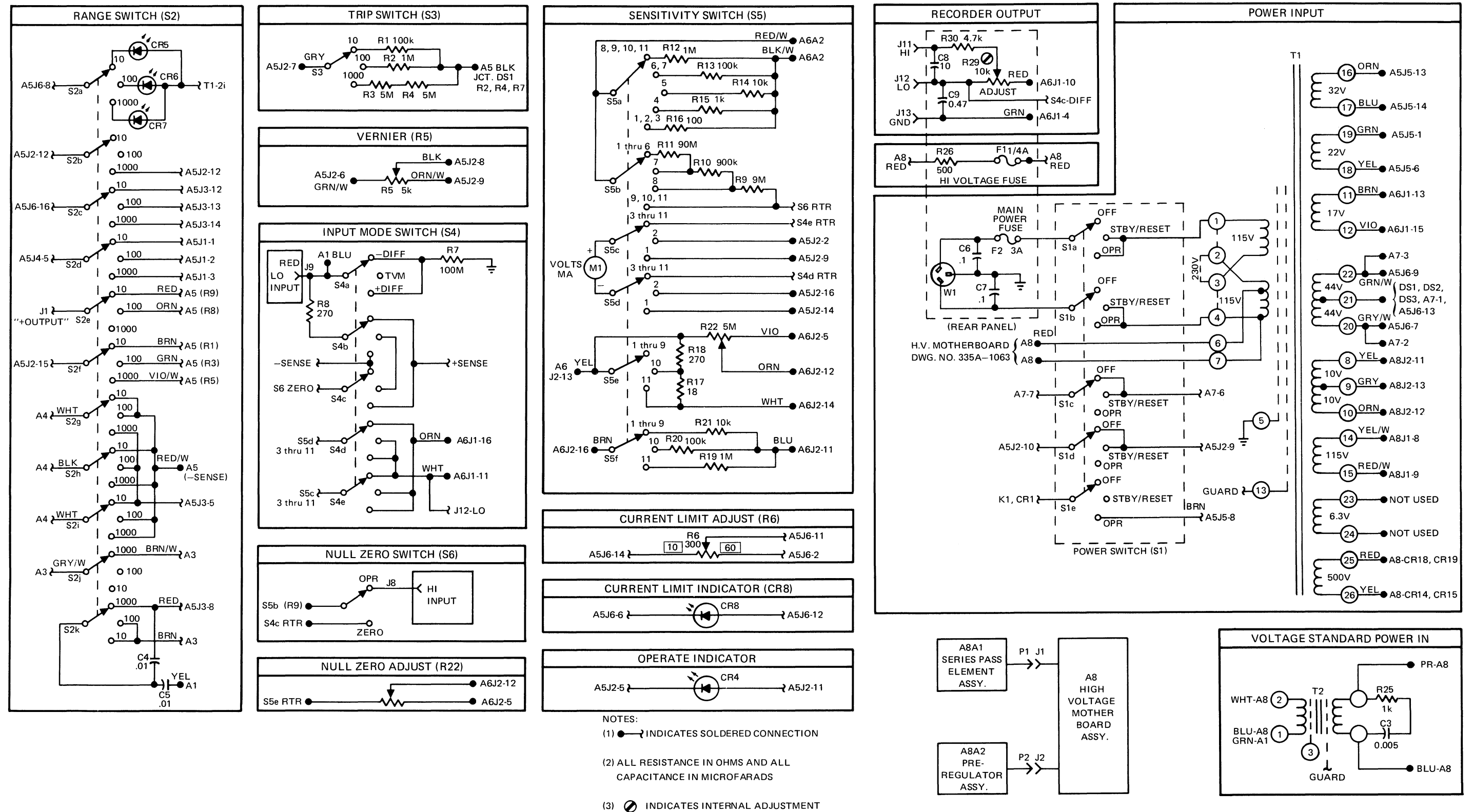
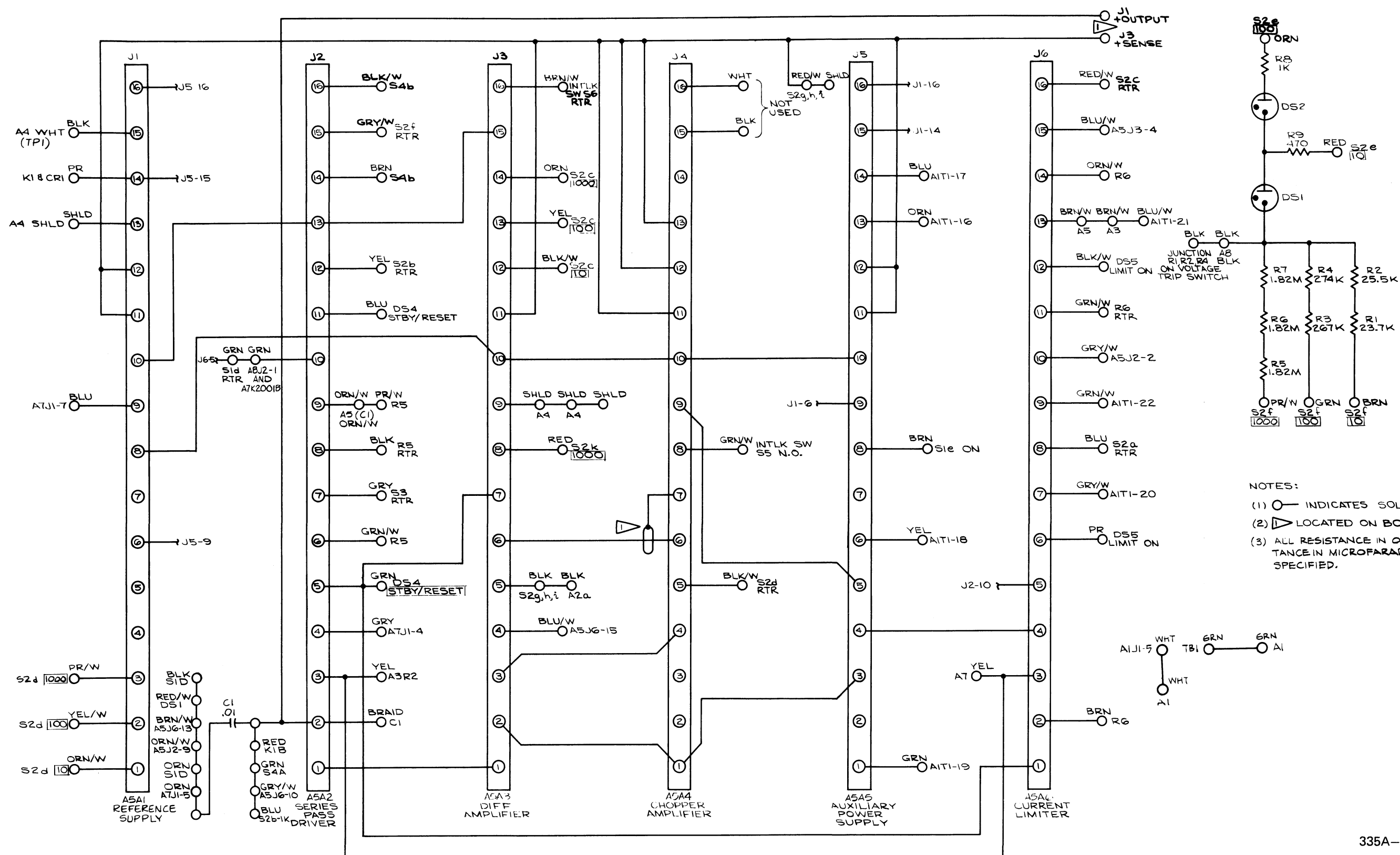


