NOTE

This manual documents the Models 732A and 732A/AN and their assemblies at the revision levels shown in Appendix 7A.

732A
732A/AN
DC Reference Standard

Instruction Manual

P/N 788414
MAY 1986

FLUKE®

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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732A DC Reference Standard

Section 1
Introduction and Specifications

1-1. INTRODUCTION

NOTE

Throughout this manual, all references to the 732A also pertain to the 732A/AN.

1-2. The Fluke Model 732A is a solid state, dc voltage reference standard. It is highly stable, rugged and transportable. The 732A has 10V, 1.018V and 1V outputs. These outputs are available on front panel binding posts. The calibration adjustments for the 10V, 1.018V, and 1V outputs are accessible through the front panel. A non-conducting adjustment tool is supplied with the unit for this purpose.

1-3. All outputs of the 732A can be shorted indefinitely without damage. Recovery occurs in less than 2 minutes after the short is removed, with no loss of stability.

1-4. The stability and accuracy of the 732A allow direct substitution for saturated standard cells in many applications. The stability specification of 0.5 ppm for 30 days is achieved by enclosing the reference amplifier and output divider of the 732A in a high gain thermal oven. Full accuracy is attained over the specified ambient temperature range of 23 ± 5°C (64.4 to 82.4°F). Variations in oven temperature may be monitored externally via the OVEN TEMP THERMISTOR terminals on the front panel.

1-5. The 732A may be powered from ac line power, an internal rechargeable battery, or an external low voltage ac or dc source. The 732A is designed to be powered continuously, including during storage or shipment. The backup battery will continue to operate the 732A for up to 24 hours. Either line or battery power may be removed without affecting the output. The battery is kept charged by an internal battery charger when operating from ac line power, or from an external low voltage ac or dc source.

1-6. Various front panel LEDs (light-emitting diodes) provide a continuous indication of the operating status of the 732A. The AC PWR indicator illuminates in the presence of ac line power. The BTRY CHG indicator is on steadily for normal charging activity, and is off when the battery is charged. The IN CAL indicator monitors the input voltage to the Reference and Oven. Should this voltage fall below that needed to keep the 732A operational, the IN CAL indicator is latched off, indicating a loss of power and standardization. Once power is restored and standardization has been verified, the IN CAL indicator can be reset.

1-7. The 732A may be used on the bench or mounted in a rack. The 732A is a half-rack-width instrument and occupies four standard 1.75-inch rack spaces. The instrument's outside dimensions are given in Figure 1-1. Accessories for the 732A are listed in Table 1-1 and described in more detail in Section 6 of this manual. Calibration options are listed in Section 6.

1-8. SPECIFICATIONS

1-9. Table 1-2 lists the specifications for the 732A.

Table 1-1. Accessories

MODEL NUMBER	DESCRIPTION
M00-800-523	Dual Mounting Fastener
M07-203-601	Half Width Rack Mount Kit
M07-200-603	Full Width Rack Mount Kit
5440A-7002	Low Thermal EMF Test Lead Set
732A-7005	Battery Pack
732A-7002	Transit Case
732A-7003	Battery Charger
732A-7004	Rack Tray

Table 1-2. 732A Specifications

OUTPUT VOLTAGE ..... 10 volts, 1.018 volts, and 1 volt

TRANSFER UNCERTAINTY ..... @18°C to 28°C

Output Voltage	Time Interval			
	30 Days	90 Days	6 Months	1 Year
10V	0.5 ppm	1.0 ppm	1.5 ppm	3.0 ppm
1.018V	1.5 ppm	3.0 ppm	6.0 ppm	12.0 ppm
1V	1.5 ppm	3.0 ppm	6.0 ppm	12.0 ppm

These specifications assume the unit has been continuously powered up with either ac or battery or both. The specifications include effects due to line regulation.

TEMPERATURE COEFFICIENT OF OUTPUT

Range	Temperature Coefficient (ppm/°C)	
	0°C to 18°C	28°C to 40°C
10V	±0.05	±0.05
1.018V	±1.0	±1.0
1V	±1.0	±1.0

OUTPUT ADJUSTMENT AND RESOLUTION

Output	Adj. Range	Adj. Resolution
10V	±50 μV	<0.05 ppm
1.018V	±50 μV	<0.25 ppm
1.0V	±5 μV	<0.10 ppm

OUTPUT IMPEDANCE

10V ..... ≤1.0 milliohms

1.018V, 1V ..... ≈1 kilohm

OUTPUT CURRENT

10V ..... 12 mA maximum

1.018V, 1V ..... Current limited by 1k Ω source impedance

OUTPUT PROTECTION ..... The output may be shorted indefinitely without damage to the instrument. The instrument is protected against high voltage up to 1000V provided that the net current into the 732A does not exceed 30 mA.

OUTPUT NOISE ..... ≤1 μV RMS at 10V output, 0.1-10 Hz.

COMMON MODE REJECTION ..... For common mode voltages up to ±20 volts and frequencies up to 400 Hz, applied between ground and ground terminals, the common mode rejection is > 140dB.

LOAD REGULATION AT 12.0mA OUTPUT CURRENT ..... ≤1.2 ppm

LINE REGULATION ..... ≤0.05 ppm of output for full ±10% power line variation.

Table 1-2. 732A Specifications (cont)

LINE POWER REQUIREMENTS ..... 100, 120, 220, or 240V ac ±10% 50 to 60 Hz ±5%, 32W

Nominal Setting	Voltage Limits	Fuse
100V	90-110V	0.375A/250V SLO-BLO
120V	108-132V	0.375A/250V SLO-BLO
220V	198-242V	0.250A/250V SLO-BLO
240V	216-264V	0.250A/250V SLO-BLO

AUXILIARY LOW VOLTAGE POWER REQUIREMENTS ..... 24-40V dc or 24-30V ac 50-400 Hz

INTERNAL BATTERIES ..... 24V gelled-electrolyte sealed lead-acid

TYPICAL BATTERY LIFE ..... 24 hours at 23°C

PROTECTION CLASS ..... Class 1 as defined in IEC 348.

SIZE (HxWxD) ..... 19.1 cm x 22.1 cm x 60.3 cm
7.5 in. x 8.5 in. x 23.7 in. (see Figure 1-1)

WEIGHT ..... 12.3 kg (27 lbs.)

COMPLIANCE WITH EXTERNAL STANDARDS ..... ANSI C39.5 Draft #8
IEC 348 2nd edition, 1978
CSA bulletin 556B, 17 Sep 1973
VDE 0411-1973
UL 1244

OPERATING TEMPERATURE ..... 0°C to 40°C

ALTITUDE
Non-operating ..... 0-12,200 meters, (40,000 feet)
Operating ..... 0-3,050 meters, (10,000 feet)

TEMPERATURE AND HUMIDITY

Condition	Temperature (°C)	% Relative Humidity (Non-condensing)
Non-operating	-40 to +50 0 to 50	Not Controlled 95 ±5%
Operating	0 to 30 30 to 40	95 ±5% 75±5%

VIBRATION

Frequency	G Force Frequency	Double Amplitude
5-55 Hz	2 @ 55 Hz	0.013 inch

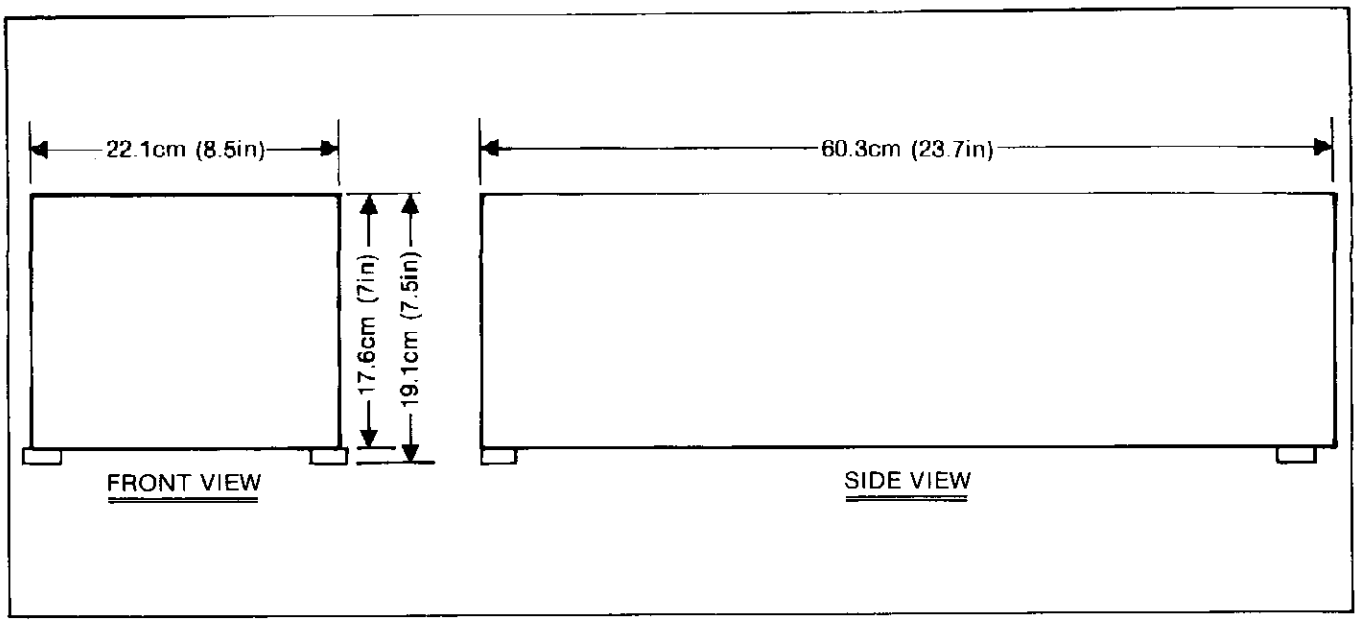
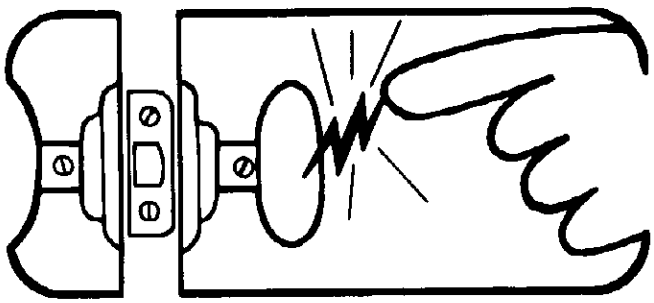


Figure 1-1. Outside Dimensions

static awareness

A Message From

John Fluke Mfg. Co., Inc.

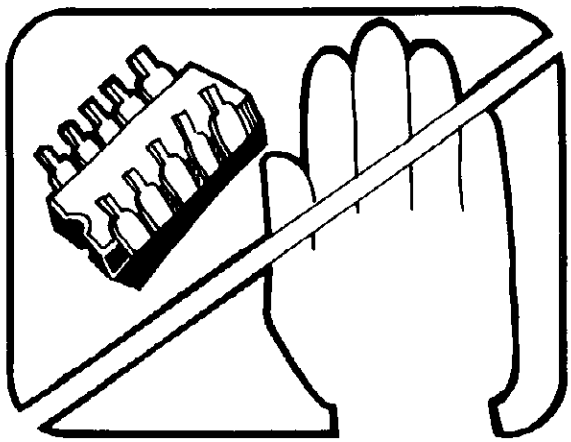


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

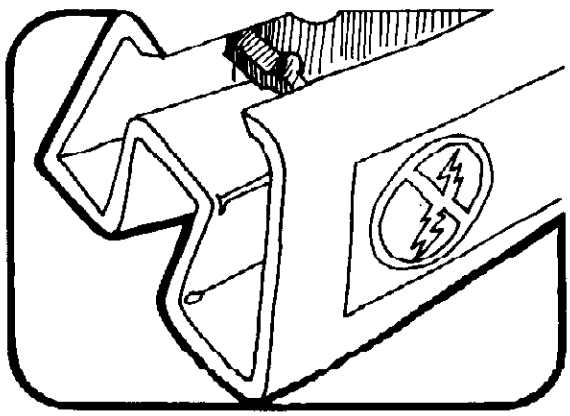
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

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

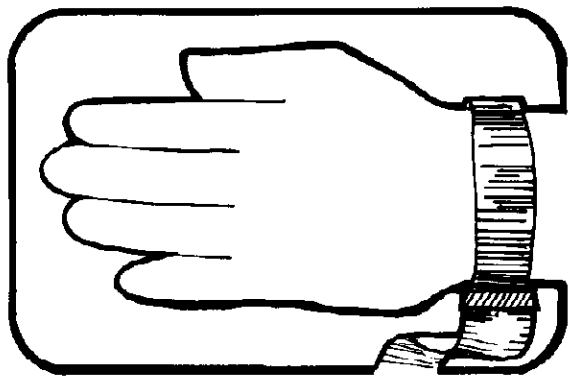
The following practices should be followed to minimize damage to S.S. devices.



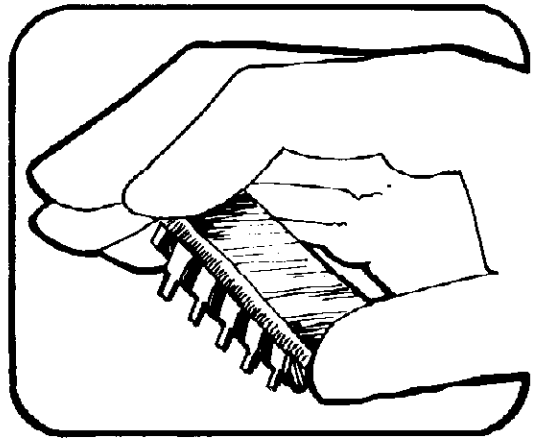
1. MINIMIZE HANDLING



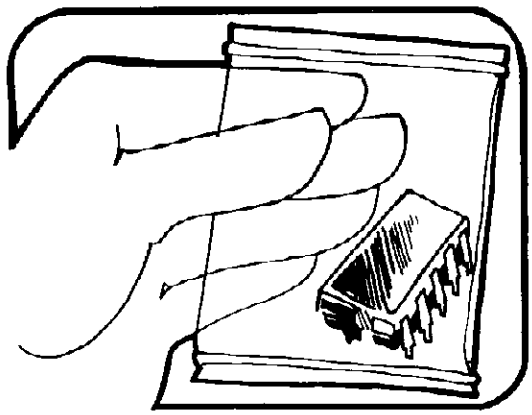
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



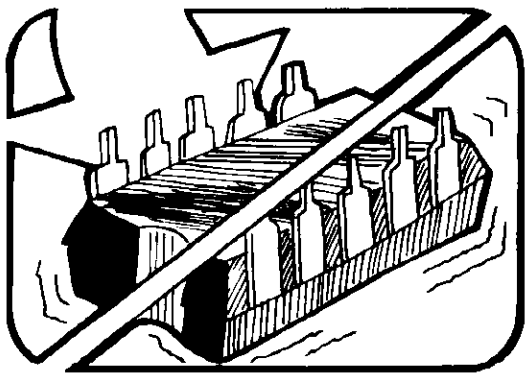
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



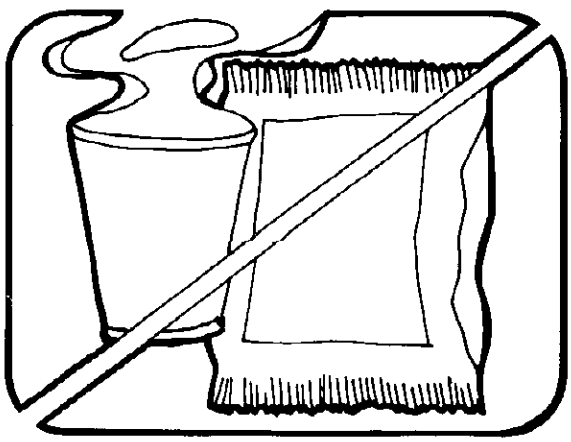
4. HANDLE S.S. DEVICES BY THE BODY



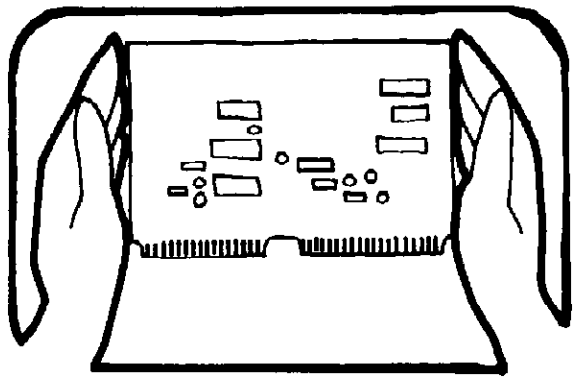
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



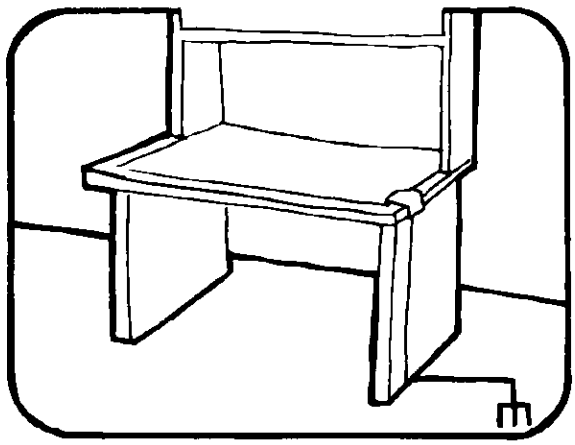
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



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
Operation

2-1. INTRODUCTION

2-2. This section describes the installation and operation of the Model 732A. The contents of this section should be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales or Service Representative. To determine the nearest sales or service center, refer to the list of sales and service centers in Section 7 of this manual. The factory may be contacted at:

John Fluke Mfg. Co., Inc.
P.O. Box C9090
Everett, WA 98206
Tel: (206) 347-6100

2-3. SHIPPING INFORMATION

2-4. The 732A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, make a thorough physical and electrical inspection to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container or equivalent should be used.

2-6. If the instrument is to be shipped with battery power on, use the Transit Case accessory described in Section 6. Alternatively, 24V to 40V dc or 24V to 30V ac may be applied, via the rear panel connector, to supply power during shipment.

NOTE

At an ambient temperature of 23° C, battery current drain is approximately 120 mA. Current drain will increase or decrease, respectively, with higher or lower ambient temperatures.

2-7. INSTALLATION

2-8. The 732A is designed for convenient operation as either a bench or a rack-mount instrument. Rack mounting accessories are described in Section 6.

2-9. FRONT AND REAR PANEL FEATURES

2-10. The Front and Rear panels are shown in Figures 2-1 and 2-2. The various controls and connections are listed and explained in Tables 2-1 and 2-2.

2-11. PRE-OPERATION CONSIDERATIONS

2-12. Introduction

2-13. The following paragraphs describe various conditions that should be considered before operating the 732A. If the 732A is brand new, set the rear panel BATTERY OPR switch to ON, and perform the acceptance test described in Section 4 of this manual.

2-14. Input Power Requirements

2-15. The 732A is designed to be powered continuously (including during storage or shipment) to maintain standardization. Normally, power is continuously applied, either to the ac line input connector or to the low voltage ac or dc input connectors. The ac line power requirements are: 100V, 120V, 220V or 240V ac ± 10%, at 50 or 60 Hz. Low voltage, 24-40V dc or 24-30V ac, 50-400 Hz may be connected to supply instrument power and charge the internal backup battery through the external input connector on the rear panel (see Table 2-2). The internal, rechargeable gel-cell (sealed, gelled electrolyte lead-acid) battery provides approximately 24 hours of continuous operation when ac power is not available.

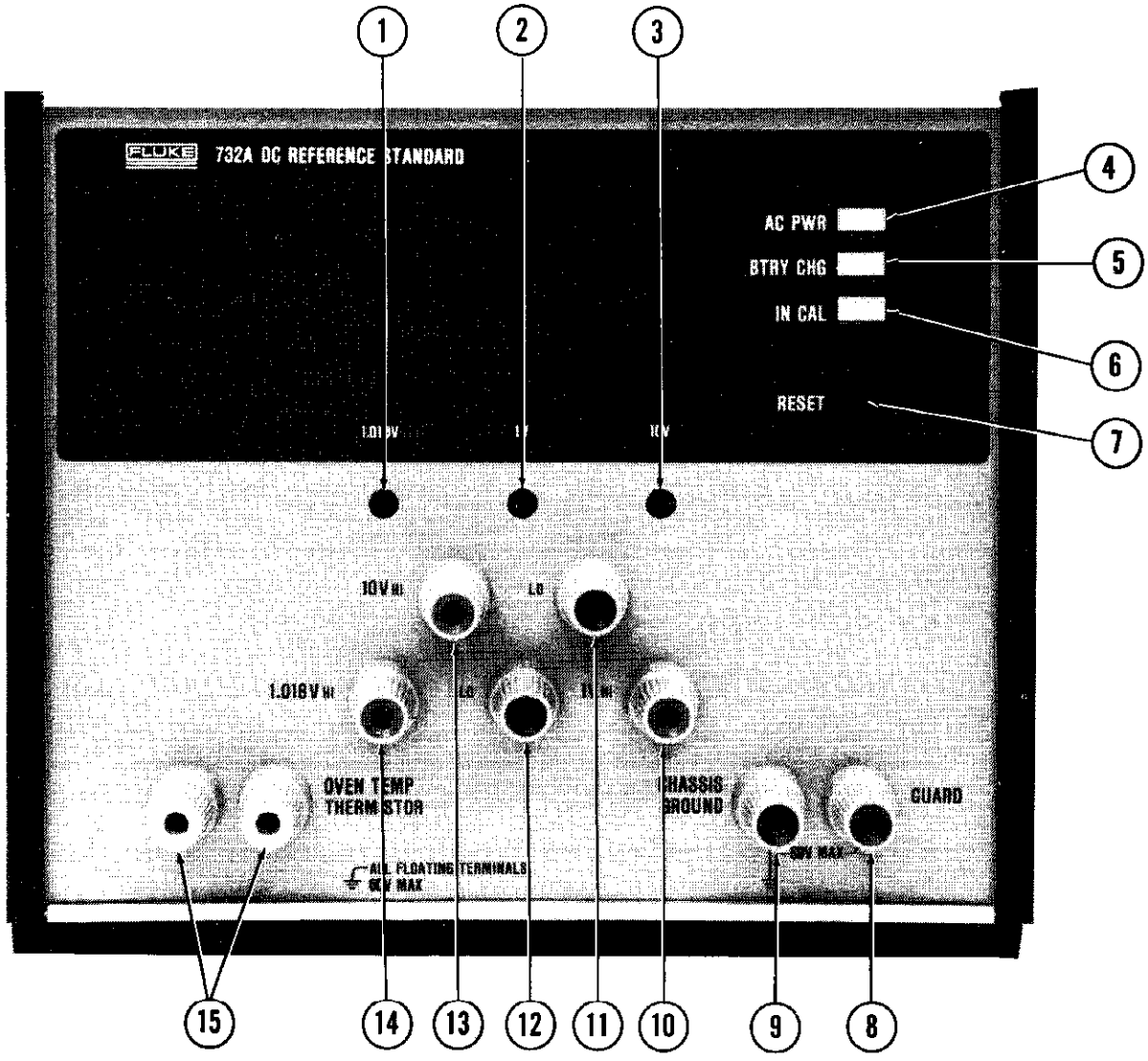


Figure 2-1. Front Panel Features

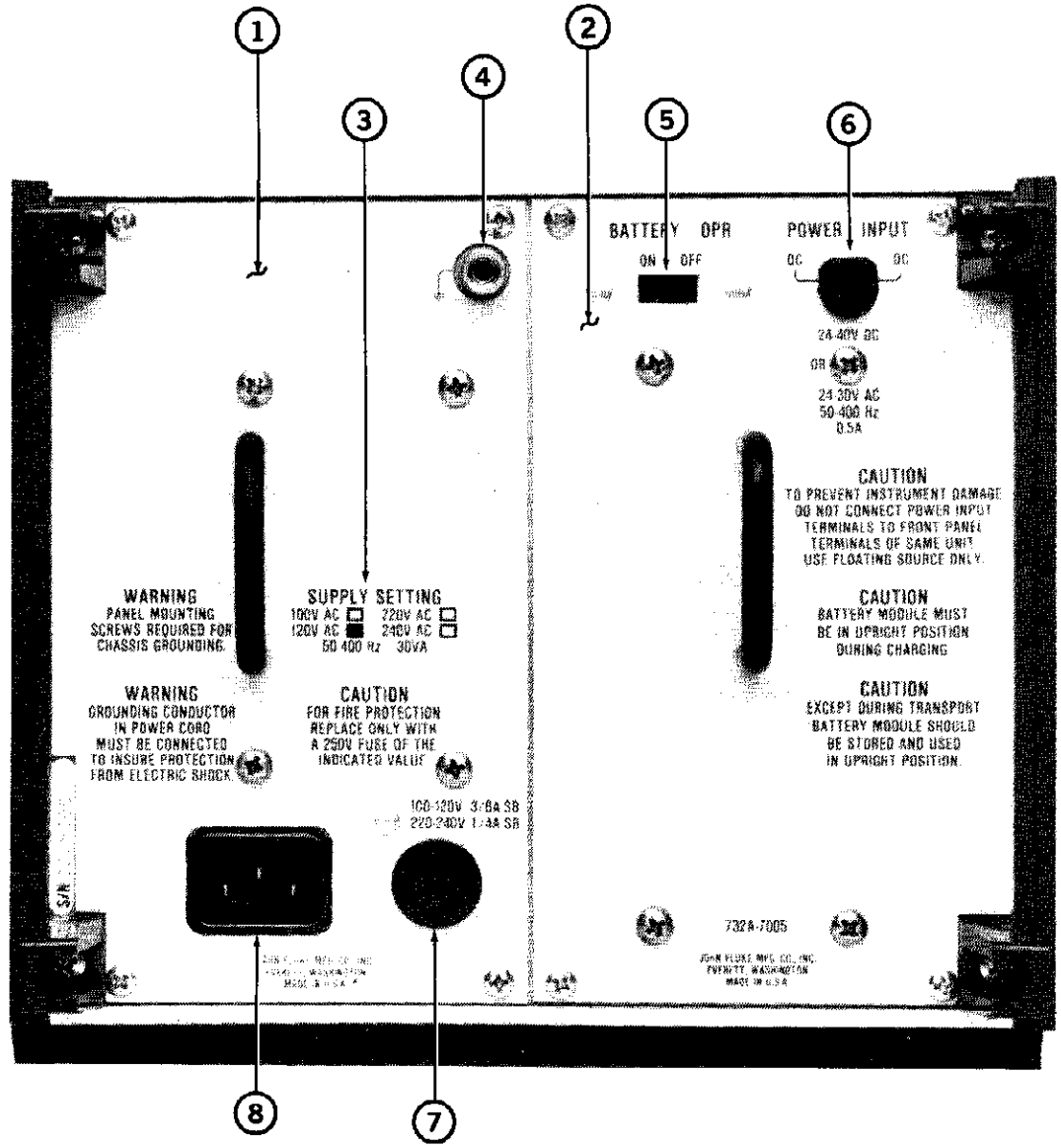


Figure 2-2. Rear Panel Features

Table 2-1. 732A Front Panel Controls and Adjustments

ITEM	FEATURE NAME	DESCRIPTION
1	1.018V Adjustment*	Calibration tool adjustment. ±50 μV adjust for 1.018V output.
2	1V Adjustment*	Calibration tool adjustment. ±5 μV adjust for 1V output.
3	10V Adjustment*	Calibration tool adjustment. ⊥50 μV adjust for 10V output.
4	AC PWR Indicator	LED that indicates the presence of ac power when illuminated.
5	BTRY CHG Indicator	LED that indicates battery charger operation when illuminated.
6	IN CAL Indicator**	LED that indicates out-of-calibration condition when not illuminated.
7	RESET**	Terminal behind front panel to reset the IN CAL indicator to ON condition.
8	GUARD Terminal	Binding post that connects to internal Guard circuit. Normally connected to OUTPUT LO at some point in the measurement system. 60V is the maximum differential allowed between GUARD and CHASSIS GROUND.
9	CHASSIS GROUND Terminal	Binding post connected to the chassis of the 732A.
10	1V HI Terminal	Binding post on which the 1V output of 732A is available.
11	LO Terminal	Binding post which provides common connection for the 10V output.
12	LO Terminal	Binding post which provides common connection for the 1V and 1.018V outputs.
13	10V HI Terminal	Binding post on which the 10V output of the 732A is available.
14	1.018V HI Terminal	Binding post on which the 1.018V output of the 732A is available.
15	OVEN TEMP THERMISTOR terminals	3/4-inch spaced dual binding posts. Floating thermistor for monitoring oven temperature.

*The 10V adjustment affects both the 1.018V and 1V outputs. This adjustment should be made first when calibrating the 732A. See Section 4.

**The IN CAL indicator detects an out-of-range condition within the power supply of the 732A. If not illuminated, the 732A is not operating at its specified accuracy. Use the RESET terminal to restore the IN CAL indicator after re-calibration. See Section 4.

Table 2-2. 732A Rear Panel Features and Controls

ITEM NO.	FEATURE NAME	DESCRIPTION
1	AC Module	Rear panel module containing the A3, Pre-Regulator PCB Assembly.
2	Battery Module	Rear panel module containing the A6A1, Battery PCB Assembly.
3	SUPPLY SETTING (Ac power requirements)	Specifies the correct ac line voltage required to operate the instrument.
4	⏚ chassis terminal	Binding post that provides a direct chassis connection.
5	BATTERY OPR switch	Slide switch that sets instrument back-up battery supply, on or off.
6	EXTERNAL POWER INPUT conncetor	External power input connector for connecting an external power source (24-40V dc or 24-30V ac, 50-440 Hz). The internal back-up battery voltage may also be measured at this connector.

Table 2-2. Rear Panel Features (cont)

ITEM	FEATURE NAME	DESCRIPTION
7	Fuse holder	AC line fuse holder.
8	Power connector	IEC 3-wire receptacle, for ac line power connection. See item 3 for specified ac line voltage.

2-15a. A connector plug (P/N 720847) for the external power input connector (Figure 2-3) is provided with each 732A Battery Module. To wire the plug, use the following procedure:

1. Remove the strain relief nut and the strain relief from the plug housing.
2. Push the contact header out of the plug housing in the direction of the strain relief.
3. Solder a wire to each contact using AWG 19- to 22-gauge wire or 2-conductor cable with an outside diameter smaller than .216 inches (see Figure 2-3).
4. Install the strain relief nut and the strain relief onto the cable in the correct order and orientation.
5. Insert one soldered contact into the contact header hole #1 (+) and the other into hole #2 (-).
6. Reassemble the plug.

2-16. AC Line Voltage Selection

2-17. The Line Voltage Selector switches are located inside the instrument. Their setting is marked on the rear panel (See Figure 2-2). If the marked setting does not agree with the locally available ac power, the settings of the internal Line Voltage Selector switches must be changed. Refer this and all servicing to qualified personnel. The ac line voltage selection procedure is described in Section 4.

2-18. Fuse Replacement

2-19. The ac line fuse is located on the rear panel of the instrument. If the fuse requires replacement, replace it with one appropriate for the ac line voltage indicated on the rear panel. Use a ⅜A slow-blow fuse (P/N 109264) for ac line voltages from 100V to 120V. Use a ¼A slow-blow fuse (P/N 166306) for ac line voltages from 220V to 240V.

2-20. Backup Operating Power

2-21. If ac line power fails or drops more than 30% below the nominal value, the internal battery automatically maintains operation. Set the rear panel BATTERY OPR switch to ON to enable the internal battery. When line power fails, the AC PWR indicator goes out, but the IN CAL indicator remains on. The unit continues to operate normally until the battery discharges. When the battery is discharged, the IN CAL indicator will go out. When ac power is restored, the BTRY CHG indicator illuminates until the battery is fully charged. If the IN CAL indicator does not illuminate, standardization of the instrument must be verified before the 732A is used. The battery voltage may be measured at the POWER INPUT connector with a high impedance multimeter, such as Multimeter A, specifications for which are given in Table 4-1.

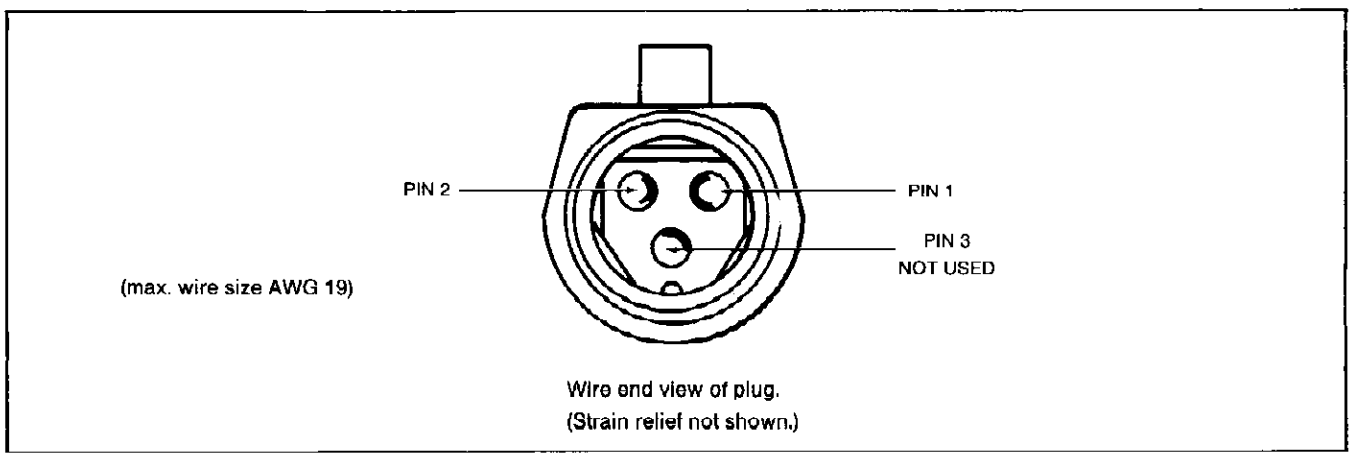


Figure 2-3. Connector Plug for External Input Connector

2-22. Battery Charging

CAUTION

Permanent battery damage will result if the battery is allowed to discharge below 19V. The degree of damage is a function of the depth of over-discharge and the battery temperature.

CAUTION

The unit must be in an upright position during charging to avoid possible venting of the electrolyte. The battery unit should be kept in an upright position at all times except during transit.

2-23. Under normal operation, battery life should exceed 5 years. For best battery life, minimize the number of charge/discharge cycles and avoid deep (<19V) discharge.

2-24. If the battery is fully discharged, 24 hours is required to recharge it fully when the 732A is operating from ac line power. If the battery is not fully discharged, the charging time will be less, but always in excess of the discharge time. When the battery is charging, the BTRY CHRG indicator illuminates to indicate charging activity; the indicator turns off when the battery is fully charged.

2-25. IN CAL Indicator and RESET Terminal

2-26. If the IN CAL indicator does not illuminate (indicating loss of ac power, a dead battery, or that the instrument is turned off), the output of the 732A may not meet the specifications listed in Section 1. The RESET terminal, located behind the front panel, is used to restore the IN CAL indicator to the on condition. See Section 4 for the reset procedures. Before resetting the indicator, apply power (ac line or low voltage external ac or dc), allow a stabilization period of 24 hours, then check the 732A to ensure that the various outputs are within specification. (See Section 4, Maintenance.)

2-27. Portability

2-28. The 732A is portable and operational at ambient temperatures between 0 and 40° C (32 to 104° F). Normal handling and transportation will not alter accuracy or stability if power is maintained by the internal battery or through the external power connections. The instrument may be used immediately after transportation, provided that the IN CAL indicator is illuminated and that the instrument has not been exposed to ambient temperatures beyond the normal operating range (23 ± 5° C). If this temperature range has been exceeded, allow one hour for temperature stablization before using the instrument.

2-29. Guarded Operation

WARNING

LETHAL VOLTAGES MAY BE PRESENT WHEN OPERATING THE 732A WITH THE GUARD AND CHASSIS GROUND CONNECTIONS SEPARATED. A MAXIMUM POTENTIAL DIFFERENCE OF 60V RMS MAY APPEAR BETWEEN ANY COMBINATION OF THE GUARD TERMINAL, CHASSIS GROUND, REFERENCE STANDARD OUTPUT, OR OVEN TEMPERATURE THERMISTOR OUTPUT. IF THIS LIMITATION IS EXCEEDED, DAMAGE TO THE INSTRUMENT MAY RESULT.

2-30. The 732A is equipped with a guard that isolates the internal circuitry from the chassis and earth ground. A GUARD terminal is provided on the front panel. When the guard is properly used, it can greatly reduce errors caused by common mode voltages. In general, guarded operation is necessary under the following conditions:

1. When a potential exists between equipment power line grounds.
2. When long connection leads are used to connect a high impedance load.
3. When the instrument is operating in the presence of high level radiated noise.

2-31. A potential difference may exist between the power line grounds of the 732A and an instrument to which it is connected. This potential difference can cause circulating ground currents, which cause errors in the output voltage.

2-32. To prevent these errors, connect the 732A GUARD terminal to the load in a manner that provides a separate path for the circulating currents. Connect the GUARD terminal to the grounded side of the load, at the load. Figure 2-4 illustrates the correct GUARD terminal connection and the rerouted ground currents. The circulating current path may also be broken by operating the 732A on battery power as described later in this section.

2-32a. When using the 732A to make transfer measurements involving standard cells, take care to avoid coupling alternating currents into the circuit which may be rectified by the standard cell. Otherwise, erroneous results can be produced. Observe the following precautions:

I. Use low-thermal emf, shielded cables for all interconnections between test instruments.

2. Use only test instruments that are isolated and guarded from power line ground. If necessary, use battery powered instruments to achieve this isolation.

3. Connect the test lead shields to the instrument guard terminals.

4. At one point, and ONE POINT ONLY, connect the test circuit low to the ground circuit, and connect the ground circuit to power line and chassis ground.

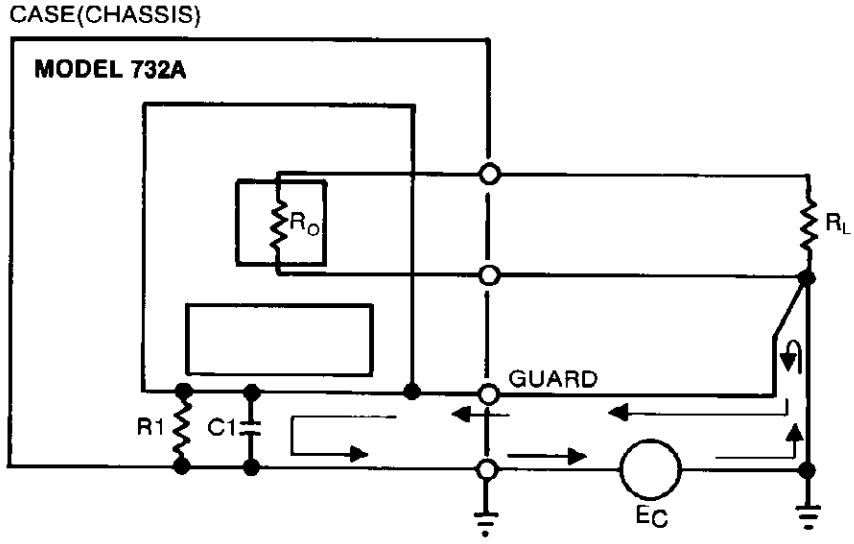
2-32b. Careful attention to these precautions usually eliminates the effects of capacitive coupling, which is present in most line-operated instruments, between the ac power line and the instrument circuits. If the effectiveness of these measures is in doubt, the 732A (and possibly other instruments) may be disconnected from the power lines and operated on battery power to determine if the test results change. Line coupling may come from unexpected sources. For example: standard cell enclosures have line-operated heater circuits; potentiometers have line-operated power sources; galvanometers have line-operated illumination sources.

2-33. Oven Temperature Thermistor

2-34. A thermistor, mounted inside the Oven Assembly, senses changes in the internal oven temperature. Use the Oven Temperature Thermistor in conjunction with an external ohmmeter to monitor the temperature stability of the oven vs time. The thermistor terminals are on the front panel of the 732A. Both leads of the thermistor are isolated from all parts of the 732A circuitry. A maximum potential difference of 60V is allowed between either of the thermistor terminals and any other front panel terminal (Guard, Ground, Reference Standard Outputs).

2-35. The nominal value of the Oven Temperature Thermistor is between 4 kΩ and 5 kΩ at the normal oven operating temperature. The thermistor has a temperature coefficient of minus 3.8%/ °C. The actual operating value is shipped with the instrument and should be recorded in the instrument data log book as soon possible.

2-35a. In order to ensure optimum performance of the 732A, the value of the oven temperature thermistor should be recorded to three significant digits whenever the 732A is used (or on a daily basis when the instrument is not in use). The thermistor drift rate is normally ±50



WHERE:

R1 C1 = Leakage Resistance & Capacitance From Guard to Chassis

E_c = Potential Difference Between Power Line Grounds

R_O = 732A Output Resistance

R_L = Load Resistance

Figure 2-4. Guard Connection

ohms per year in the first year and ±10 ohms per year thereafter. A long-term temperature shift of 5% in thermistor resistance would not be excessive (in terms of actual temperature drift of the oven). On a short-term basis, variations of ±20 ohms from day-to-day indicate probable oven problems. Short-term changes of ±100 ohms would affect the 1.0 and 1.018V outputs appreciably, but would be unlikely to have a significant effect on the 10V output.