Figure 8-1. Wiring Diagrams (cont)



335A-1064

Figure 8-2. A5 Main Mother Board

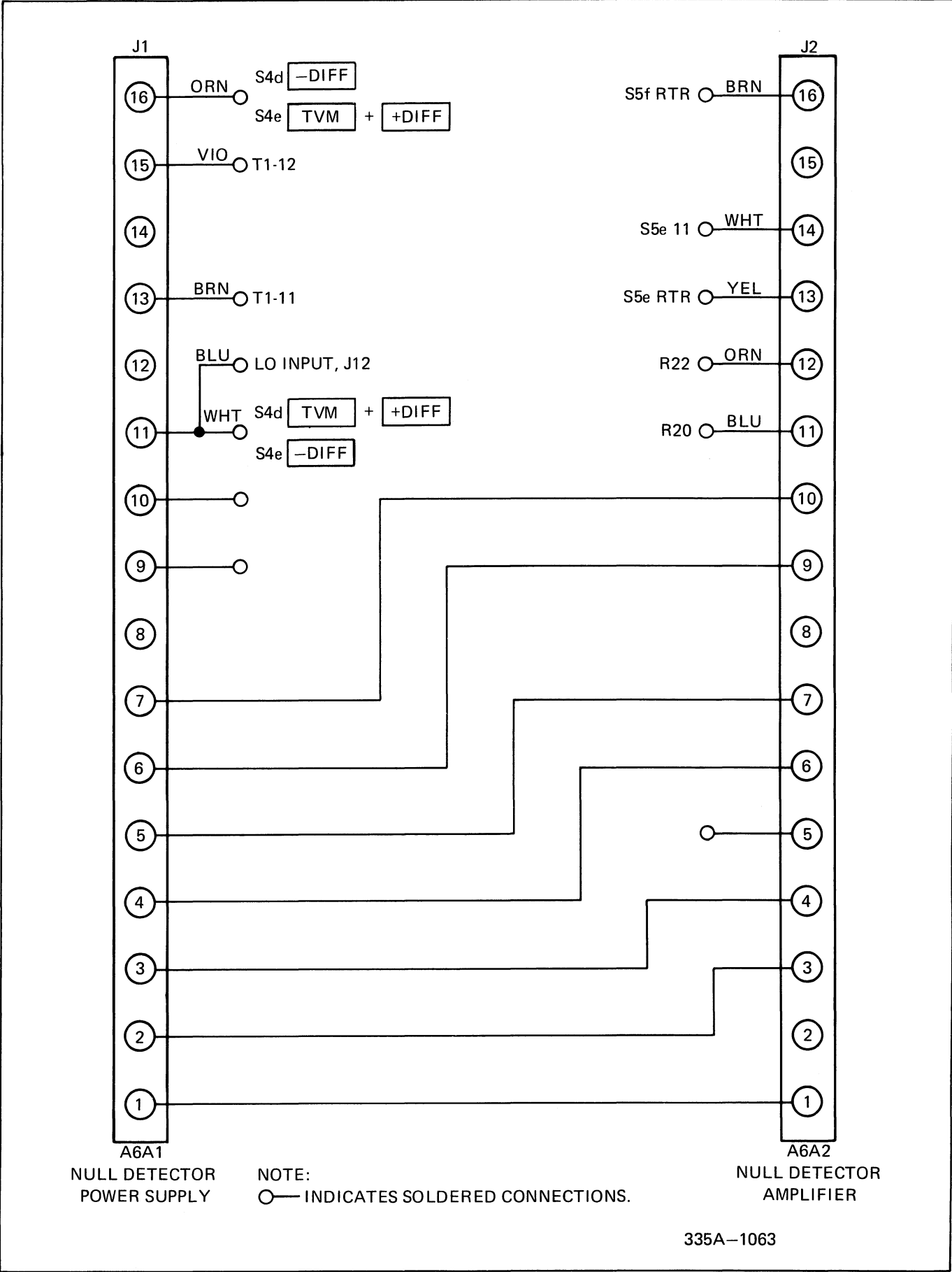


Figure 8-3. A6 Isolated Mother Board