2-36. Minimizing Error Sources

2-37. The inherent accuracy and stability of the 732A may be easily degraded if the effects of thermal emf, lead resistance, and other factors are not considered and minimized.

2-38. THERMAL ERRORS

2-39. When parts of a circuit operate at different temperatures, thermal voltages are normally present at the equipment connections. These thermal voltages can exceed 10 μV. Use the following techniques to minimize thermal errors:

1. Use the Fluke 5440A-7002 Low Thermal EMF Cable Set. See Section 6, Accessories.
2. Use #24 AWG or larger, bare copper, Teflon®-insulated connecting wires. It is preferable to use shielded, twisted pair cable. Avoid splices.
3. Avoid the use of ordinary, nickel-plated, banana plugs for equipment interconnections. Use of low-thermal emf, copper spade, lugs is recommended. Crimp the lug onto the wire before soldering. Loosen the top of the binding post, insert the lug, and tighten the binding post on the lug.

NOTE

Tighten the binding posts with fingers only.

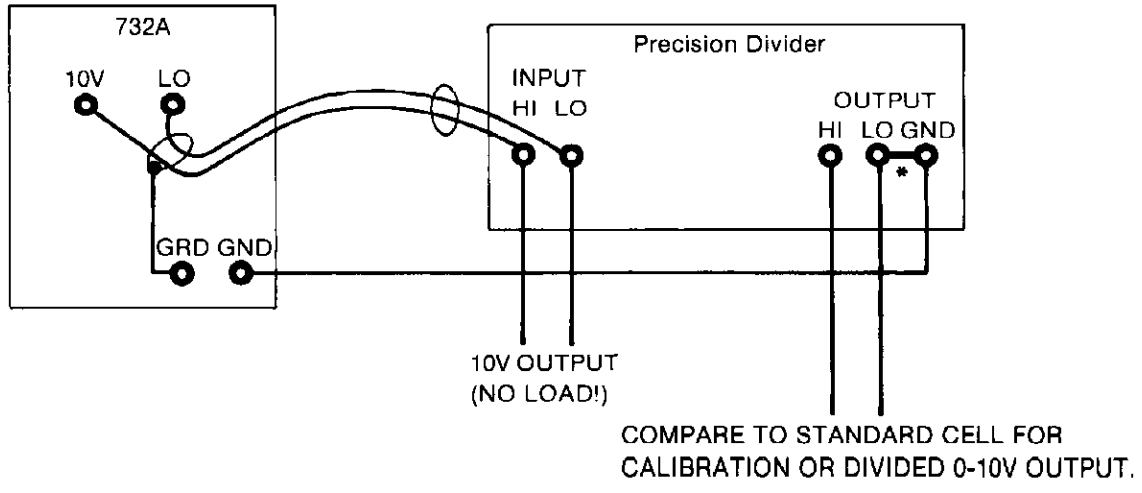
2-40. OTHER ERROR SOURCES

2-41. When using the 732A with a reference divider, the effects of the finite (though very low) output impedance of the 732A, the lead wire resistance, and the loading caused by the reference divider cannot be ignored. Use the following procedure to minimize the effects of test lead resistance and output loading:

1. Connect the equipment as shown in Figure 2-5.
2. Calibrate the 732A/Reference Divider combination at the divider input terminals.
3. When calibration is complete, treat the 732A and the Reference Divider as a system.

NOTE

Use low thermal emf connections between the 732A and the precision divider input terminals.



* *To eliminate ac common mode voltage, a signal ground connection should be made at one and only one point in the set-up. The actual ground source in this set-up is at the 732A, assuming the 732A is plugged into the line.*

Figure 2-5. 732A/Precision Divider, Providing a Stable Adjustable Source

4. Do not disconnect the Reference Divider at any time, even if it is not required in a given procedure. Since the 732A/Reference Divider system was calibrated at the divider input terminals, disconnecting it will change the loading on the 732A and affect the calibration.

2-42. LONG-TERM STABILITY

2-43. The user can determine the long-term stability of the 732A by periodically comparing the output voltage to a known reference standard and plotting the difference as a control chart. Output voltage drift, with respect to the legal voltage, may be positive or negative and is a characteristic of the individual 732A. Accumulated test data have shown that, once established, the measured drift is generally constant, provided the instrument continues to receive uninterrupted operating power. When drift rate is established, extrapolations of output voltage are justified, and allow the use of the reference with less uncertainty than would be obtained from the stability specifications alone. A convenient method of performing the needed periodic calibration is to use the Fluke Direct Voltage Measurement Program, Option 732A-200 (described in the Fluke Catalog), which provides calibration against a traceable reference standard in the user's lab.

2-44. Due to the possibility of undetected damage or malfunction, there is a risk involved in relying completely on any single standard. This risk is reduced significantly by using two or more independent standards (with frequent intercomparisons) to ensure that all are stable within the range of expected normal deviations. An added advantage of having multiple, independent standards is the opportunity to use a statistical average of the individual outputs. Multiple 732A's may be used in this way to gain statistical improvements in the uncertainty specification of the reference voltage.

2-45. OPERATION

2-46. Use the following procedure to prepare the 732A for operation.

1. Check the rear panel for ac power requirements and connect the 732A power cord to an appropriate power source.

2. Set the BATTERY OPR switch to ON.

3. Verify that the AC PWR indicator is illuminated. The BTRY CHG indicator is also illuminated if the batteries are not fully charged.

4. Allow the unit to stabilize for a period of 24 hours if either of the following applies:

   a. The IN CAL indicator is not illuminated.

   b. The instrument has been stored in or exposed to ambient temperatures in excess of the normal operating range ($23 \pm 5°C$).

5. Ensure that the 732A is calibrated according to the procedures described in Section 4.

6. The instrument is now ready for use.

7. If the IN CAL indicator goes out, the output of the 732A is not standardized. Notify the Calibration department or person(s) responsible for maintaining the 732A. Refer to Section 4.

2-47. OPERATION ON BATTERY

2-48. Prior to operating the 732A on battery power, the following procedure should be followed.

1. Connect a voltmeter at the rear terminal POWER INPUT jack to monitor the battery voltage.

2. Note the voltage while the battery is on trickle charge (the AC PWR LED is on, but BTRY CHG off). The voltage should be around 27V.

3. Disconnect the line cord, wait 10 minutes, and monitor the battery voltage for one-half hour. The battery package may have to be replaced if the voltage decreases by more than 0.2V during this period and the load represented by the 732A is correct (see Section 4, Battery Discharge).

2-49. It may also be advisable to perform the above procedure periodically to ensure battery backup capability is maintained.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section describes the theory of operation of the 732A, including an overall functional description, followed by a circuit description of the 732A. Both descriptions are supported by a block diagram (Figure 3-1). Component-level descriptions contained in the circuit analysis refer to the detailed schematics in Section 8 of this manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The 732A dc Voltage Reference Standard is a highly stable 10V, 12 mA power supply. Refer to Figure 3-1. AC line input power is full wave rectified and fed to a two-stage voltage regulator. The first stage, or Pre-regulator, converts the raw dc to 32V dc. The second stage, or Regulator, converts this voltage to 18.6V dc, which powers the Oven Controller and the Reference.

3-5. The Voltage Monitor disables the Oven Controller and latches the IN CAL indicator off when the output of the Regulator is insufficient for proper operation. The RESET terminal is used to restore the IN CAL indicator to the on condition after standardization of the instrument has been performed.

3-6. If ac line power fails or is not available, an internal, sealed, lead-acid battery maintains operating power to the 732A. When ac power is available, a battery charger charges the battery. While the battery is charging, the BTRY CHG indicator is on; when the battery is fully charged, the BTRY CHG goes out.

3-7. When ac line power is not available, the battery may be charged by a low voltage external ac or dc source connected at the rear panel POWER INPUT connector. The external source can also supply operating power for the instrument. The battery voltage can also be measured at the rear panel connectors.

3-8. CIRCUIT DESCRIPTION

3-9. The information in this section describes the circuitry of the 732A to the functional block diagram level. Refer to the detailed schematics in Section 8.

3-10. Power Supplies (A3 and A4)

3-11. The 732A has two cascaded regulators. The Pre-regulator (A3Q1) is a simple emitter follower regulator that clamps the full wave rectified power from the bridge rectifier to approximately 32V dc.

3-12. The Regulator (located on A4) supplies operating voltages to all of the circuitry in the 732A except the battery charger. During battery operation, the battery drives the Regulator input.

3-13. The Regulator (Q1, Q2, Q3, Q4) is a conventional series-pass transistor, error-amplifier design that regulates the 32V to 18.6V dc.

3-14. Voltage Monitor

3-15. The Voltage Monitor circuit (Q5, Q6, Q7, Q8) checks the regulator output and disables the instrument when the supply voltage falls below a critical value. When this happens, the Oven Controller is disabled and the IN CAL indicator is latched off. The reset circuit is used to turn the IN CAL indicator back on after standardization has been verified by qualified personnel. The Voltage Monitor is located on the A4 Regulator PCA (printed circuit assembly).

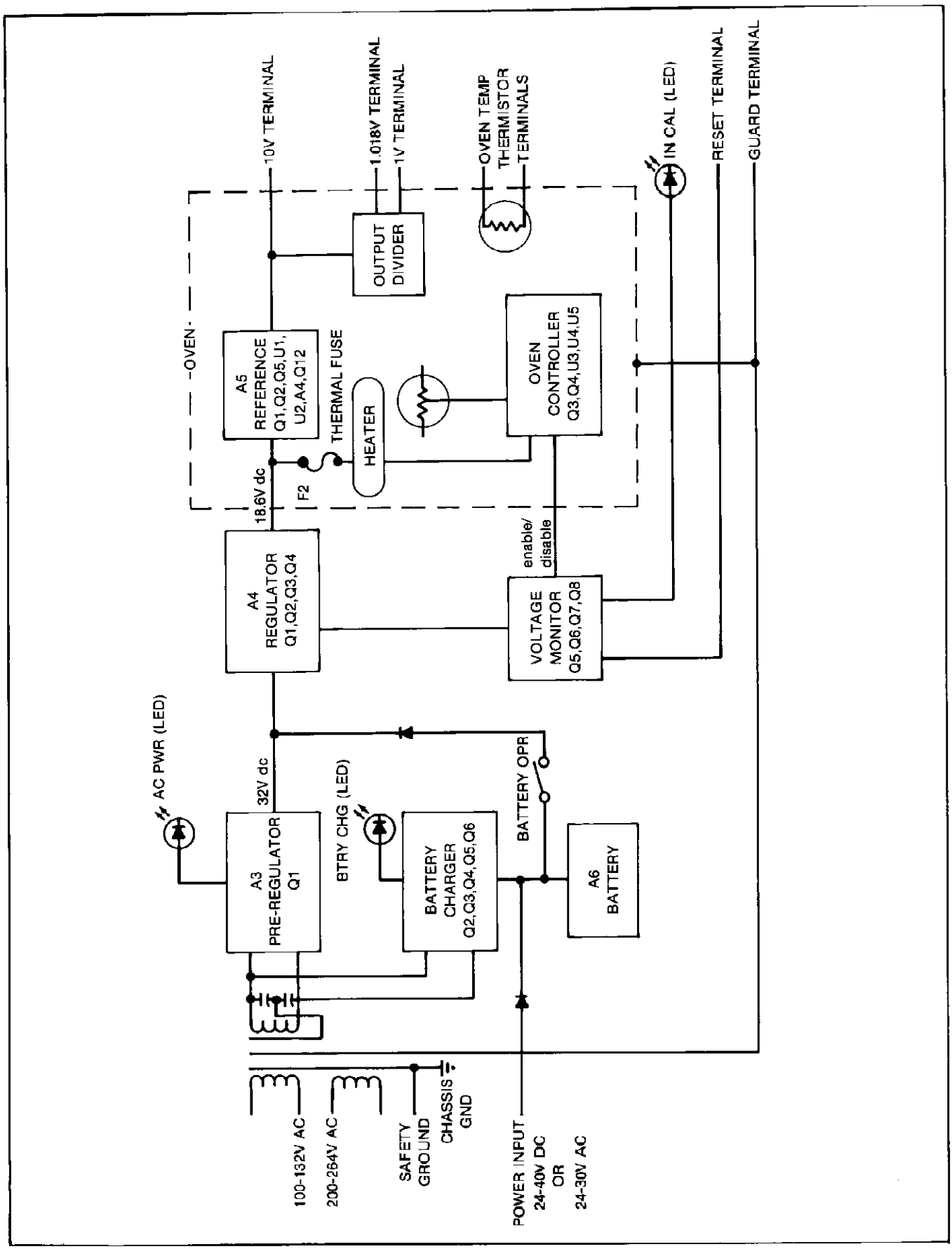


Figure 3-1. Functional Block Diagram

3-16. Transistor Q8 is turned on by the voltage drop across the Regulator circuit series-pass transistor. This causes switching transistor Q5 to saturate, supplying power to the Oven Controller circuit and the IN CAL indicator circuit. When the output falls below that needed for normal operation, Q8 and Q5 turn off, shutting down the Oven Controller and removing drive from Q7, a Programmable Unijunction Transistor (PUT). This removes the drive from Q6, shutting off the IN CAL indicator on the front panel. When power is restored, Q7 remains latched off until its emitter is connected momentarily to the COMMON output terminal via the RESET connection, which is accessible through the front panel.

3-17. Reference Circuit, A5

3-18. The Reference Circuit (A4Q12, Q1, Q2, Q5, U1, U2) reduces the 18.6V output of the Regulator to precisely 10V. The Reference Circuit is a highly stable series-pass voltage regulator. The entire reference supply (except the pass transistor) is enclosed in an oven to provide the consistent thermal environment necessary for the stability of the output.

3-19. U2, the Ref-Amp, is a transistor and zener diode mounted on a common substrate. This construction compensates for ambient temperature changes; thus U2 has an extremely low temperature coefficient. The Ref-Amp compares the 10V output to its internal zener reference to derive an error voltage that is amplified by op amp U1. U1 drives the series-pass element (Q1, A4Q12). Q2 provides current limiting to protect the series-pass element under short-circuit conditions. Variable resistor R20 allows a small adjustment ($\pm 50\ \mu V$) in the output voltage of the Reference. Larger adjustments can be made by jumper changes on the Calibration PCA, A7.

3-20. Output Divider

3-21. Two precision resistive voltage dividers divide the precise 10V output down to 1V and 1.018V. Each of these dividers is adjustable over a limited range to allow calibration. Both dividers are enclosed in the oven with the reference.

3-22. Oven Controller

3-23. The Oven Controller (A4Q13, A4Q14, Q3, Q4, U3, U4, U5) maintains the internal temperature of the oven at a nominal temperature of $45 \pm 2°C$. The Oven Controller is a high gain thermal proportional control circuit. The Oven Controller circuit is partially located on the A5 Reference PCA, inside the oven. The oven driver and output transistors are located on the A4 Regulator PCA.

3-24. Thermistors RT1, series connected RT2, and RT3 are connected in a bridge configuration with R28 and R29, and are located inside the oven. U3 buffers the bridge output and drives differential amplifier/integrator U5, which drives the driver (A4Q13) and output transistors (A8Q1, A8Q2) and subsequently the oven heaters. U4 shapes the overall loop frequency response.

3-25. Battery Charger

3-26. The battery charger determines the state of charge of the internal battery and sets the charging current accordingly: constant current charging for deep discharge or constant voltage trickle charging for charge maintenance. The Battery Charger circuit is located on A3.

3-27. Transistor Q2 is a current source that supplies all the charging current. Transistors Q3 and Q4 form a Schmitt trigger. Transistor Q6 supplies a constant voltage output for trickle charging and thus maintains the battery at full charge. Two thermistors monitor the battery temperature (A6RT1, A6RT2) and adjust the charging rate accordingly.

3-28. During initial charging, Q3 enables Q2 and the high charge rate. When the battery voltage rises to approximately 32V, Q4 turns off, shutting off the constant current charge. The battery is then constant voltage charged by Q6 (approximately 27V at 23°C). Potentiometer R10 sets the threshold point of this transition and hence the end of charge current. At this point, Q6 supplies a constant voltage trickle charge to the battery, and R20 sets this voltage level. Thermistors RT1 and RT2, located on the battery pca, and Q5 prevent high current charging at temperatures below 5°C, and/or high temperatures.

3-29. Overtemperature Protection

3-30. Protection against overtemperature is provided by a 58°C thermal fuse (F1), which is placed directly on top of the ovenized reference module. When F1 opens, it interrupts the +18.6V supply connection to the oven heater, and also disconnects the +18.6V from the latch circuit Q6 on the regulator PCA, causing the IN CAL LED to go out (and stay out) until the fault is corrected.

Section 4
Maintenance

WARNING

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

4-1. INTRODUCTION

4-2. This section provides maintenance information for the 732A. It includes general maintenance procedures, an acceptance test, a calibration test, calibration procedures, and troubleshooting information.

4-3. The acceptance test is used to verify that the instrument is operating within specifications. Perform the acceptance test upon receipt of the instrument.

4-4. The instrument should be calibrated at intervals commensurate with the accuracy and stability requirements of the user. Necessary test equipment is listed in Table 4-1. Equivalent instruments may be used, provided that they meet the minimum specification(s).

NOTE

To limit thermally induced errors, use the Fluke Low Thermal EMF Cable Set (accessory 5440A-7002). Alternatively, copper wire, (preferably shielded twisted pair), with crimped and soldered low-thermal lugs may be used. Avoid the use of ordinary nickel-plated banana plugs.

CAUTION

To avoid cracking the plastic binding post insulator, tighten only with finger pressure. Do not use tools.

4-5. SERVICE INFORMATION

4-6. The 732A is warranted for a period of one (1) year upon delivery to the original purchaser. The warranty is given on the back of the title page located in the front of this manual.

4-7. Factory-authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of Fluke service centers is included in Section 7 of this manual. Shipping information is given in Section 2 of this manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are not currently under warranty.

4-8. GENERAL MAINTENANCE

4-9. Access Procedure

4-10. Use the following procedures to disassemble the 732A for adjustment or repair. Disconnect ac power connections before disassembling the 732A.

Table 4-1. Required Test Equipment

TYPE	REQUIRED SPECIFICATIONS	RECOMMENDED MODEL	PROCEDURE*
Certified 732A	As required by the user	Fluke 732A**	A, B
Voltage Divider	7 decade, 0.1 ppm resolution 0.1 ppm absolute linearity	Fluke 720A	B
Null Detector	1 μV full-scale sensitivity. 10 MΩ input resistance. ZERO/OPR switch must open circuit input terminals in ZERO position.	Fluke 845AB, AR	B
Adjustable Source	10V dc output 1 μV resolution 0.3 ppm + 2 μV stability	Fluke 5440A, 5440B or 5442A	B
Multimeter A	4½-digit display 20 kΩ resistance range 200 mV to 200V ac or dc	Fluke 8050A, 8060A	A,C,D
Multimeter B	6½-digit display 10V dc range, 100 μV resolution 1V dc range, 10 μV resolution	Fluke 8500A, 8502A	B,D
Rheostat	50 kΩ, ½W	Fluke P/N 501601	C
Variac	120V, 1A, metered	GenRad W5MT3A	C
Load Resistor	1 kΩ, ½W Carbon Composition	Fluke P/N 108597	B,C
Adjustment Tool	Supplied with 732A	Fluke P/N 686113	A,B

* A = Acceptance Test
B = Calibration procedure
C = Battery charger adjustment
D = Troubleshooting

**The 732A selected for use as the Certified 732A in the Calibration Procedure should be calibrated at a calibration facility whose transfer uncertainties are consistent with the user's needs.

4-11. COVER REMOVAL

4-12. Use the following procedure to access the interior of the 732A. (Refer to Figure 4-1.)

1. Remove all screws securing the top and/or bottom cover(s).

2. Lift the cover(s) off the instrument.

4-13. REAR MODULE REMOVAL

4-14. The AC Module and the Battery Module are located in the rear of the 732A. Use the following procedure to remove either of the rear modules. (Refer to Figure 4-2.)

NOTE

Either module, but NOT both, may be removed without loss of standardization. If the AC Module is removed, ensure that the rear panel, BATTERY OPR switch is set to ON and that the battery is charged before removing the AC Module. This will ensure continued standardization.

1. Remove the screws securing the module to the rear of the instrument.

2. Pull the module out from the rear of the instrument.

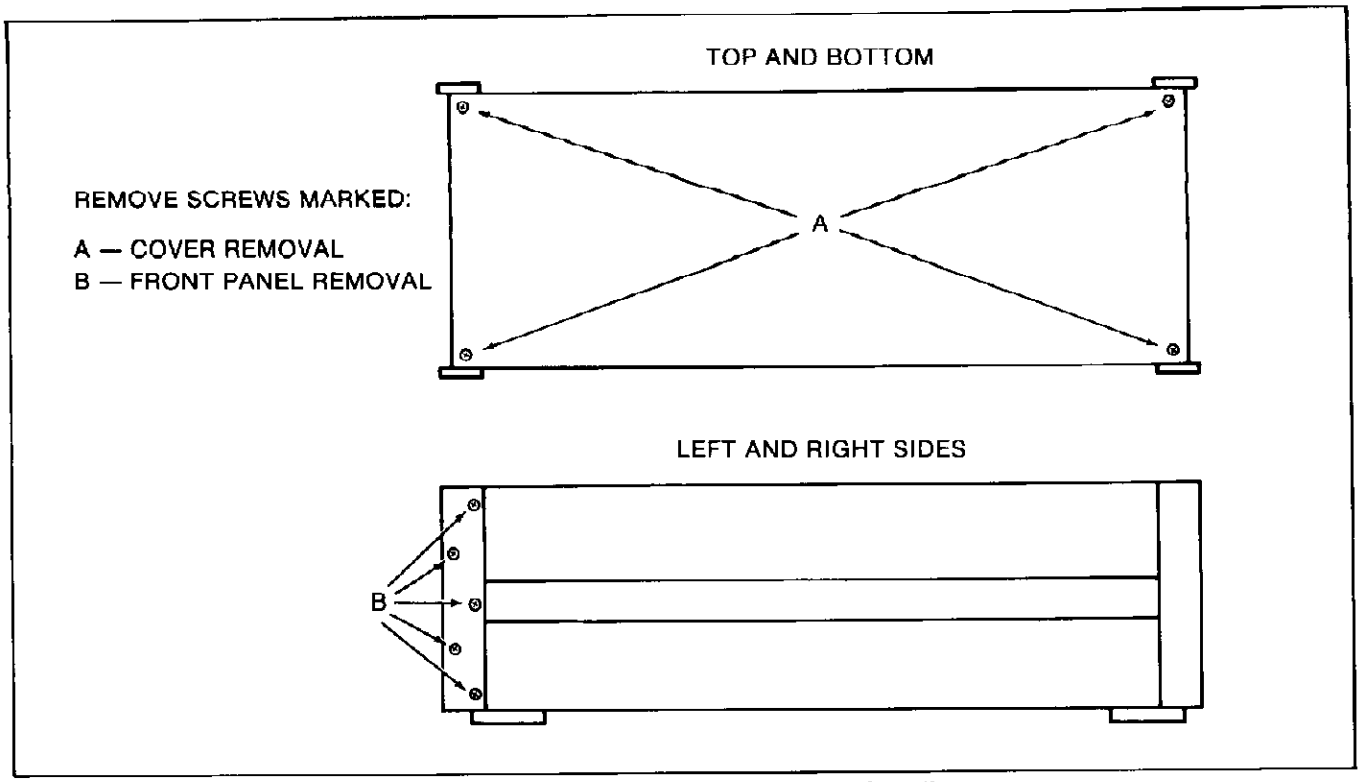


Figure 4-1. Cover and Front Panel Screw Locations

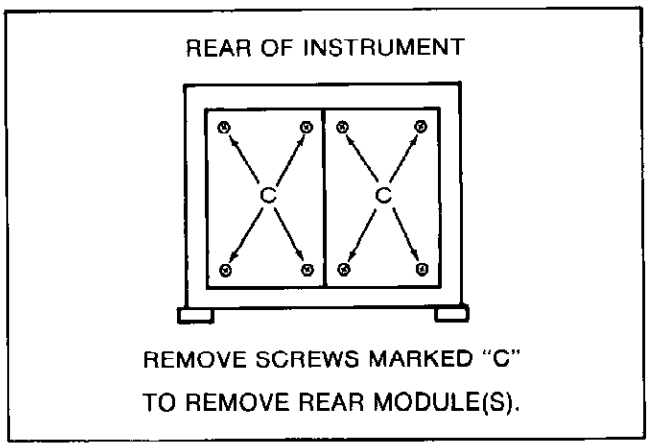


Figure 4-2. Rear Module Mounting Screw Locations

4-15. REGULATOR PCA (PRINTED CIRCUIT ASSEMBLY) REMOVAL

NOTE

Since the Regulator PCA removal requires the removal of BOTH rear modules, standardization will not be maintained after this procedure.

4-16. Use the following procedure to remove the Regulator PCA from the 732A. (Refer to Figure 4-3.)

1. Remove the top and bottom covers.
2. With the 732A resting on its bottom, remove the screws securing the inner shield top cover and remove the shield.
3. Remove both of the rear modules.
4. Remove the screws that fasten the T0-220 power transistor to the bottom of the chassis. Save the insulator and the shoulder washer. Note the positions of the insulating hardware so they can be reassembled properly.
5. Unplug the Regulator PCA from the motherboard by pulling it out towards the rear of the 732A.

4-17. OVEN REMOVAL

4-18. Use the following procedure to remove the Oven Assembly from the 732A. (Refer to Figure 4-4.)

1. Remove the top and bottom covers.
2. With the 732A resting on its bottom, remove the screws securing the inner shield cover and remove the cover.
3. Carefully pry out the top foam insulating block from the front of the instrument using a blade type screwdriver.

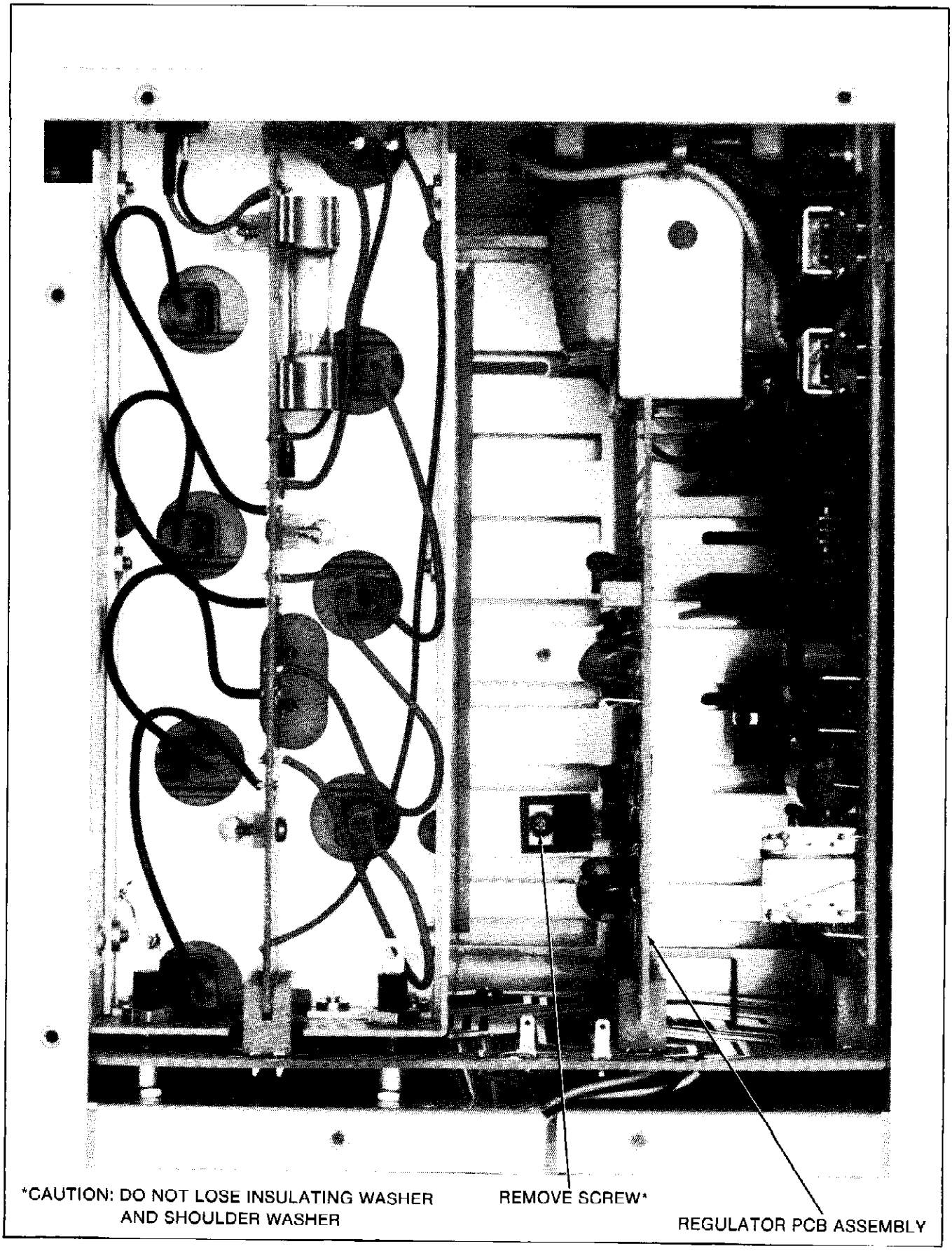


Figure 4-3. Regulator PCA Removal

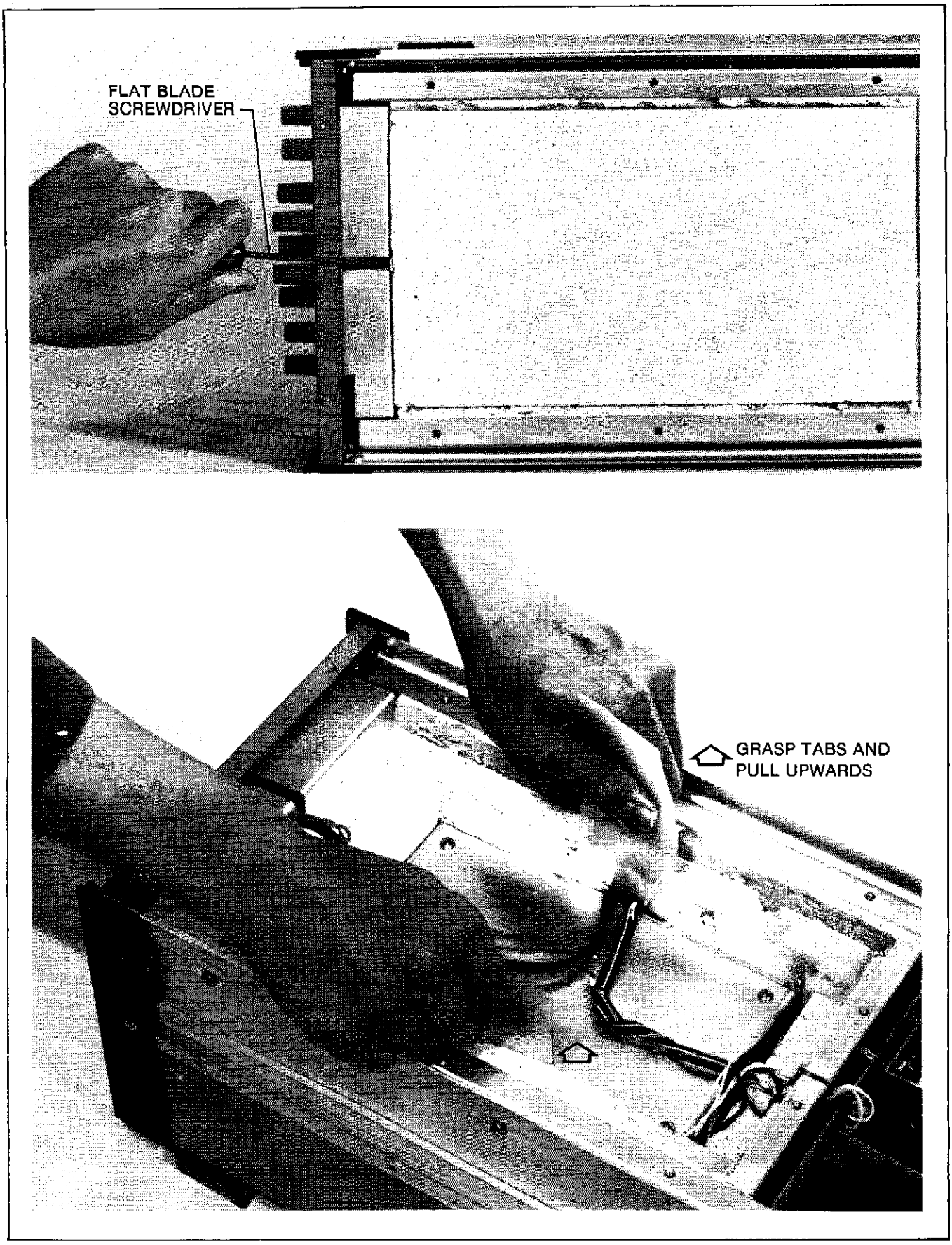


Figure 4-4. Oven Assembly Removal

4. Do the same for the foam block that is now exposed.

5. Locate the two mylar tabs on each side of the Oven Assembly.

6. Grasp both mylar tabs and pull them steadily and evenly upwards.

7. Disconnect the Oven Assembly cable harness at the motherboard and at the front panel.

4-19. OVEN DISASSEMBLY

4-20. Use the following procedure to disassemble the Oven Assembly only if access is necessary to make repairs on the Oven Controller circuit. Do not attempt to repair the Reference circuit.

1. Remove the Oven Assembly from the 732A.

2. Lay the instrument on its side, with its top facing you, and lay the Oven Assembly on the work surface.

3. Remove the four screws holding the inside clamshell. (The inside clamshell contains the adjustment holes for the calibration potentiometers.)

NOTE

Do not turn the screws on the outside clamshell, as this will cause difficult disassembly and reassembly.

4. Move the wire bundle to the side and lift the heater assembly free of the Oven Assembly.

5. Lay the heater assembly to the side. The Reference PCA circuitry is now accessible.

NOTE

In most cases, repairs to the pca can be more easily performed from the component side of the pca. If access to the bottom of the pca is necessary, unscrew the outside four Teflon standoffs.

4-21 FRONT PANEL REMOVAL

4-22. Use the following procedure to detach the front panel from the 732A:

1. Remove the front screws of the top and bottom cover.

2. Peel the decal from both of the front corner side moldings and remove the exposed screws. Refer to Figure 4-1 for screw locations.

3. Remove the front corner side moldings from the instrument.

4. The front panel is now free. Be extremely careful of the wire harness connected to the front panel binding posts. The service loop provided is quite limited.

4-23. Cleaning

CAUTION

To prevent possible damage to the front panel, do not use aromatic hydrocarbons or chlorinated solvents on the front panel of the 732A.

4-24. When the 732A is properly cared for and kept in a controlled atmosphere, cleaning is seldom required. However, any contamination in the instrument, particularly oil, can contribute to an increase in leakage, which may impair accuracy.

4-25. Clean the exterior and the front panel of the 732A with a soft cloth dampened in a mild solution of detergent and water. Do not attempt to clean the interior of the instrument.

4-26. Fuse Replacement

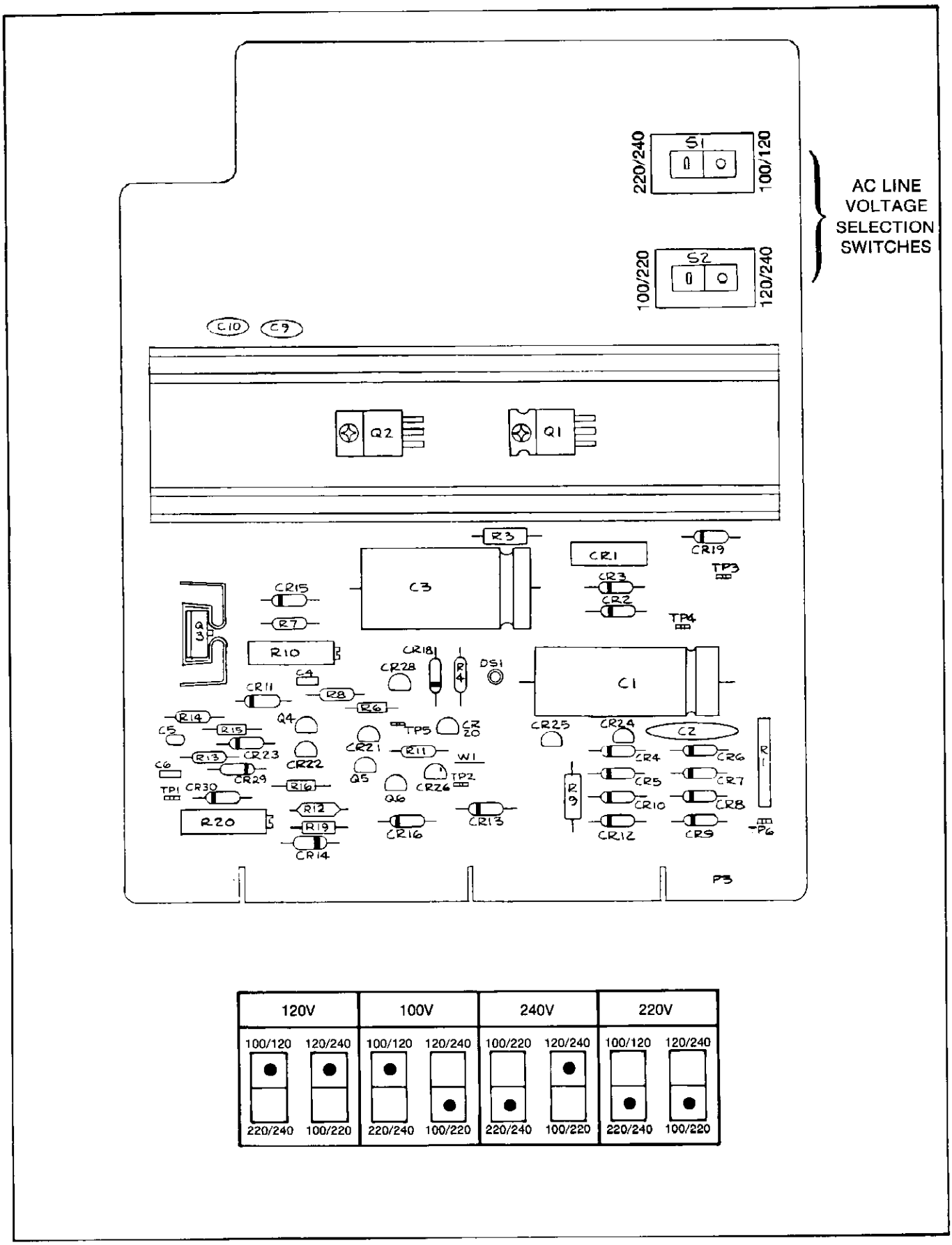
4-27. The power fuse, F1, is located on the rear panel of the 732A. If replacement is necessary, use the following rated fuses:

100V or 120V ac operation — MDL ⅜ (⅜A slow-blow, Fluke P/N 109264)
230V or 240V ac operation — MDL ¼ (¼A slow blow, Fluke P/N 166306)

4-28. AC Line Voltage Change

4-29. The 732A may be operated from 100V, 120V, 220V, or 240V ac ± 10%. The assigned line voltage may be changed to match the available source using the following procedure. Refer to Figure 4-5.

1. Ensure that the battery is charged or that an appropriate external ac or dc source is connected to the POWER INPUT jack on the rear panel. This will maintain the unit's standardization when ac line power is removed. The BTRY CHG indicator on the front panel will extinquish when the battery is fully charged and the 732A is still connected to the ac power source.



120V		100V		240V		220V	
100/120	120/240	100/120	120/240	100/220	120/240	100/120	120/240
220/240	100/220	220/240	100/220	220/240	100/220	220/240	100/220

Figure 4-5. AC Line Voltage Conversion on A3 Pre-Regulator PCA

2. Set the BATTERY OPR switch to ON and remove ac line power from the instrument.

3. Remove the AC Module.

4. Locate the voltage selector switches (the slide switches on the top of pca near the rear panel). Set the switches so that the dots on the switch actuators select the correct line voltage, as shown in Figure 4-5.

5. Reinsert the AC Module; replace the screws.

6. On the rear panel, change the mark to the appropriate box (under the SUPPLY/ SETTING heading) to indicate the present power configuration.

7. Replace the line fuse with one of the appropriate value.

8. After verifying that the local ac line voltage matches the voltage selected on the 732A, apply ac line power to the instrument.

4-30. ACCEPTANCE TEST

4-31. Use the following procedure to verify that the instrument is operational. The required test equipment is listed in Table 4-1. Equivalent instruments may be used, provided the minimum specifications are met.

1. Check the IN CAL indicator on the front panel. If the indicator is illuminated, proceed to step 2. If the indicator is not illuminated, complete steps a through g.

   a. If the IN CAL indicator was not on, set the rear panel BATTERY PWR switch to OFF. Apply ac power to the instrument using the Variac to the Supply Setting limit listed on the rear panel.

   b. Adjust the Variac for 120V ac output. The ac line current should be less than 0.3A.

   c. Set the BATTERY PWR switch to ON. The ac line current should be less than 0.35A. If the battery is very low, the BTRY CHG indicator will blink.

   d. Allow the 732A to stabilize (under power) for 24 hours.

   e. Measure the value of the Oven Temperature Thermistor at the front panel binding posts with Multimeter A. The value should be within ± 20 ohms of the value shipped with the instrument.

   f. Perform or obtain calibration as described in the paragraphs following the heading, CALIBRATION, below.

   g. Once the 732A has been calibrated, proceed to step 2.