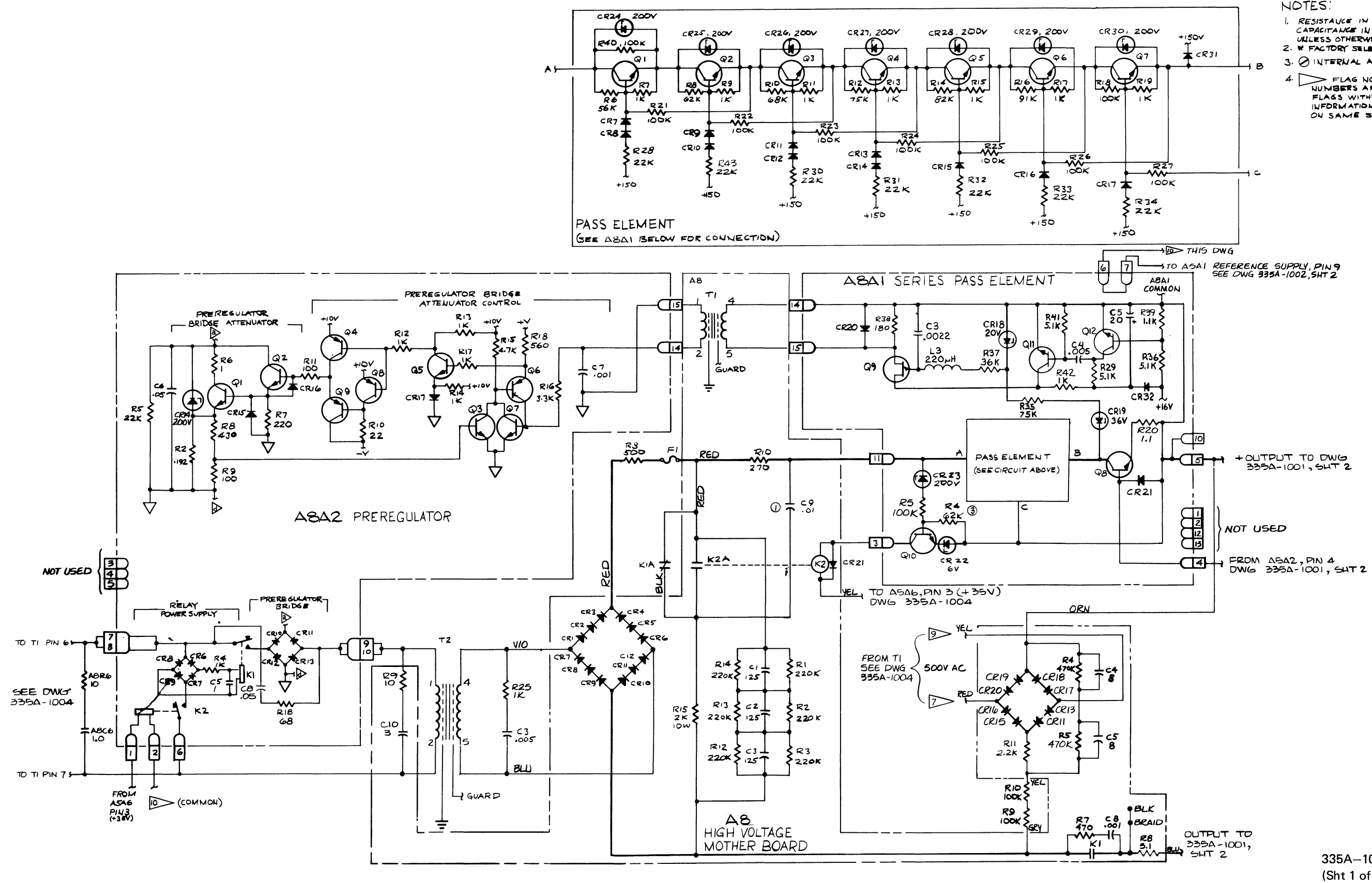


Figure 8-4. DC Voltage Standard

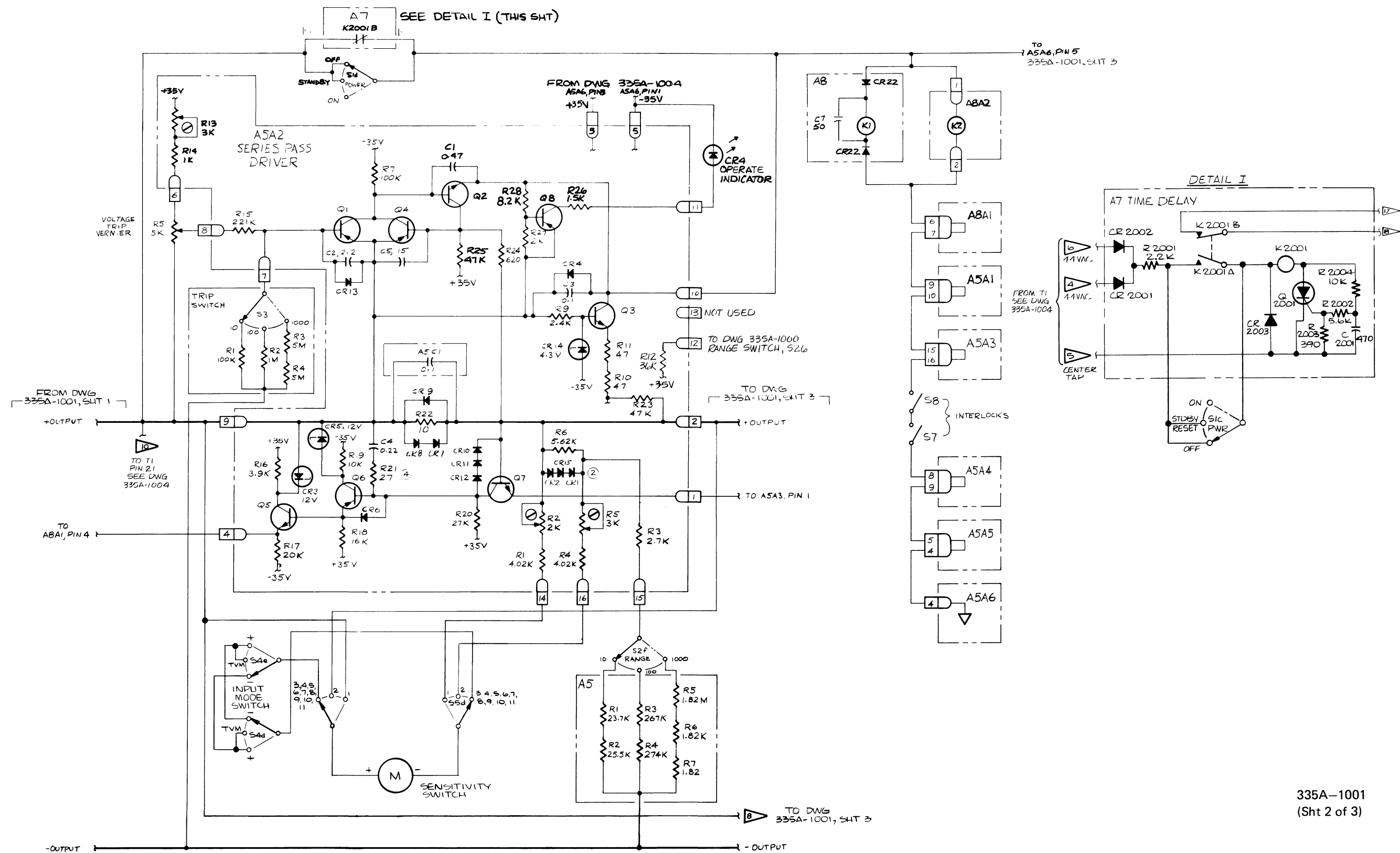