2. Apply ac power of the correct voltage and frequency to the instrument. The AC PWR and BTRY CHG indicators should both be on.

3. Repeat step 1(e).

4. Check the output voltage at the 10V output using Multimeter B. It should be accurate within the performance limitations of the Multimeter.

5. Measure load regulation. Connect the 732A under test as shown in figure 4-6. Use copper hook-up wire under the binding posts, leaving the connector socket free. Measure the null voltage, then insert the leads from a 1000 Ohm load resistor into the connector sockets and determine the shift in the null voltage. The voltage change should be less than 10 μV or 1.0 ppm.

6. Repeat step 4 for the 1V and 1.018V outputs.

7. If a standards laboratory is available, verify stability by comparison to another precertified 732A. This step is optional.

8. The instrument is operational.

4-32. CALIBRATION

4-33. Complete the following calibration procedure to certify the 732A. The procedure uses direct comparison between the Unit Under Test (UUT) and a Certified 732A to calibrate the 10V output. The 10V output of the UUT is then transferred to a stable adjustable voltage source. The voltage source is then divided down, as required, for comparison with the UUT 1.018V and 1V outputs.

4-34. The 732A is normally shipped from the factory with the BATTERY OPR switch OFF. Upon receipt, the instrument must be powered up and stabilized for a minimum of 24 hours before calibration against traceable standards. To maintain calibration as a traceable standard, the 732A must continue to receive uninterrupted operating voltage from line power or from the

self-contained batteries, which provide approximately 24 hours of off-line operation when fully charged. If operating power is interrupted, the IN CAL light on the instrument front panel will be extinguished and recalibration will be necessary.

4-34a. The 732A may be calibrated in several ways. For calibration by the Fluke Standards Laboratory and shipment under power, refer to Options 732A-000 and 732A-100 described under Direct Voltage Maintenance Program in the Fluke catalog. For calibration in the user's lab, the Direct Voltage Maintenance Program (Option 732A-200) also provides for shipment of a Fluke-owned certified 732A, together with all necessary connecting cables and operating instructions, for on-site comparison. Calibration may be obtained directly from the National Bureau of Standards in Gaithersburg, Md., providing the necessary arrangements are made to have the 732A transported back to the user's lab under power. The Bureau of Standards should be contacted directly for details on this special calibration service (listed as 3.4H, Solid State Voltage Ref. Devices Calibration). Calibration by comparison with another certified 732A is described in detail in the following paragraphs. Other methods, using standard cells for reference, may be considered. However, these methods are not recommended due to the difficulty in obtaining the transfer from a standard cell voltage of 1.018 up to 10V without introducing significant errors from voltage dividers and thermal emfs.

4-35. Null Verification Procedure

4-36. Use the following procedure to verify the accuracy of null in the calibration procedure. The Null Verification procedure identifies the thermal voltages present and allows the null adjustment to be made independently of them. Use the Null Verification procedure when instructed to "verify the null" in the Calibration Procedure.

1. Adjust the UUT for zero on the Null Detector.
2. Reverse the HI and LO (positive and negative) leads on the UUT and the certified 732A.
3. Observe the Null Detector reading. If the reading does not equal zero, adjust the UUT for one-half of the Null Detector reading.
4. Reverse the HI and LO (positive and negative) leads on the UUT and the Certified 732A. The Null Detector should have the same reading as it did at the end of step 3. If it does not, adjust the UUT for one-half the difference.
5. Repeat steps 2 through 4 until the Null reading does not change when the UUT and Certified 732A leads are reversed.
6. The residual reading on the Null Detector equals the sum of the thermal voltages in the circuit.

4-37. Calibration Procedure

4-38. Complete the following procedure to standardize the outputs of the 732A to a Certified 732A. Battery operation of the 732A and 845AB/AR is preferred. Set the Null Detector to ZERO when changing leads. Use the supplied adjustment tool for all adjustments (Fluke P/N 686113).

1. Obtain a certified 732A.
2. Perform the self-calibration procedure on the Precision Divider immediately prior to this procedure.
3. Connect the UUT and the Certified 732A as shown in Figure 4-6.
4. Set the OPR switch on the Null Detector to the ZERO position. Adjust the Null Detector for zero on the 3 μV range.
5. Set the Null Detector to the 30 μV range and the OPR switch to OPR.
6. Decrease the range setting on the Null Detector slowly, while simultaneously adjusting the 10V calibration potentiometer (through the front panel opening on the UUT) for a null indication on the Null Detector on the 3 μV range. Let the system stabilize for about 1 minute before final adjustment. Use the non-conducting adjustment tool supplied with instrument.
7. Verify the null, using the Null Verification Procedure.
8. Connect the equipment as shown in Figure 4-7. Set the Precision Divider ratio switches to 0.999999X.
9. Adjust the Adjustable Source for a null indication.
10. Verify the null.
11. Connect the equipment as shown in Figure 4-8. Set the Precision Divider ratio switches to 0.1018000.

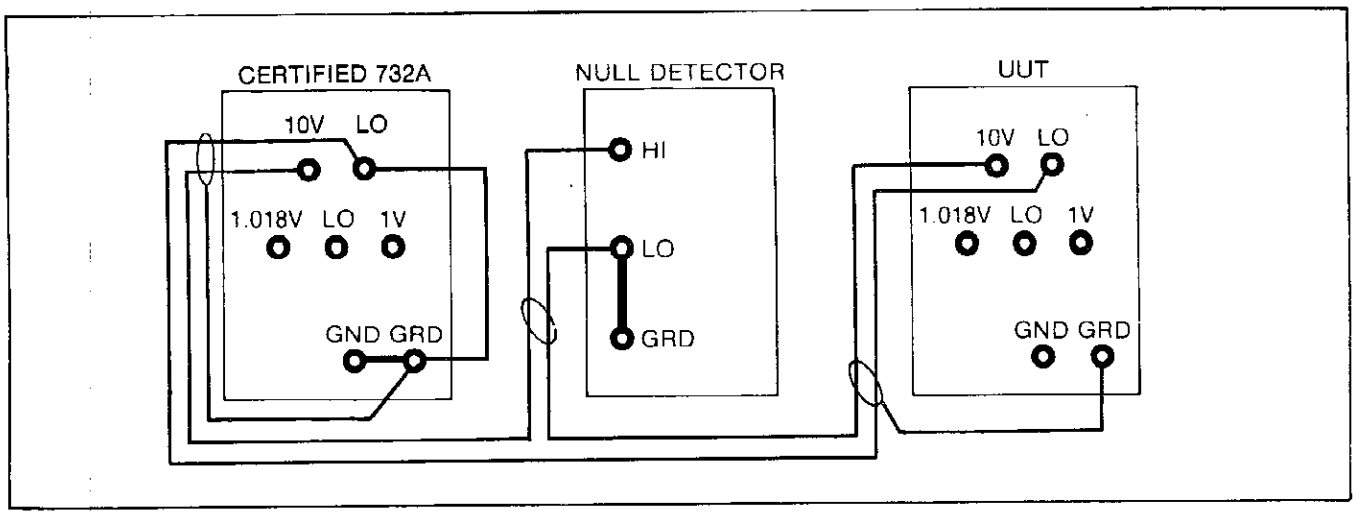


Figure 4-6. 732A 10V Calibration

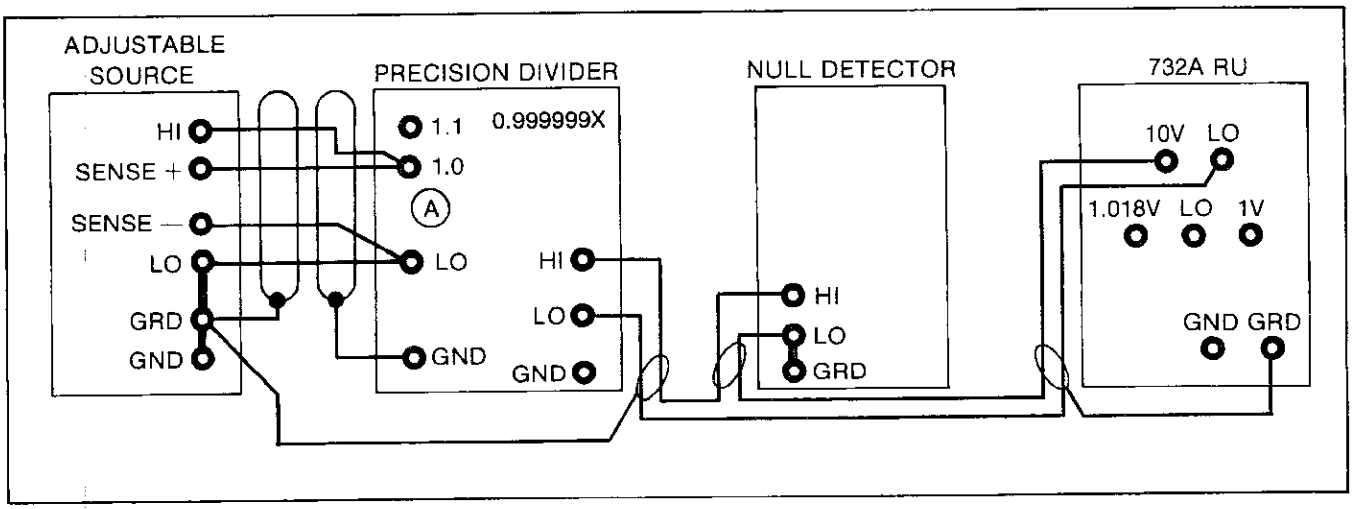


Figure 4-7. Calibration of Point A to 10V Using 732A

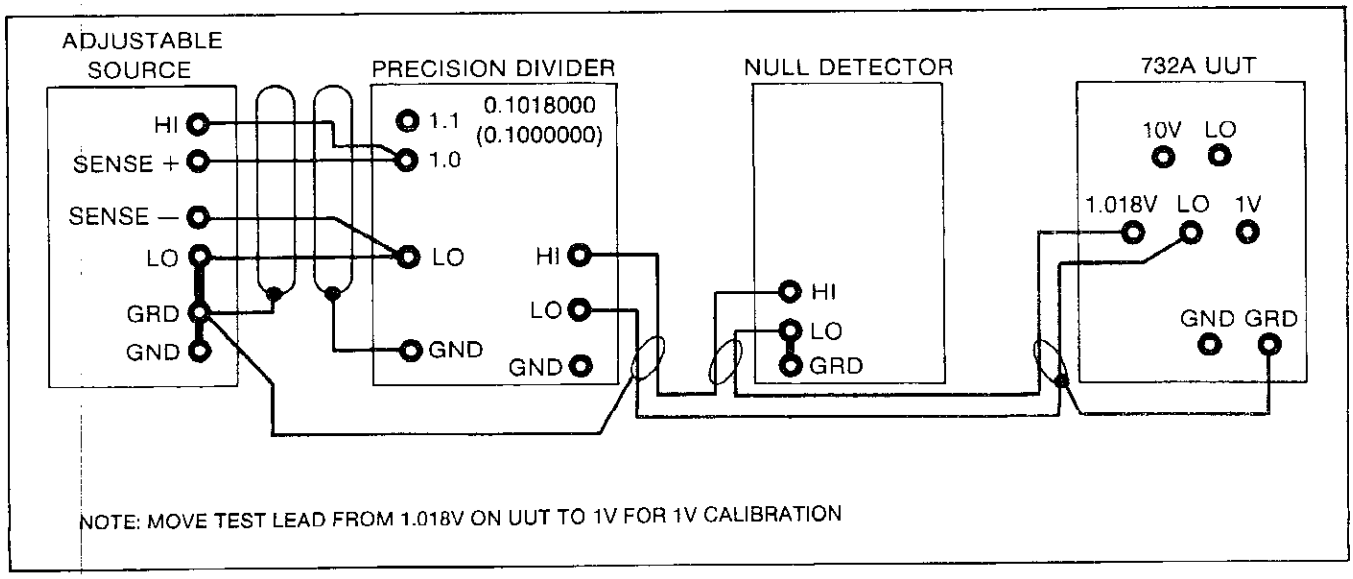


Figure 4-8. Calibration of 1.018V (and 1V) to 732A

12. Set the Null Detector RANGE switch to the 30 μV volt. Switch the Null Detector to OPR.

13. Adjust the 1.018V calibration potentiometer on the UUT while decreasing the RANGE setting on the Null Detector to obtain a null on the 3 μV range. Use the non-conducting adjustment tool.

14. Verify the null.

15. Transfer the Null Detector input lead from the 1.018V terminal to the 1V terminal on the UUT.

16. Set the Precision Divider ratio switches to 0.1000000.

17. Set the RANGE control on the Null Detector to the 30 μV position. Adjust the 1V calibration potentiometer on the UUT while decreasing the RANGE setting on the Null Detector to obtain a null on the 3 μV range. Use the non-conducting adjustment tool.

18. Verify the null.

19. If the IN CAL indicator is illuminated, proceed to step 20. If the indicator is not illuminated, connect a short wire to one of the front panel COMMON terminals. touch the other end of this wire to the circuit board behind the RESET hole. The IN CAL indicator should illuminate.

20. Calibration is complete. Record all test results. Disconnect all test equipment. Cover the output adjustment access holes and the RESET hole with tamper-proof calibration seals.

4-39. SERVICE/REPAIR PROCEDURES

4-40. Introduction

4-41. The Battery Charger Adjustment procedure is the only field service procedure for the 732A. There is no field serviceable circuitry within the oven/reference supply assembly. All adjustments within the oven must be made at the Factory or at a Fluke Technical Service Center. The following paragraphs describe the Battery Charger adjustments for the 732A.

4-42. +18.6V Adjustment

4-43. To perform the +18.6V adjustment, perform the following:

1. Connect a dc voltmeter to TP2 (LOW) and TP1 (HI) on the A4 Regulator PCA.

2. Adjust R22 for 18.6V as indicated on the dc meter.

4-44. Battery Charger Adjustment Procedure

CAUTION

This procedure will cause loss of standardization. Calibration must be performed before reusing the instrument.

4-45. Refer to Figure 4-9. Perform this procedure to calibrate the battery charger after repair of the battery charger circuit. The equipment required is listed in Table 4-1.

1. Remove ac power from the instrument.

2. Set the BATTERY OPR switch to OFF.

3. Remove the top cover from the instrument.

4. Remove the AC Module from the instrument.

5. Locate test points TP1, TP2, and TP5 on the A3, Pre-Regulator PCA (part of the AC Module). Locate trimpots R20 and R10 and jumper wire W1, also on the AC Module.

6. Connect a 50 kΩ rheostat between TP1 and TP2. Adjust the Rheostat for maximum resistance.

7. Connect Multimeter A between TP5 and TP1. TP5 is positive with respect to TP1.

8. Reinstall the AC Module in the instrument.

9. Apply ac power to the UUT using the Variac. Adjust the Variac for the line voltage indicated on the rear of the instrument.

10. Adjust R20 for a 28.2V dc reading on Multimeter A.

11. Turn the ac power off by reducing the Variac to zero volts or by unplugging the UUT.

12. Remove jumper W1 on A3.

13. Restore ac power.

14. Connect Multimeter A between TP2 and TP1. TP2 is positive with respect to TP1. Set Multimeter to read dc volts, 200V range.

15. Set the BATTERY OPR switch to ON.

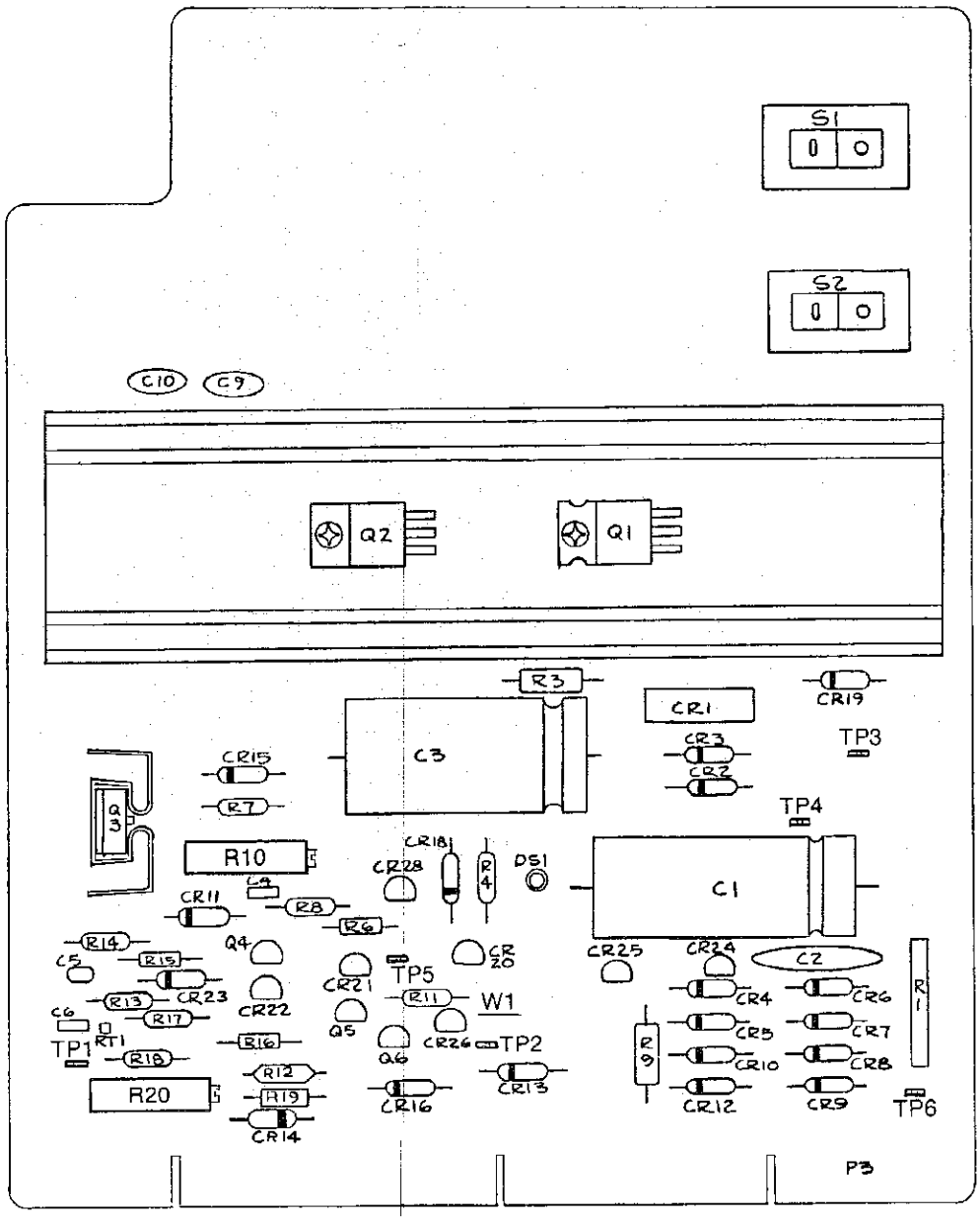


Figure 4-9. Battery Charger Test Points and Adjustments on A3 Pre-Regulator PCA

16. Set R10 fully clockwise (CW). Multimeter A should read approximately 45 to 50V dc.

17. While observing Multimeter A, adjust the rheostat toward minimum resistance. At approximately 26V dc, the BTRY CHG indicator and DS1 should come on. (DS1 is the voltage reference, located on A3, for the constant current source in the battery charger circuit.) The ac line current should increase approximately 110 mA at 115V ac (55 mA at 220V ac).

18. Adjust the rheostat for a Multimeter A reading of 32V dc.

19. Turn R10 counter-clockwise (ccw) until the BTRY CHG indicator and DS1 go out. Note that the ac line current has dropped.

20. Adjust the rheostat toward minimum resistance while observing the BTRY CHG indicator. When the BTRY CHG indicator lights, DS1 lights, and the ac line current increases suddenly. Multimeter A should read between 24.5 and 26.5V dc.

21. Adjust the rheostat until the BTRY CHG and DS1 indicators turn off. Multimeter A should indicate a dc voltage greater than +31V.

22. Disconnect all test equipment and the rheostat.

23. Remove the AC Module from the 732A.

24. Reinstall jumper W1.

25. Reinstall the AC Module.

26. Apply ac power to the UUT.

27. After a 30 minute warm up, perform the following procedure to make the final adjustment of trickle charge voltage.

    a. With the battery pack installed and the unit on trickle charge (BTRY CHG LED not on), measure the battery pack voltage. It must be between 27.0 and 27.6V.

    b. If the trickle charge voltage at the battery pack is not within the required range, record the value and connect the multimeter between TP5 and TP1 (TP5 positive with respect to TP1). Turn the battery switch off.

28. Adjust R20 the same amount as the difference between the recorded value and 27.0V.

29. Turn the battery switch on.

NOTE

After making the adjustment, allow 30 minutes for the battery voltage to achieve its final value.

30. Recheck the battery voltage.

31. Remove the multimeter.

32. Battery Charger adjustment is now complete. Perform the Calibration Adjustment Procedure described earlier in this section.