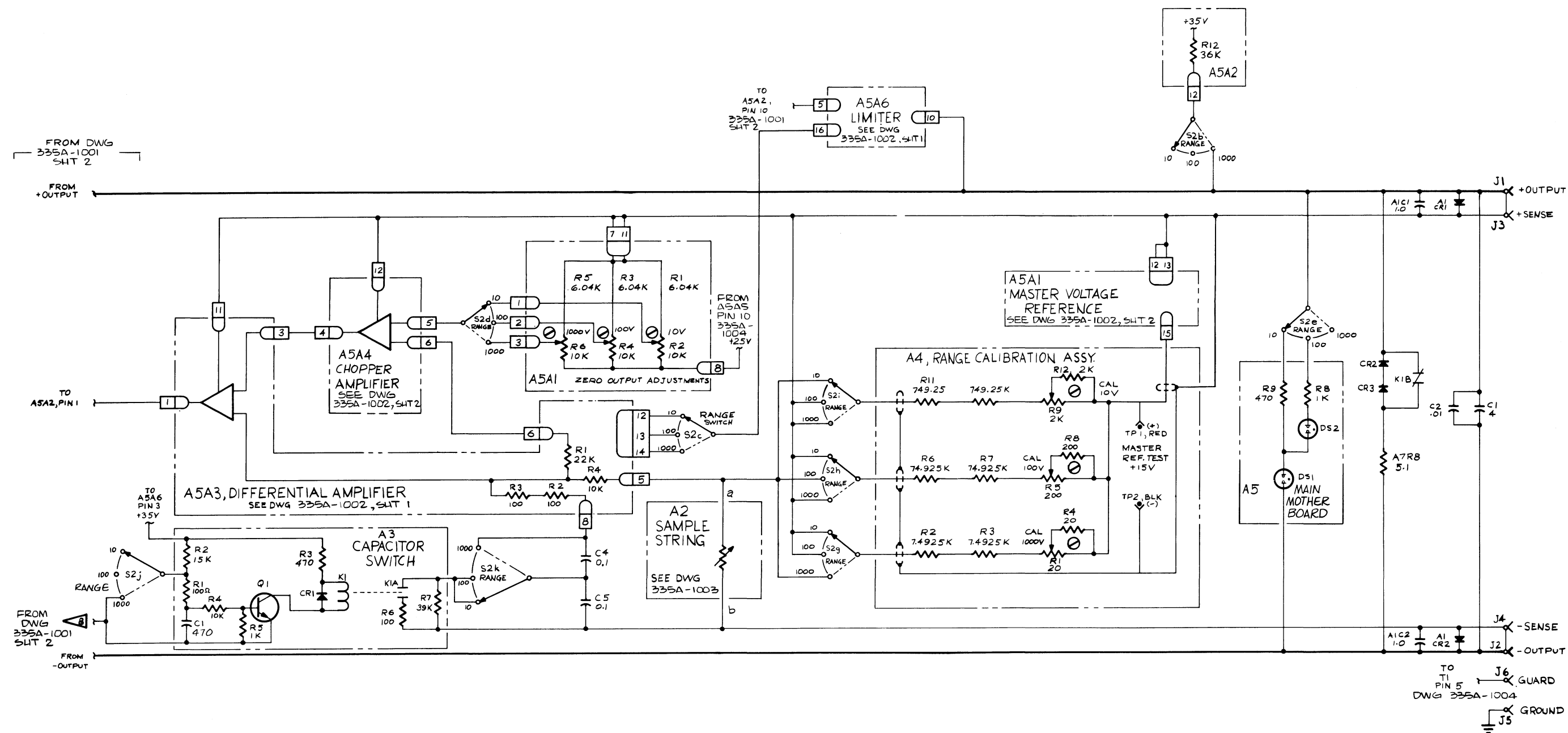
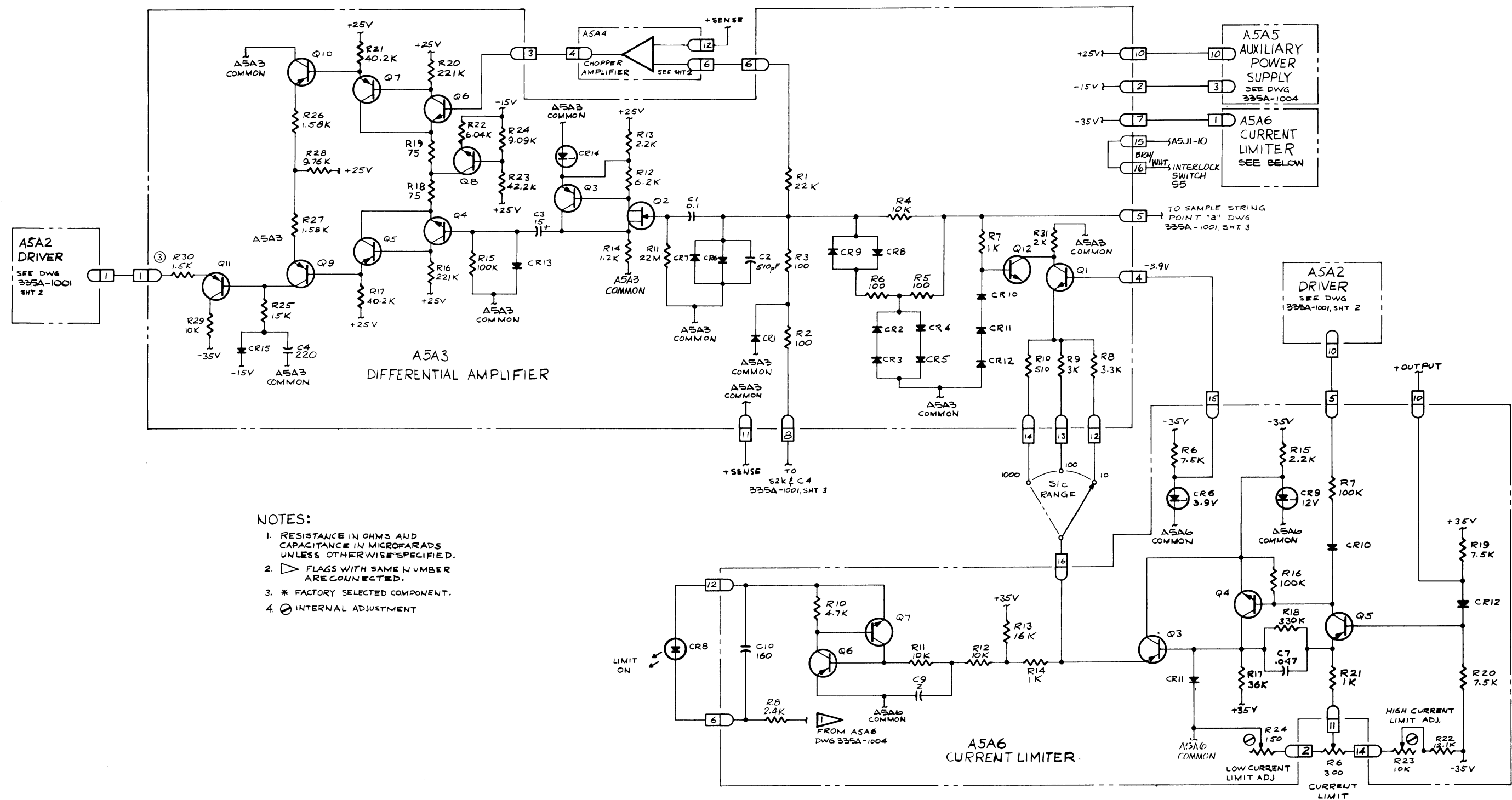