4-46. BATTERY CHARGING NOTES

4-47. Battery Charge

4-48. To check the charging and discharging current on the Battery Pack, connect a milliammeter to the two black wires on the BATTERY OPR switch. Then set the switch to OFF.

4-49. The charger has two modes: constant current mode and constant voltage mode. In the constant current mode, charging current should be about 200 to 400 mA if the battery is not fully charged. This mode lasts until battery voltage reaches about 31V, at which time it switches to the constant voltage mode (27V) for a few milliamps trickle charge.

4-50. Battery Discharge

4-51. At 23°C (the normal oven temperature), with the line cord unplugged, the nominal current drain from the battery is approximately 110 mA.

4-52. Individual Battery Checkout

4-53. Individual batteries will accept a charge of 300 to 400 mA at 7.75V max (31V divided by 4) if the terminal voltage is below 6V.

4-54. TROUBLESHOOTING

4-55. Introduction

4-56. The following paragraphs describe troubleshooting procedures for the 732A.

4-57. External Symptom Troubleshooting

4-58. Using malfunction symptom(s), refer to Table 4-2 to isolate problems within the 732A. Table 4-1 lists the required test equipment for troubleshooting.

4-59. Internal Voltage Measurements

WARNING

TO AVOID ELECTRICAL SHOCK HAZARD, OBSERVE THE FOLLOWING PRECAUTIONS WHILE WORKING ON THE INSIDE OF THE 732A. REMOVE ANY JEWELRY BEFORE BEGINNING TESTING. LINE VOLTAGE AC MAY BE PRESENT DURING THE FOLLOWING TESTS, WHICH SHOULD NOT BE PERFORMED WHILE WORKING ALONE. EXERCISE APPROPRIATE CAUTION TO AVOID ELECTRICAL SHOCK WHEN WORKING IN OR AROUND THE VICINITY OF THE AC POWER CONNECTOR, FUSEHOLDER, AND POWER TRANSFORMER. THE BATTERY ASSEMBLY IS CAPABLE OF GENERATING EXTREMELY HIGH PEAK CURRENTS. AVOID ACCIDENTAL SHORTING OF BATTERY TERMINALS.

CAUTION

The following tests are conducted with power applied to the instrument. To avoid instrument damage, exercise appropriate caution to avoid inadvertently shorting adjacent test points or circuit board traces with test probes or other instrument(s).

CAUTION

To ensure continued instrument performance, do not attempt to replace individual wires in the reference output wiring harness. Replace the entire harness.

4-60. Use the tests shown in Table 4-3 to isolate problems to the major functional circuit groups of the 732A. It is assumed that the external symptoms given in Table 4-2 have been examined and that the primary circuit of the power transformer is operable. This procedure is conducted with the instrument energized. Observe the previously stated WARNINGS and CAUTIONS.

4-61. Oven Repair

4-62. Shifts in the output level that cannot be compensated for by adding or removing jumpers from the A7 Calibration PCA will require the entire Oven Assembly to be returned to Fluke and exchanged for a working unit. Do not attempt to repair the circuitry involving U1, U2, Q1, Q2, Q5, the resistors associated with TP1 through TP4, or any other component(s) associated with the aforementioned components. Special procedures and auxiliary test equipment are necessary for component replacement within the Reference Circuit. Module exchange is the most economical and expedient method of repair for the user.

4-63. Troubleshooting the A4 Regulator on the Bench

NOTE

No extender is available for the A4 Regulator PCA, but both sides of it are easily accessed while it is installed. To gain better access to the A3 Pre-Regulator PCA, remove the A4 board. Then, when certain that the A3 Pre-Regulator is functioning per Table 4-3 (Internal Measurements), reinstall and test the A4.

4-64. The following procedure may be used to troubleshoot the A4 PCA on a bench top totally isolated from the 732A. An 18 to 32V dc source with current limiting (such as the Fluke 33X series, Fluke 343A, or any common lab supply) is required.

1. Refer to Figure 4-10, a simplified drawing of the A4 Regulator.

2. First, apply +18.6V between TP2 (-) and TP1 (+) to the test sense circuitry. Troubleshoot as needed to obtain the values of circuit voltage shown.

NOTE

Normal current drain is less than 5 mA for either sense of input circuit, therefore set the dc source limit to 10 mA.

3. Then apply 32V between TP3 (-) and TP1 (+) to test the remaining circuitry.

CAUTION

Do not apply a load to the A4 regulator except when it is installed in the 732A with the required heat sinking. Otherwise, damage to power transistor (Q4) could occur.

Table 4-2. External Symptom Troubleshooting

SYMPTOM	PROBABLE CAUSE	ACTION
732A inoperative.	Fuse blown.	Check fuse.
	Battery dead.	Measure battery voltage at rear panel jacks. Recharge battery.
	Battery opr switch set to OFF.	Visual check.
	732A not plugged in.	Restore power.
IN CAL indicator off.	Lost ac power, battery dead.	Charge battery, verify instrument calibration.
Repeated fuse blowing.	AC line primary circuit.	Visual inspection.
	Power transformer.	(2)
	Bridge rectifier.	Use ohmmeter.
	Battery charger rectifier.	Use ohmmeter.
Will not run on external ac or dc source.	Ballast lamp open.	Replace lamp.
Output voltage drifts.	Oven or reference.	(1)
Temperature sensitive.	Oven.	Check oven controller circuit.
Output voltage not correct.	Reference.	Perform calibration procedure.
Output voltages not adjustable to specifications.	Reference.	(1)
Battery won't charge.	Defective battery.	Replace.
	Battery charger defective.	Troubleshoot and repair.
Battery won't charge from external source.	Ballast lamp open.	Replace lamp.

(1) The Reference portion of the Oven/Reference Supply assembly is not field repairable. Refer repair to a Fluke Technical Service Center.

(2) Return instrument to Fluke Technical Service Center for service.

Table 4-3. Internal Measurements*

PCB	TEST POINTS	CORRECT VOLTAGE READING	CORRECTIVE ACTION
A3	TP3, TP4	≤60V dc	AC line voltage, Rectifier, Power Transformer
A3	TP6, TP4	32V dc	Pre-Regulator
	TP2, TP1	≤31V dc	Battery Charger**
A3	TP5, TP1	28.2V dc	Battery Charger**
A4	TP1, TP3	32V dc	Pre-Regulator, Motherboard
A4	TP1, TP2	≈18.6V dc	Regulator
Front Panel	10V, COM	10.00000V dc	Oven, Reference Supply
Front Panel	1V, COM	1.000000V dc	Output Divider***
Front Panel	1.018V, COM	1.018000V dc	Output Divider***
Rear Panel	EXT. PWR.	≥24V dc	Battery

*Voltage measurements taken with Multimeter A, except for those marked with *** in corrective action column.

**Conditions: battery installed, BATTERY OPR switch ON.

***Calibration of 10V output affects calibration of this output.

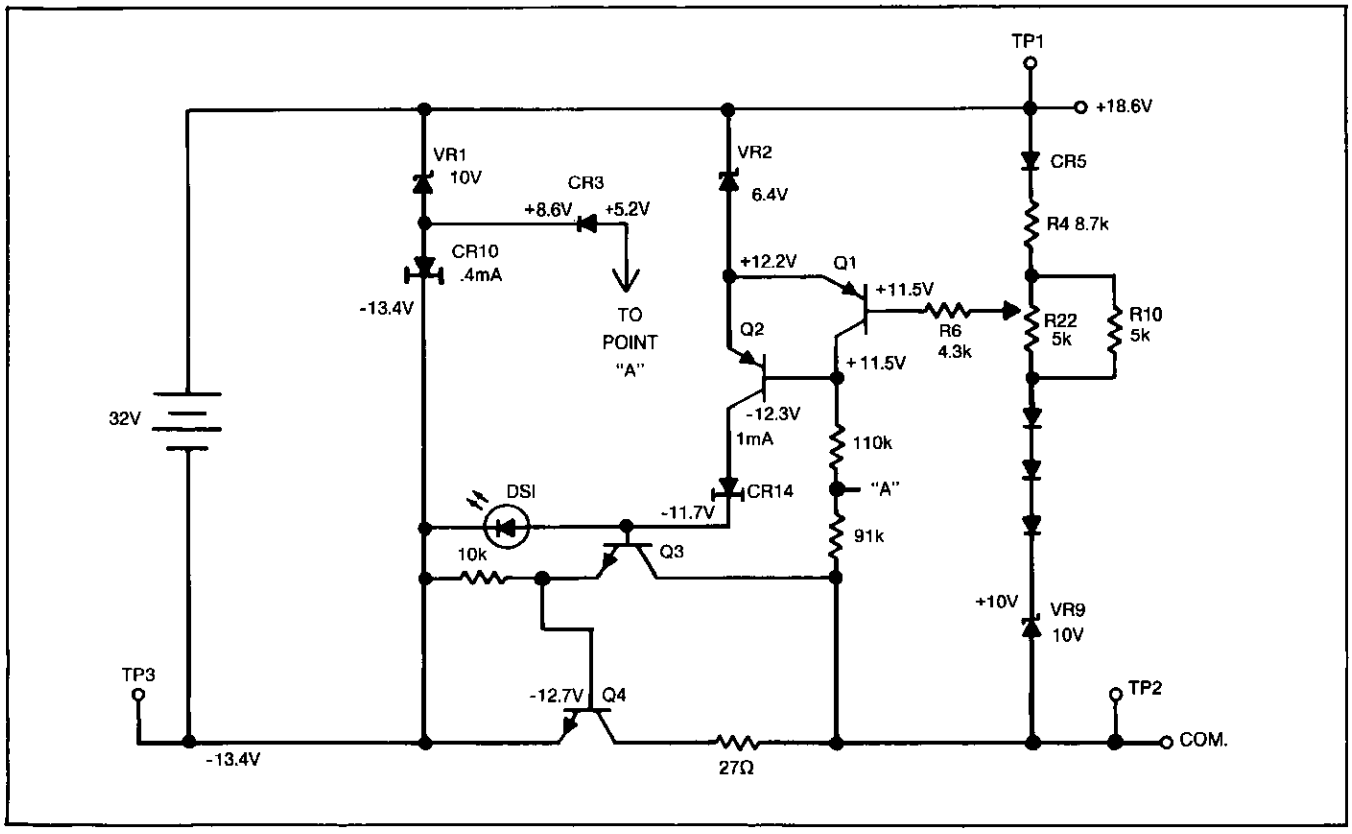


Figure 4-10. A4 Regulator (Simplified Diagram)

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

5-1. INTRODUCTION

5-2. This section contains the parts lists for the 732A DC Reference Standard. Components are listed alphanumerically.

5-3. The parts lists include the following information:

1. Reference Designation.
2. Description of each Part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers.
5. Manufacturer's Part Number.
6. Total Quantity of Components Per Assembly.

5-4. Although Fluke recommends module exchange in place of component-level repair, this manual also includes schematics (Section 8) and a discussion of the theory of operation (Section 3). Service by non-factory personnel voids the warranty. Use of parts not approved by Fluke may compromise board specifications and operation.

CAUTION

*****

INDICATED DEVICES ARE SUBJECT TO DAMAGE BY STATIC DISCHARGE.

5-5. HOW TO OBTAIN PARTS

5-6. Components may be ordered directly from the John Fluke Mfg. Co., Inc. (or its authorized representative) by using appropriate Fluke Stock Number(s), or from the manufacturer by using the manufacturer's part number.

5-7. 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 instructions, if necessary. To ensure prompt handling of your order, include the following information:

1. Quantity.
2. Fluke Stock Number.
3. Description.
4. Reference Designation.
5. Printed Circuit Board Part Number and Revision Letter.

5-8. Parts price information is available from the John Fluke Mfg. Co., Inc. or from its representatives.

TABLE 5-1. 732A FINAL ASSEMBLY
(SEE FIGURE 5-1.)

REFERENCE DESIGNATOR A->NUMERICS---->		S	----------DESCRIPTION----------	FLUKE STOCK --NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
A	1		LED PCA	642280	89536	642280	1		
A	2		MOTHERBOARD PCA	650994	89536	650994	1		1
A	3		PRE-REGULATOR PCA	642264	89536	642264	1		
A	4		REGULATOR PCA	642256	89536	642256	1		
A	5		REFERENCE PCA	642272	89536	642272	1		
A	6		BATTERY PCA	732628	89536	732628	1		
A	7		CALIBRATION PCA	645028	89536	645028	1		*
A	8		PREHEATER PCA	788323	89536	788323	1		
C	1		CAP,TA,82UF,+-20%,20V	357392	12954	D82GS2D20M	1		
CR	1	*	DIODE,SI, 100 PIV. 1.5 AMP	116111	05277	1N4817	1		
DS	1		LAMP,NEON,105-125V,700MA,WIRE LEADS	100347	74276	T2-24-2	1	1	
E	1- 3		BINDING-POST-ASSY-CP-RED	637892	89536	637892	3		
E	4, 5		BINDING-POST-ASSY-CP-BLK	637900	89536	637900	2		
E	6		BINDING-POST-ASSY-BR-BLU	637876	89536	637876	1		
E	7		BINDING-POST-ASSY-BR-GRN	637868	89536	637868	1		
E	8, 9		BINDING-POST-ASSY-BR-WHT	637884	89536	637884	2		
E	10		BINDING POST,BRASS,1/4-28	102707	89536	102707	1		
H	1		WASHER	644740	89536	644740	2		
H	2		WASHER,FLAT,BRASS,#8,0.032 THK	631606	89536	631606	16		
H	3		B-P-WASHER	606293	89536	606293	7		*
H	4		NUT,MACH,HEX,BR,8-32	631614	89536	631614	9		
H	5		WASHER,FLAT,S STEEL,#6,0.016 THK	260471	86928	5710-23-16	2		
H	6		NUT,HEX,MINI,S.STL,6-32	110569	89536	110569	2	*	
H	7		WASHER,LOCK,INTRNL,STEEL,#8	110320	89536	110320	9		
H	8		NUT, NYLON, PUSH-IN	222414	83058	PC-97726	16		
H	9		NUT,MACH,HEX,BR,1/4-28	110619	89536	110619	1		
H	10		WASHER,LOCK,SPLIT,STEEL,0.263 ID	111518	89536	111518	1		
H	11		WASHER,SHLDR,NYLON,#3	485417	89536	485417	1		
H	12		SCREW,MACH,PHP,STL,4-40X5/16	152116	89536	152116	1		
H	13		SCREW,MACH,PHP,STL,6-32X1/4	152140	89536	152140	12		
H	14		SCREW,MACH,FHP,STL,8-32X1/2	114355	89536	114355	2		
H	15		SCREW,MACH,PHP SEMS,STL,6-32X1/2	177030	89536	177030	4		
H	16		SCREW,MACH,FHUP,S.STL,6-32X1/4	320093	89536	320093	4		
H	17		SCREW,MACH,PHP,STL,8-32X5/8	114983	89536	114983	4		
H	18		SCREW,MACH,FHP,STL,8-32X5/16	281725	89536	281725	8		
H	19		SCREW,MACH,FHP,STL,8-32 X 7/16	306159	89536	306159	12		
H	20		SCREW,THD FORM,PHP,S.STL,8-18X1/2	306233	89536	306233	16		
H	21		NUT,MACH,HEX,STL,4-40	184044	73734	8002A-NP	2		
H	22		SCREW,MACH,PHP,STL,6-32X1-1/4	159756	89536	159756	4		
H	23		SCREW,MACH,FHP,STL,6-32X3/8	114363	73734	182444	4		
H	24		WASHER,SHLDR,NYLON,#3	485417	89536	485417	2	1	
H	25		NUT,MACH,HEX,STL,4-40	184044	73734	8002A-NP	2		
H	26		SCREW,MACH,FHUP,S.STL,6-32X1/4	320093	89536	320093	4		
H	27		SCREW,MACH,PHP,STL,6-32X1/4	152140	89536	152140	20		
H	28		SCREW,MACH,PHP,STL,6-32X3/4	114223	73734	19048	4		
HR	1, 2		STRIP TYPE	643387	89536	643387	2		
HR	3, 4		PATCH TYPE, 4" X6"	643411	89536	643411	2		
#J	1		CONN,CIRC,CABLE,PLUG,3 CONTACT	720847	89536	720847	1		
MP	1		FRONT PANEL	641902	89536	641902	1	1	
MP	2		CABLE TIE,4"L,0.100"W,0.75 DIA	172080	89536	172080	1		
MP	3		TERM STRIP,LUG,RT ANG,0.375CTR,2 POS	654988	89536	654988	1		
MP	4		SLEEV,POLYOL,SHRINK,.500-.250ID,BLACK	196683	89536	196683		1	
MP	5		SLEEV,TEFLON,0.018ID,NATURAL	325506	89536	325506			
MP	6		REAR PANEL	641910	89536	641910	1		
MP	7		CHASSIS SIDE	641928	89536	641928	2		
MP	8		BOTTOM COVER	641944	89536	641944	1		
MP	9		CHASSIS GUARD	641951	89536	641951	1		
MP	10		BULKHEAD, REAR GUARD	641977	89536	641977	1		
MP	11		BULKHEAD, FRONT GUARD	641985	89536	641985	1		
MP	12		SHIM-OVEN	788349	89536	788349	2		
MP	13		INSULATOR, CHASSIS	644906	89536	644906	4		
MP	14		SIDE TRIM	642298	89536	642298	2		
MP	15		INSERT, SIDE TRIM	642306	89536	642306	1		
MP	16		HANDLE	642314	89536	642314	1		
MP	17		STRAP, HANDLE	644880	89536	644880	1		
MP	18		HANDLE RETAINER	579052	89536	579052	2		
MP	19		BRACKET,HANDLE SUPPORT	632414	89536	632414	2		
MP	20		ADHESIVE,SIDE TRIM	680850	89536	680850	2		
MP	21		OVEN-INSUL-OUTER-SIDE-TOP-BOTTOM	654251	89536	654251	3		
MP	22		OVEN-INSUL-INNER-SIDE-TOP-BOTTOM	654269	89536	654269	3		
MP	23		OVEN-INSUL-OUTER-FRONT-BACK	654277	89536	654277	2		
MP	24		OVEN-INSUL-INNER-FRONT-BACK	654285	89536	654285	2		
MP	25		CORNER ANGLE BRACKET-7	298166	89536	298166	2		
MP	26		NAMEPLATE, SERIAL -REAR PANEL-	472795	89536	472795	1		
MP	27		CORNER, PLASTIC 7 INCH	656231	89536	656231	4		
MP	28		FOOT,REAR PANEL 1.25 INCH	657064	89536	657064	4		
MP	29		FOOT, SINGLE BAIL TYPE (DARK UMBER)	653923	89536	653923	4		
MP	30		CABLE TIE,4"L,0.100"W,0.75 DIA	172080	89536	172080	2		

TABLE 5-1. 732A FINAL ASSEMBLY
(SEE FIGURE 5-1.)