Figure 8-4. DC Voltage Standard (cont)



335A-1001
(Sht 3 of 3)

Figure 8-4. DC Voltage Standard (cont)



335A-1002
(Sht 1 of 2)

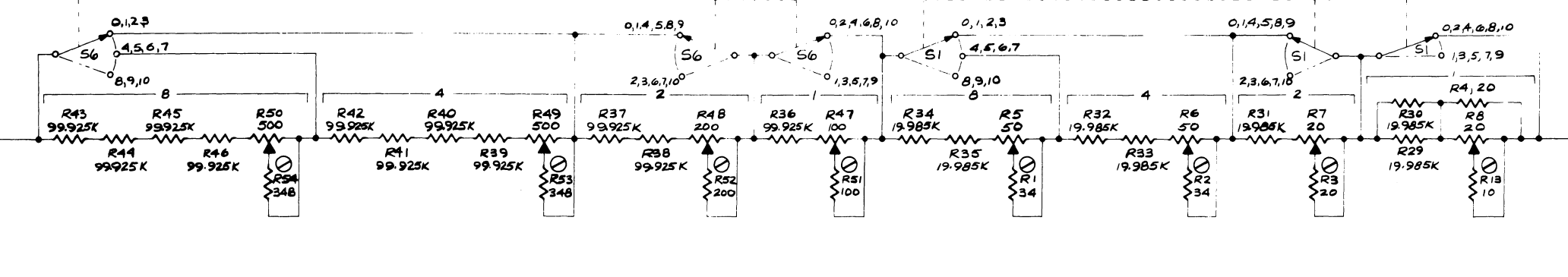
Figure 8-5. DC Voltage Standard Support Modules



TO "a"
DWG
335A-1001, SHT 3

DECK A 1ST DECADE

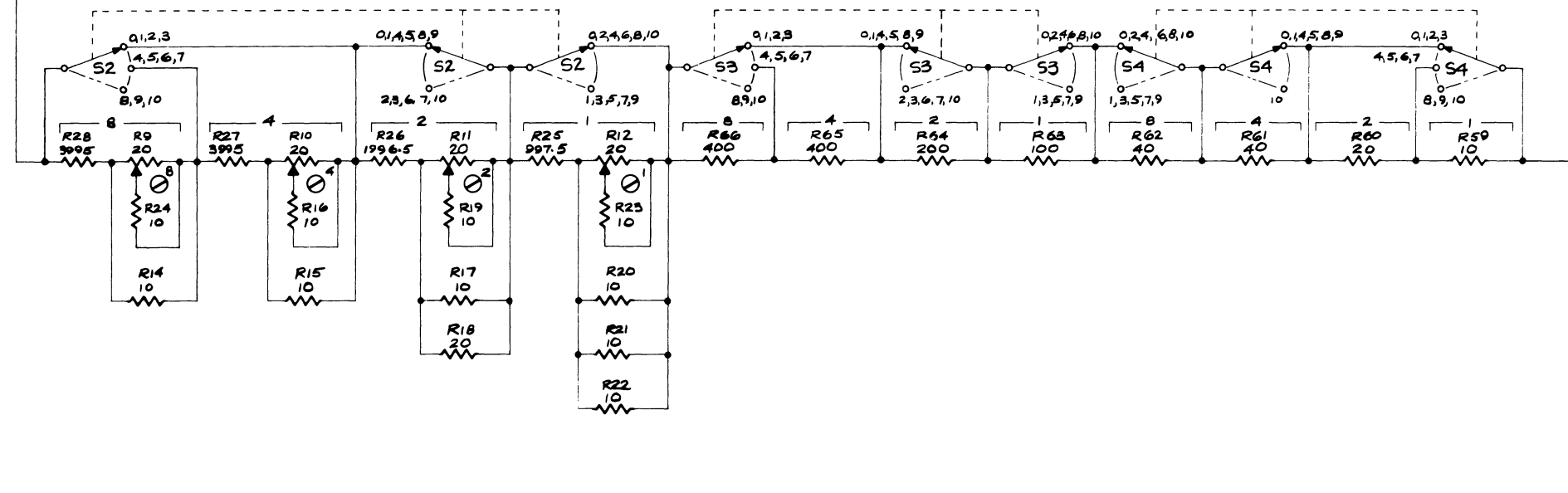
DECK B 2ND DECADE



DECK C 3RD DECADE

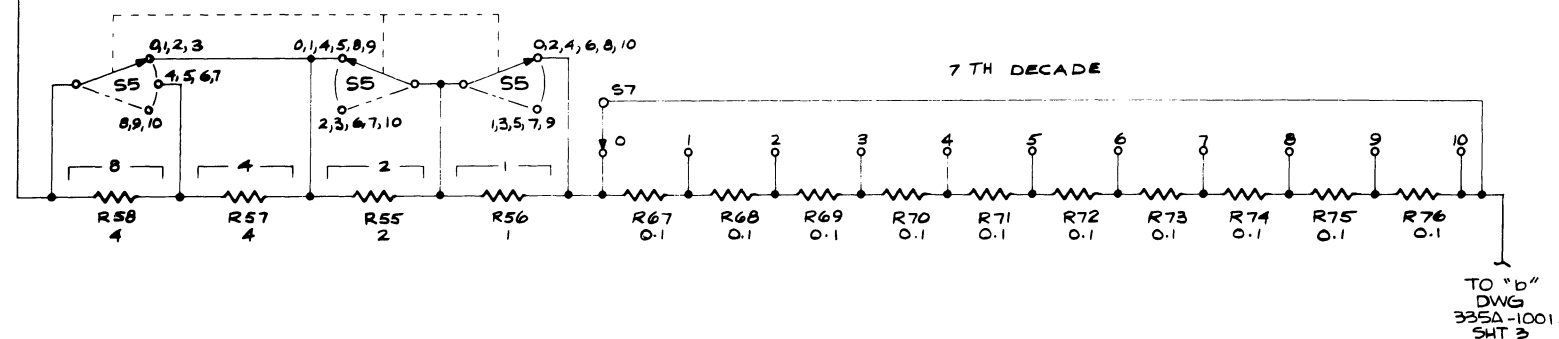
4TH DECADE

5TH DECADE



6TH DECADE

7TH DECADE



TO "b"
DWG
335A-1001,
SHT 3

NOTES:

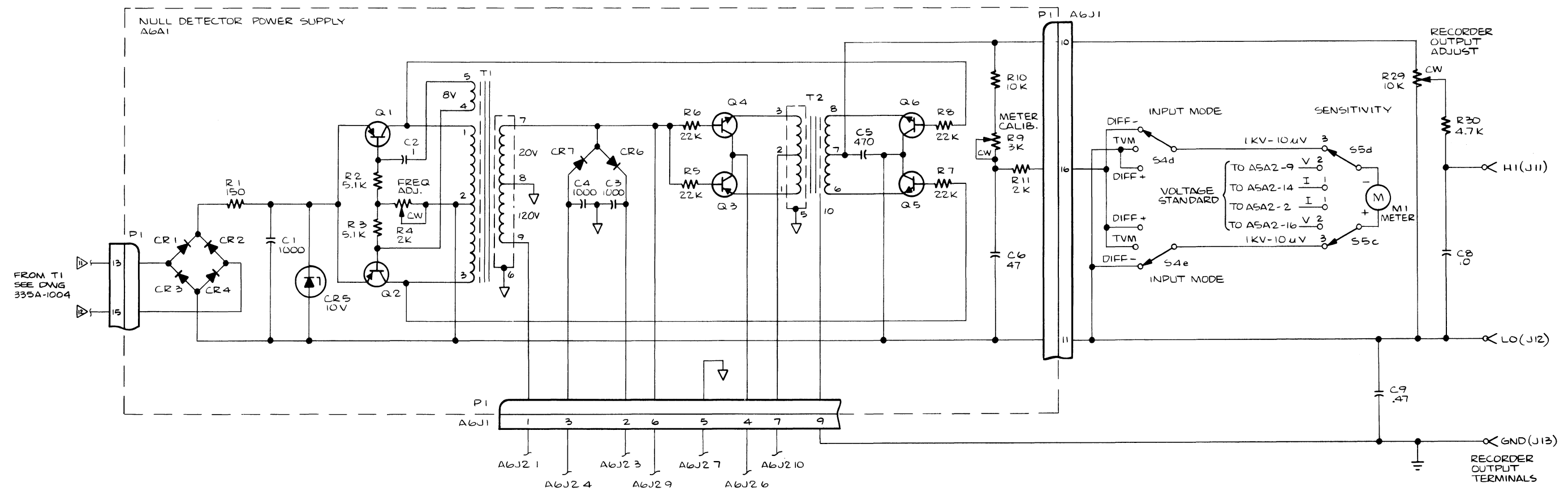
1. RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ⊗ INTERNAL ADJUSTMENT.

335A-1003

Figure 8-6. A2 Sample String

NOTES

1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE IN OHMS
ALL CAPACITANCE IN MICROFARADS



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(Sht 1 of 2)