REFERENCE DESIGNATOR A->NUMERICS--->		S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	NOT -E
MP	31		CORD,LINE,R/A 5-15/IEC,3-18AWG,SVT	363481	89536	363481	1		
MP	32		HOLE PLUG, POLYETHELENE, F/5/16 HOLE	187799	89536	187799	4		
MP	33		GUIDE,CARD,PCB,6-1/2 X .312 X .125	326009	89536	326009	4		
MP	34		BANANA PLUG,PANEL	101543	89536	101543	2		
MP	35		BINDING POST PART,HEAD,BRASS,1/4-28	102889	89536	102889	1		
MP	36		INSUL PART,TRANS,SILICONE,POWER	508630	89536	508630	1		
MP	37		TAPE,FOAM,VINYL,1/2 W,1/8 THK	330449	89536	330449	1		
MP	38		CABLE TIE,ANCHOR,ADHSV,0.122"TIE	407908	89536	407908	2		
MP	39		TAPE,FOAM,ADHSV,1"W,1/2 THK	229005	89536	229005	16		
MP	40		COMPONENT HOLDER	104794	98159	2829-115-3	1		
MP	41		PLATE, HEATER TOP	644609	89536	644609	1		
MP	42		PLATE, HEATER BOTTOM	644617	89536	644617	1		
MP	43		COVER, HEATER BOTTOM	644625	89536	644625	1		
MP	44		COVER, HEATER TOP	644633	89536	644633	1		
MP	45		PLATE, SENSOR	644641	89536	644641	2		
MP	46		HOLDER, HEATER TOP A	644658	89536	644658	1		
MP	47		HOLDER, HEATER TOP B	644666	89536	644666	1		
MP	48		HOLDER, HEATER BOTTOM	644773	89536	644773	1		
MP	49		SHIM, HEATER	644781	89536	644781	4		
MP	50		INSULATOR SHEET	650788	89536	650788	2		
MP	51		INSULATOR, THERMISTOR	788356	89536	788356	2		
MP	52		SLEEV,TEFLON,0.066ID,NATURAL	113845	89536	113845	1		
MP	53		SPACER,RND,NYLON,6-32X0.610	643361	89536	643361	4	1	
MP	54		INSUL PART,TRANS,SILICONE,POWER	508630	89536	508630	2		
MP	55		TOP COVER	641936	89536	641936	1		
MP	56		COVER, GUARD	641969	89536	641969	1		
MP	57		GUIDE,CARD,PCB,6-1/2 X .312 X .125	326009	89536	326009	2		
MP	58		DECAL, FRONT CORNER	659235	89536	659235	2		
MP	59		DECAL, REAR CORNER	685206	89536	685206	2		
MP	60		STRAP, OVEN	644799	89536	644799	1		
MP	61		OVEN-INSUL-OUTER-SIDE-TOP-BOTTOM	654251	89536	654251	1		
MP	62		OVEN-INSUL-INNER-SIDE-TOP-BOTTOM	654269	89536	654269	1		
MP	63		SPACER,RND,NYLON,6-32X1.200	394262	89536	394262	4		
MP	64		SLEEV,TEFLON,0.0421D,NATURAL	175976	89536	175976			
MP	65		SLEEV,PVC,0.505ID,CLEAR	113761	89536	113761			
MP	66		ALIGNMENT TOOL	686113	89536	686113	2		
Q	1, 2	*	TRANSISTOR,SI,BV= 60V, 40W,TO-220	642694	89536	642694	2		
R	1		RES,CC,2.7,+-5%,1W	159376	89536	159376	1		
R	21		RES,MF,5.36K,+- 1%,0.125W,25 PPM	782714	89536	782714	1		
RT	3, 4		THERMISTOR,DISC,NEG.,10K,+-10%,25C	644054	89536	644054	2		
RV	1		VARISTOR,22V,+-20%,1.0MA	500777	03508	V22ZA1	1	1	
TM	1		732A & 732A/AN INSTRUCTION MANUAL	788414	89536	788414	1		
TM	2		OVEN THERMISTOR CARD, 732A DC REF STD	715698	89536	715698	1		
W	1		WIRE,TEF,EE,UL1180,22AWG,STRN,BLU	115675	89536	115675			
W	2		WIRE,TEF,EE,UL1180,22AWG,STRN.GRN/YEL	386136	89536	386136			
W	3		CABLE ASSY, DIVIDER OUTPUT & REF OUT	644997	89536	644997	1		
W	4		CABLE ASSY, THERMISTOR	651067	89536	651067	1		
W	5		WIRE,BUS,22 AWG,TINNED COPPER	115469	89536	115469			
			RECOMMENDED SPARE PARTS KIT	648845	89536	684845			

NOTE 1 = FOR S/N'S 3345000 AND BELOW,
CONTACT YOUR NEAREST SERVICE CENTER
FOR REPLACEMENT INFORMATION.
(REFERENCE PCN 1025)

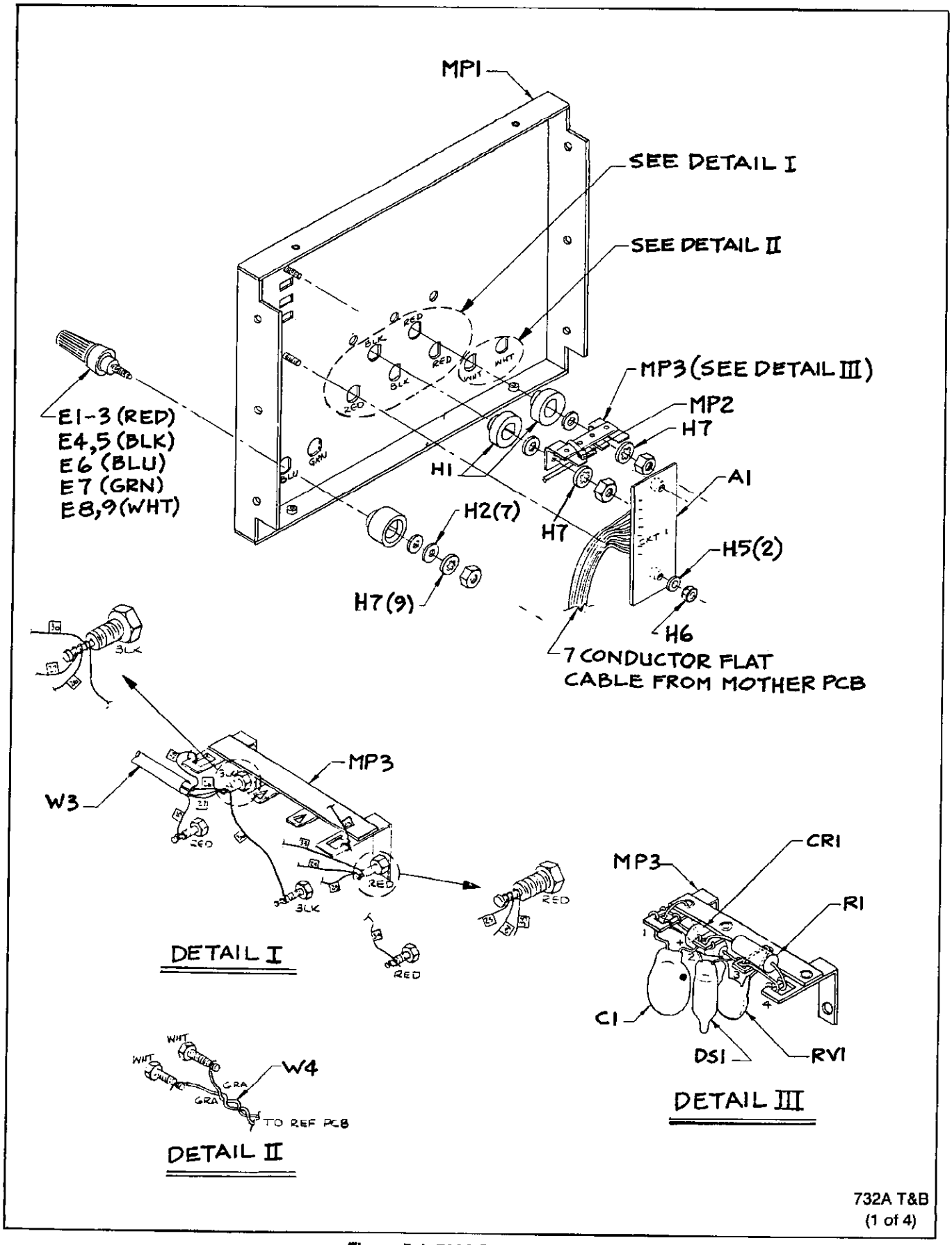


Figure 5-1. 732A Final Assembly

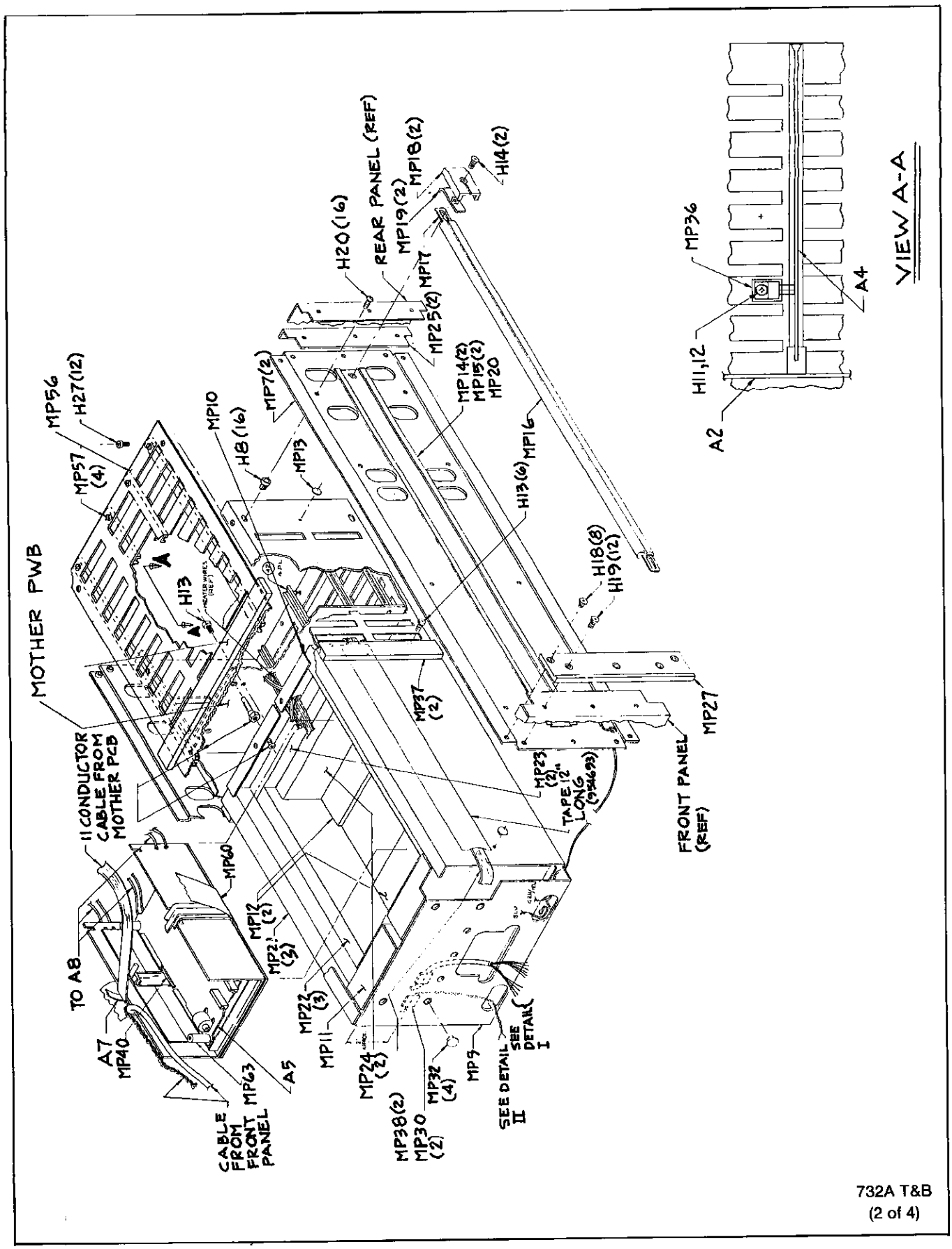
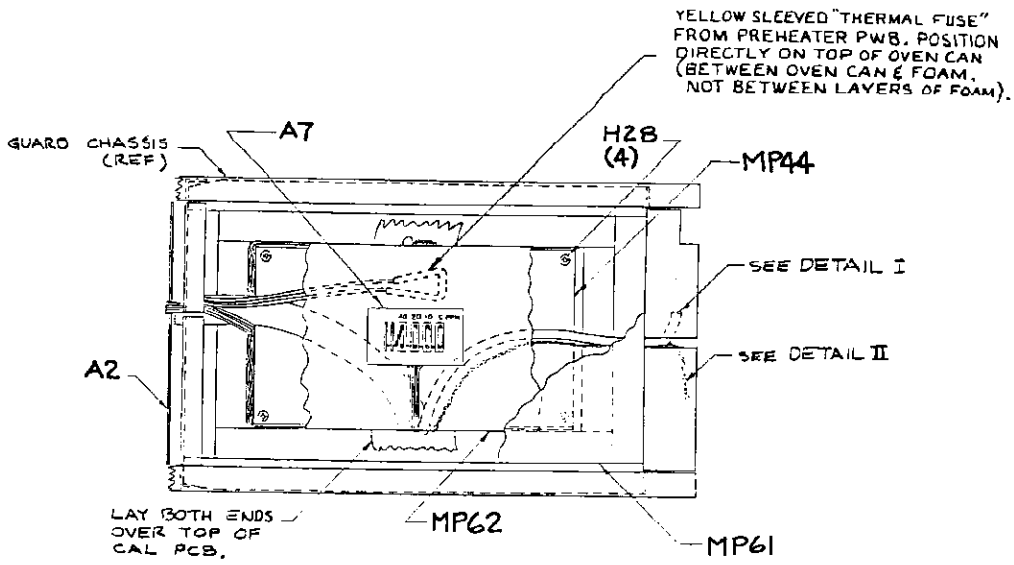
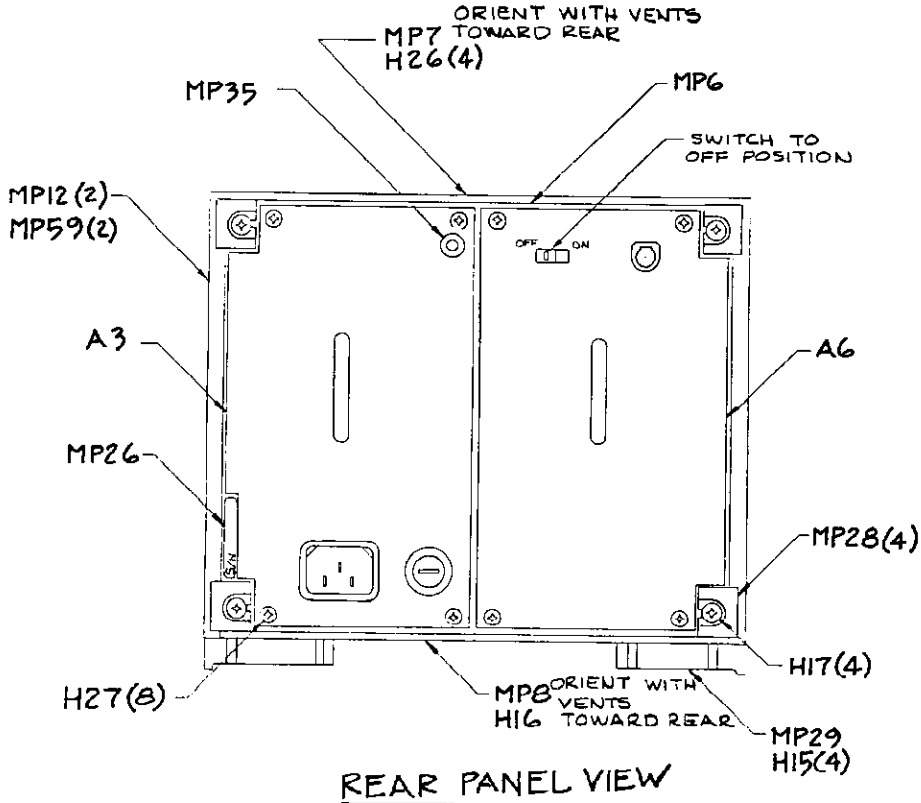


Figure 5-1. 732A Final Assembly (cont)



OVEN TOP VIEW



REAR PANEL VIEW

732A T&B
(3 of 4)

Figure 5-1. 732A Final Assembly (cont)

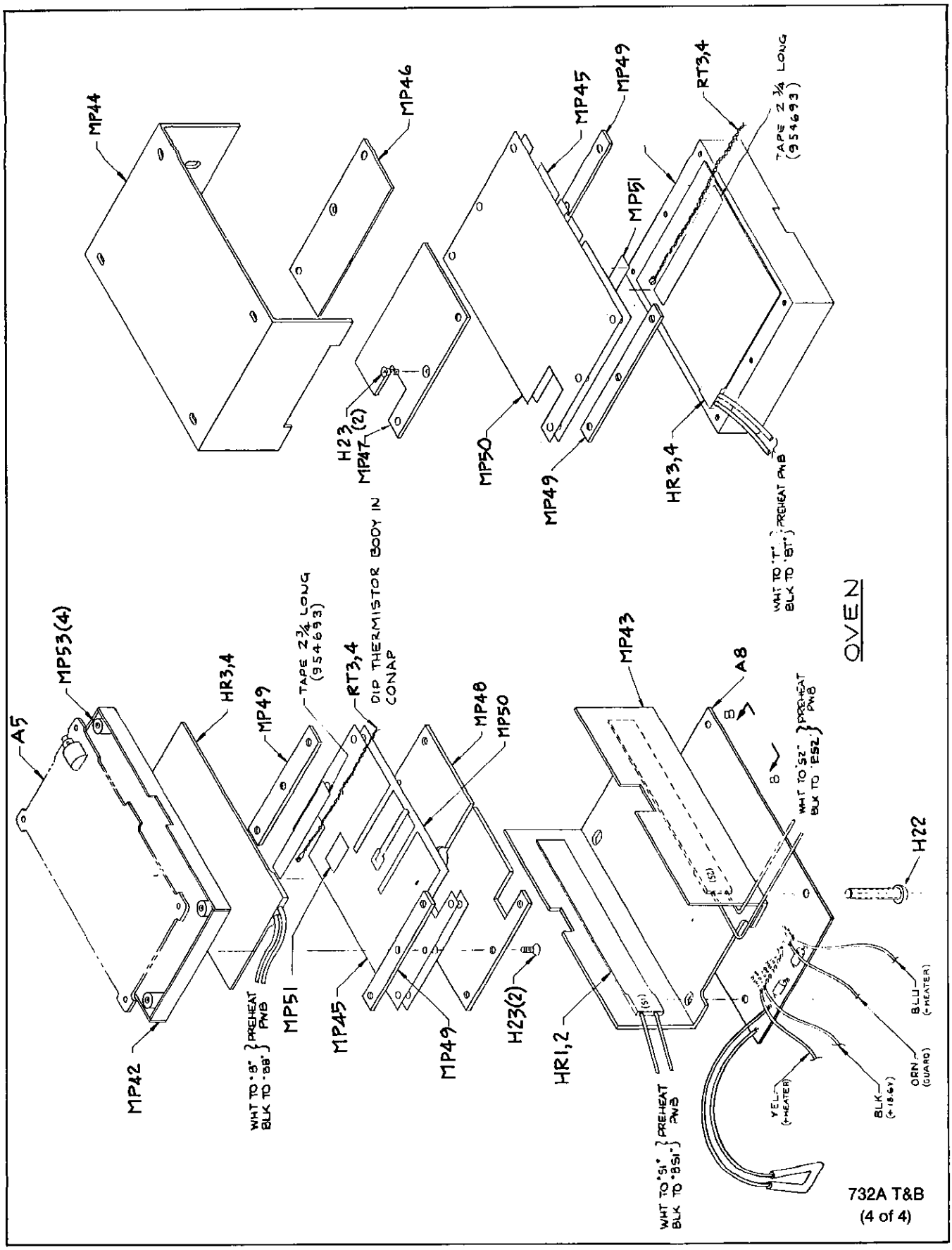


Figure 5-1. 732A Final Assembly (cont)

TABLE 5-2. A1 LED PCA
(SEE FIGURE 5-2.)

REFERENCE DESIGNATOR A->NUMERICS---->	S	----------DESCRIPTION----------	FLUKE STOCK --NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -R	N O T -E
DS 1-- 3	*	LED,RED,LIGHT BAR,PCB MOUNT	534834	28480	HLMP 2300	3		
MP 2		SPACER,SWAGED,RND,BRASS,0.150IDX0.187	357269	89536	357269	2		

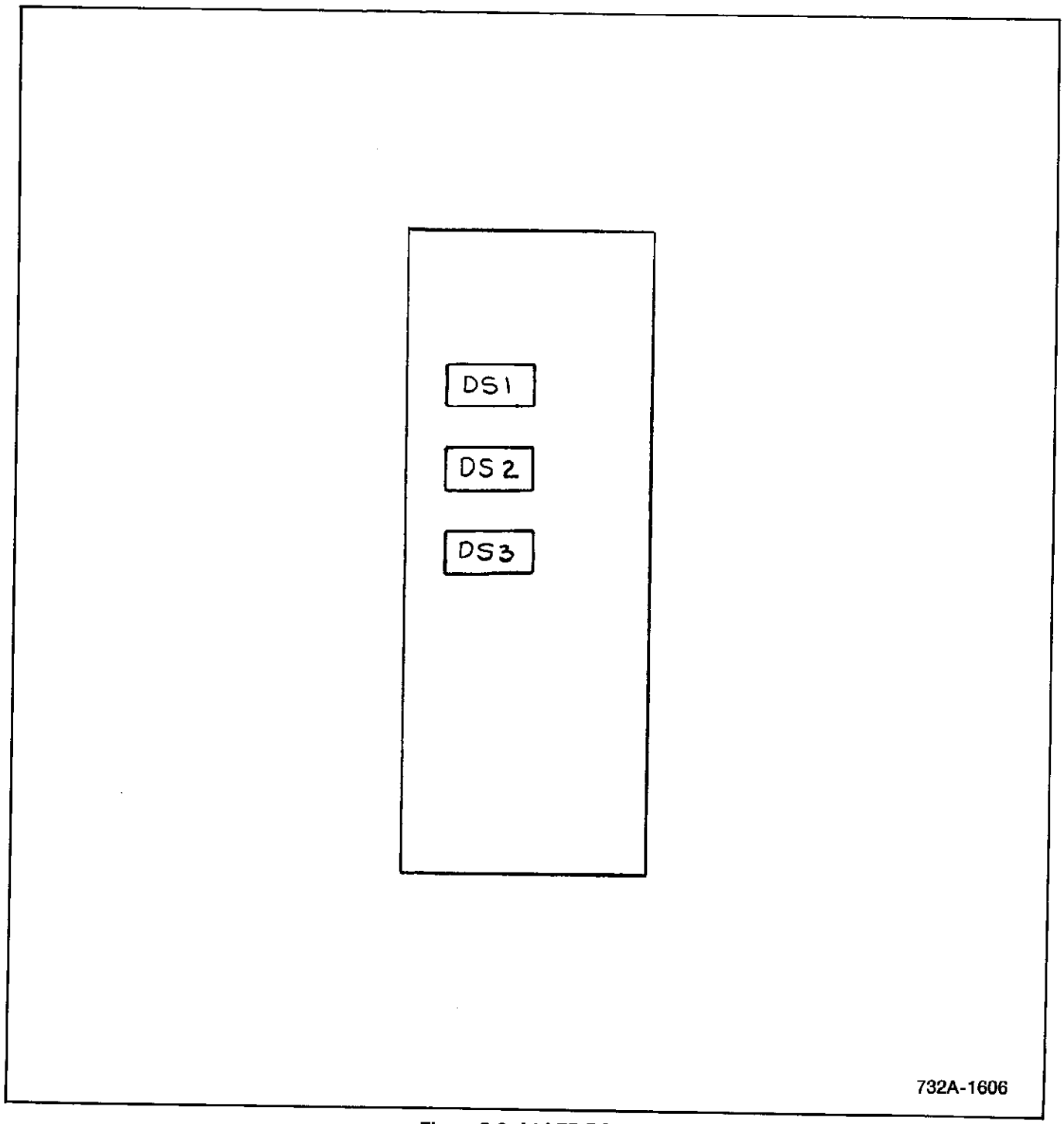


Figure 5-2. A1 LED PCA

TABLE 5-3. A2 MOTHERBOARD PCA
(SEE FIGURE 5-3.)