Figure 8-7. Voltmeter

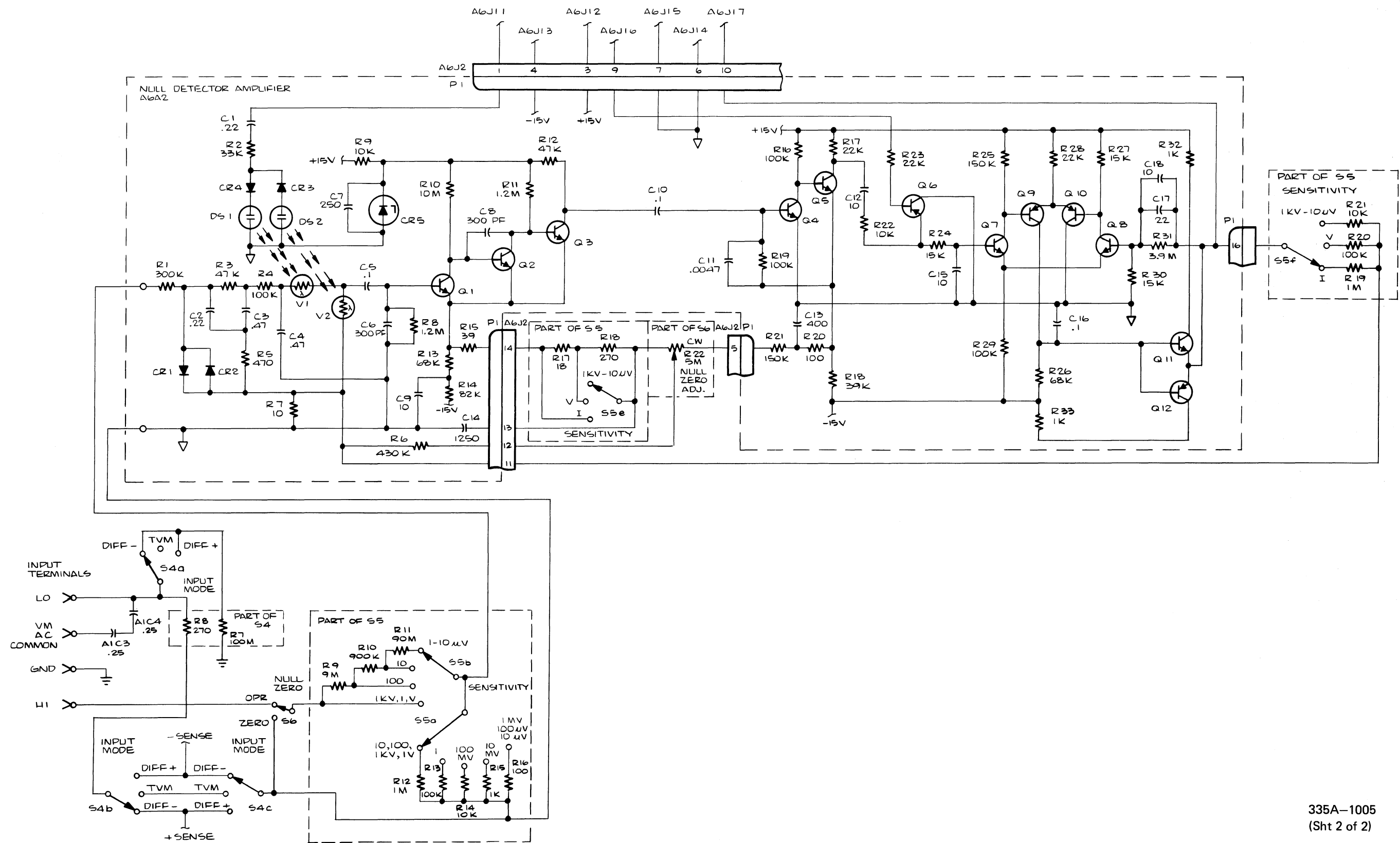
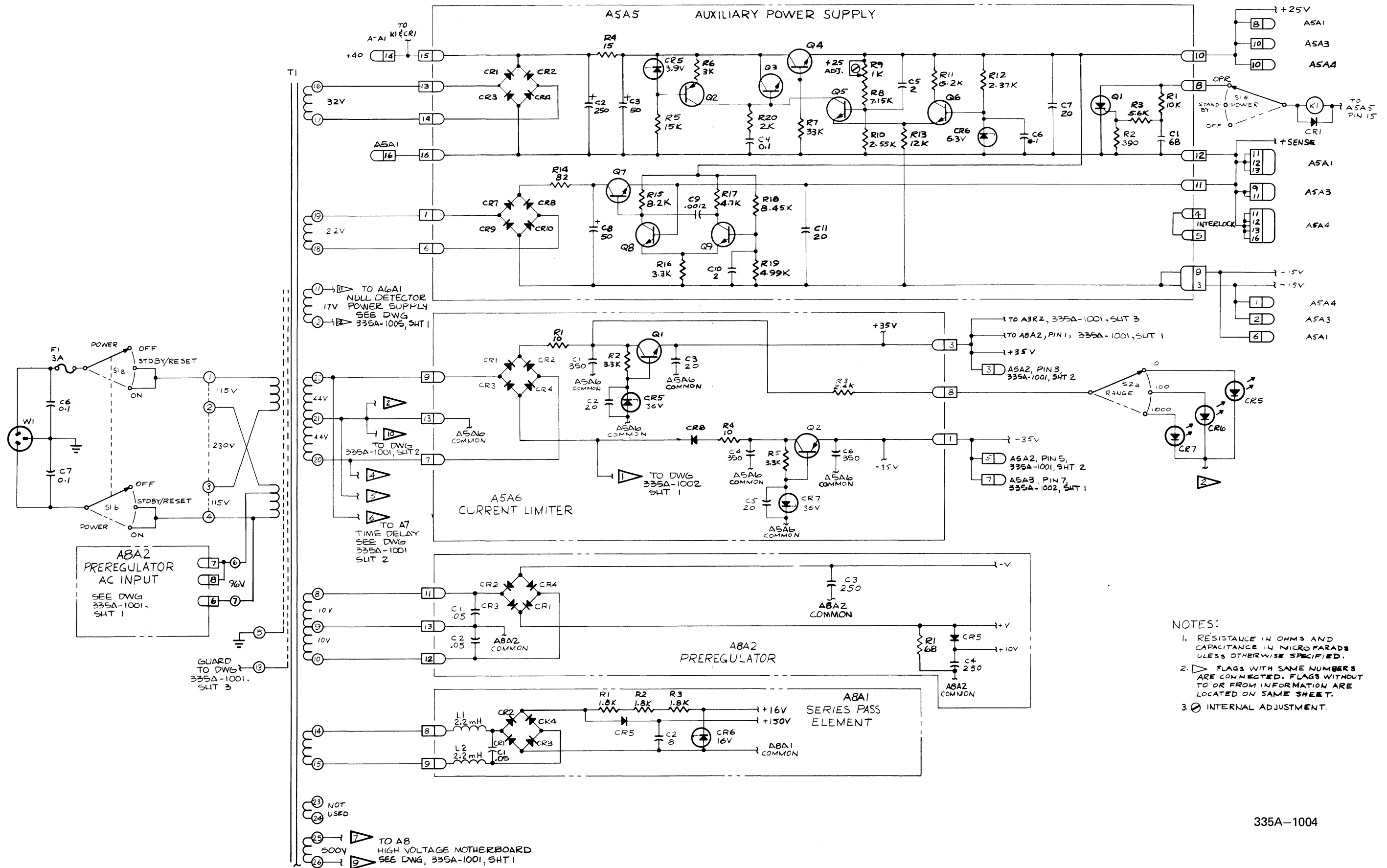


Figure 8-7. Voltmeter (cont)



335A-1004

Figure 8-8. Power Distribution