REFERENCE DESIGNATOR A->NUMERICS--->	S	----------DESCRIPTION----------	FLUKE STOCK ---NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
J 1		CONN ACC,PWB EDGE POLARIZING INSERT	291716	89536	291716	8		
J 2, 3, 4		CONN,PWB EDGE,REC,0.150 CTR,6 POS	291708	91662	6308-006-313-001	17		
TP 1- 2		TERM,FASTON,TAB,SOLDR,0.110 WIDE	512889	02660	62395	2		
W 1, 2		CABLE SET ASSY, REF AMP & LED	651059	89536	651059	1		

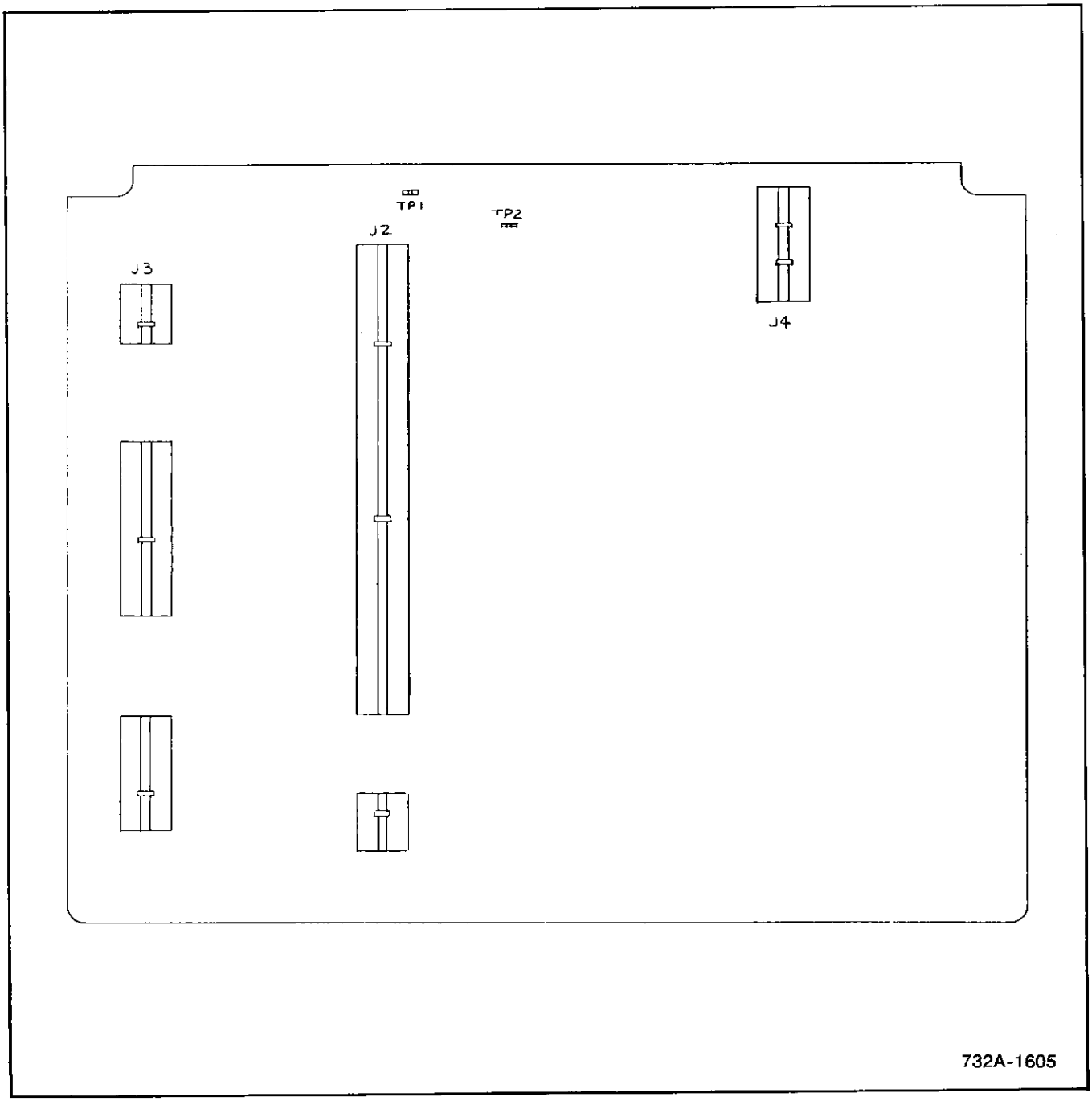


Figure 5-3. A2 Motherboard PCA

TABLE 5-4. A3 PRE-REGULATOR PCA
(SEE FIGURE 5-4.)

REFERENCE DESIGNATOR A-)NUMERICS---)	S	----------DESCRIPTION----------	FLUKE STOCK --NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER --OR GENERIC TYPE---	TOT QTY	R S -Q	N O T -E
C 1		CAP,AL,220UF,+75-20%,100V	381947	74840	ITA	1		
C 2		CAP,CER,0.1UF,+-20%,100V.Z5V	149146	56289	33C41B6	1	1	
C 3		CAP,AL,330UF,+75-20%,80V	292862	89536	292862	1		
C 4		CAP,CER,4700PF,+-20%,100V,X7R	362871	72982	8121-A100-W5R-472M	1		
C 5		CAP,TA,1UF,+-10%,35V	161919	56289	196D010X0035G	1		
C 6		CAP,CER,0.01UF,+-20%,100V,X7R	407361	72982	8121-A100-W5R-103M	1		
C 9, 10		CAP,CER,0.05UF,+-20%,100V,Z5V	149161	56289	55C23A1	2		
CR 1	*	DIODE,SI,RECT,BRIDGE,BV=200V,IO=1.0A	296509	09423	FB200	1	1	
CR 2, 3, 13,	*	DIODE,SI, 100 PIV, 1.5 AMP	116111	05277	1N4817	4	1	
CR 19	*		116111					
CR 4	*	ZENER,UNCOMP, 40.0V, 5%, 6.5MA, 1.0W	407825	89536	407825	1	1	
CR 5- 9, 11,	*	DIODE,SI,BV= 75.0V,IO=150MA,500 MW	203323	07910	1N4448	8	1	
CR 16, 23	*		203323					
CR 10	*	ZENER,UNCOMP, 30.0V,10%, 4.2MA, 0.4W	272633	04713	1N972A	1	2	
CR 12, 14	*	ZENER,UNCOMP, 5.2V, 1.0MA, 0.4W	233627	89536	233627	2	1	
CR 15	*	ZENER,UNCOMP, 5.6V, 5%, 3.0MA, 0.5W	535559	89536	535559	1	1	
CR 18	*	DIODE,GER,BV=100.0V,IO= 80MA,80 MW	149187	93332	1N270	1	1	
CR 20- 22, 28	*	DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	334839	11532	TCR5297	4	1	
CR 24, 26	*	DIODE,SI,N-JFET,CURRENT REG,IF=3.0 MA	429373	89536	429373	2	1	
CR 25	*	DIODE,SI,N-JFET,CURRENT REG,IF=5.3 MA	334714	07910	TCR5315	1	1	
CR 29	*	ZENER,UNCOMP,20.0V,5%,6.2MA,0.4W	180463	89536	180463	1		
CR 30	*	ZENER,COMP,6.4V,3%,1PPM TC. 2.0MA	357848	89536	357848	1		
DS 1	*	LED,VISBLE RED,PCB MNT,LUM INT=0.5MCD	369777	28480	5082-4480	1		
E 1		TERM,RING .072 & .196,SOLDR	101030	79963	174	1		
E 1- 6		TERM,FASTON,TAB,SOLDR,0.110 WIDE	512889	02660	62395	6		
F 1		FUSE,1/4 X 1-1/4,SLOW,0.375A,250V	109264	71400	MDX3-8	1		
FL 1		FILTER,LINE,250V/1A MAX	649988	89536	649988	1	5	
H 1		WASHER,SHLDR,NYLON,#3	485417	89536	485417	2		
H 2		SCREW,MACH,PHP,STL,4-40X5/16	152116	89536	152116	2		
H 3		SCREW,MACH,PHP,STL,6-32X5/16	152157	89536	152157	4		
H 5		SCREW,MACH,PHP,STL,8-32X1/4	228890	89536	228890	2		
H 6		SCREW,THD FORM,PHP,S STL,8-18X5/8	574673	89536	574673	4		
H 7		SCREW,MACH,PHP,STL,6-32X3/8	152165	89536	152165	2		
H 8		WASHER,FLAT,MYLAR,#8,0.010 THK	197426	89536	197426	2		
H 9		WASHER,FLAT S STEEL,#4,0.032 THK	146225	89536	146225	2		
H 10		NUT,MACH,HEX,STL,4-40	110635	89536	110635	2		
H 11		NUT, NYLON, PUSH-IN	222406	83058	PC97476	4		
MP 1		INSUL PART,TRANS,SILICONE,POWER	508630	89536	508630	2		
MP 2		SPACER,RND,SOLUBLE,0.062IDX0.156OD	296319	32559	T0806	2		
MP 3		BRACKET, PRE-REGULATOR	641993	89536	641993	1		
MP 4		PANEL, PRE-REGULATOR	644583	89536	644583	1		
MP 5		HLDR,FUSE,1/4 X 1-1/4,LOPROFILE,PNLMT	424416	89536	424416	1		
MP 6		ROUND, L=1.750, THREAD 6-32, BLACK	650242	89536	650242	1		
MP 7		HEAT SINK	644674	89536	644674	1		
MP 8		CLIP-ON TYPE FOR TO-220	644062	89536	644062	1		
MP 9		SPACER L.E.D	541284	89536	541284	1	1	
Q 1	*	TRANSISTOR,SI,BV= 60V, 65W,TO-220	386128	01295	T1P120	1		
Q 2	*	TRANSISTOR,SI,BV= 60V, 40W,TO-220	642694	89536	642694	1	1	
Q 3	*	TRANSISTOR,SI,BV=100V. 40W,TO-220	454033	04713	MJE15028	1		
Q 4	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	242065	04713	2N5089	1	1	
Q 5	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	1	1	
Q 6	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	168716	07263	S19254	1	1	
R 1		WW RESISTOR	717892	89536	717892	1		
R 3		RES,CC,3.3,+-5%,0.5W	188482	89536	188482	1		
R 4		RES,MF,1.54K,+-1%,0.125W,25PPM	335331	89536	335331	1		
R 6		RES,CC,510,+-5%,0.25W	218032	01121	CB5115	1		
R 7		RES,MF,22.6,+-1%,0.125W,100PPM	296640	89536	296640	1	1	
R 8		RES,MF,402,+-1%,0.125W,100PPM	289611	91637	CMF554020F	1		
R 9		RES,CC,10K,+-5%,0.5W	109165	01121	EB1035	1		
R 10		RES,VAR,CERM,500,+-20%,0.5W	267849	11236	190PC501B	1	1	
R 11		RES,MF,6.65K,+-1%,0.125W,100PPM	294918	91637	CMF551272F	1		
R 12		RES,MF,16.2K,+-1%,0.125W,100PPM	226233	89536	226233	1		
R 13		RES,MF,33.2K,+-0.5%,0.125W,100PPM	334102	89536	334102	1		
R 14		RES,MF,17.4K,+-1%,0.125W,50PPM	349175	89536	349175	1		
R 15		RES,CC,10K,+-5%,0.25W	148106	01121	CB1035	1		
R 16	*	RES,CC,100K,+-5%,0.25W	148189	89536	148189	1		
R 19		RES,CF,15K,+-5%,0.25W	348854	80031	CR251-4-5P15K	1		
R 20	*	RES,VAR,CERM,5K,+-20%,0.5W	267872	89536	267872	1		
RT 1		THERMISTOR,DISC,NEG.,10K,+-10%,25C	104596	73168	JA41J1	1		
S 1, 2		SWITCH,SLIDE,DPDT,POWER	234278	89536	234278	2	1	
T 1		POWER TRANSFORMER	645036	89536	645036	1		
W 1		JUMPER,WIRE,NONINSUL,0.275CTR	529271	89536	529271	1		

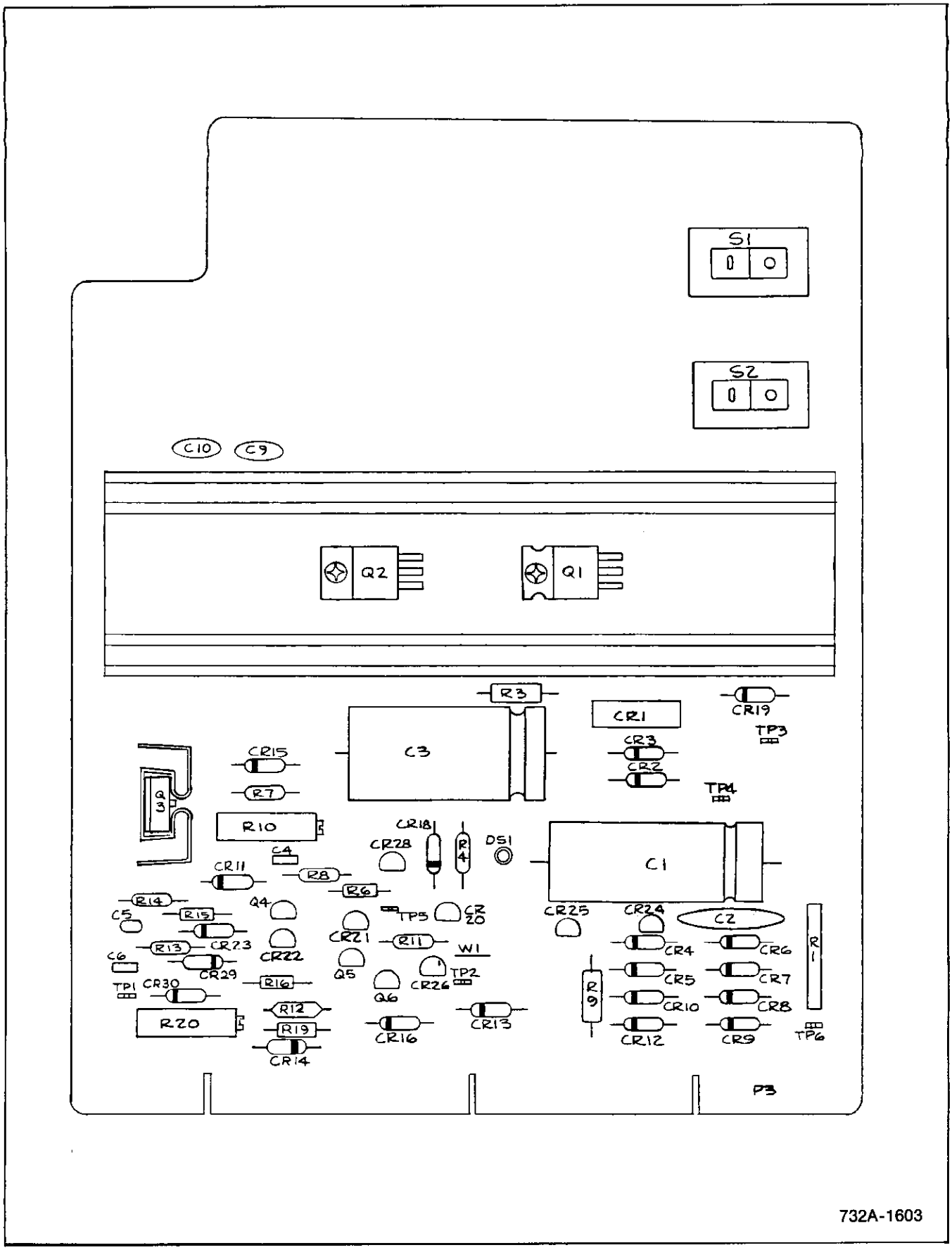
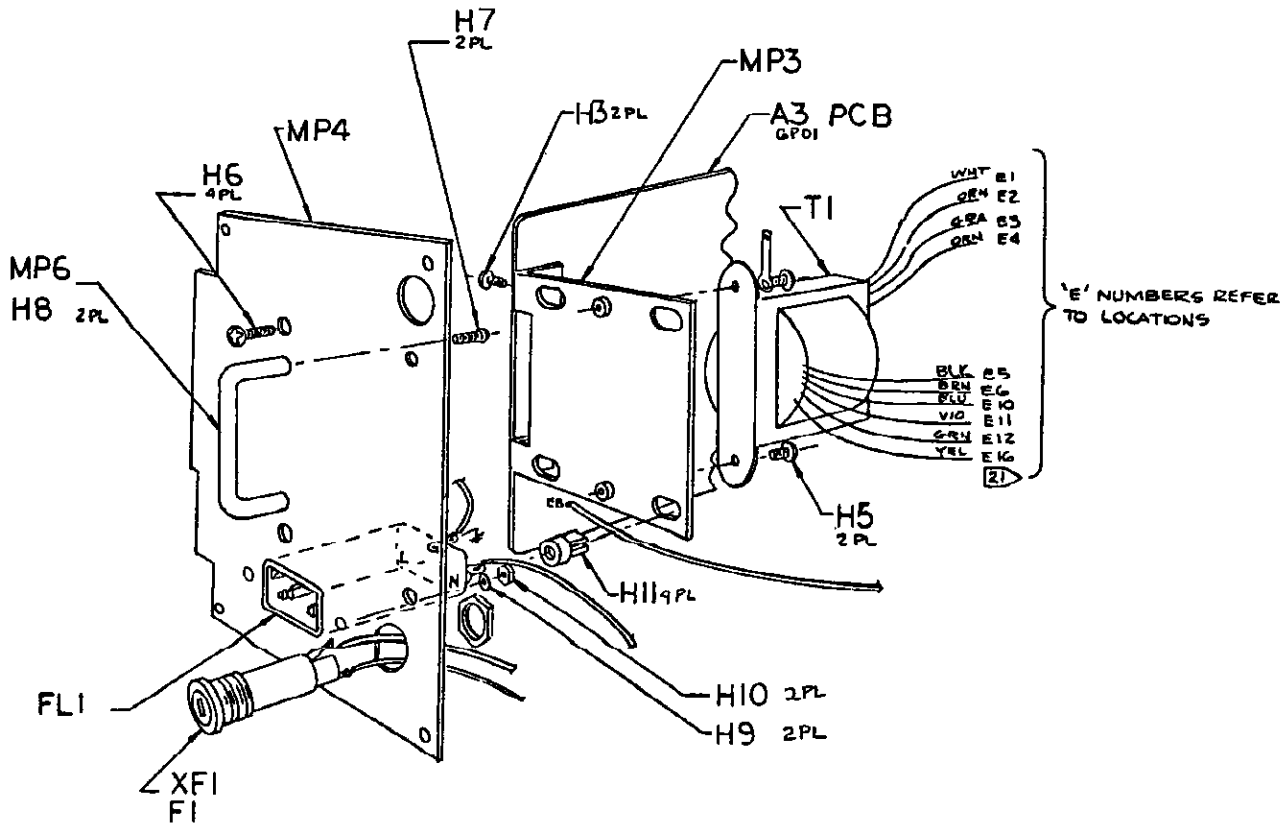


Figure 5-4. A3 Pre-Regulator PCA

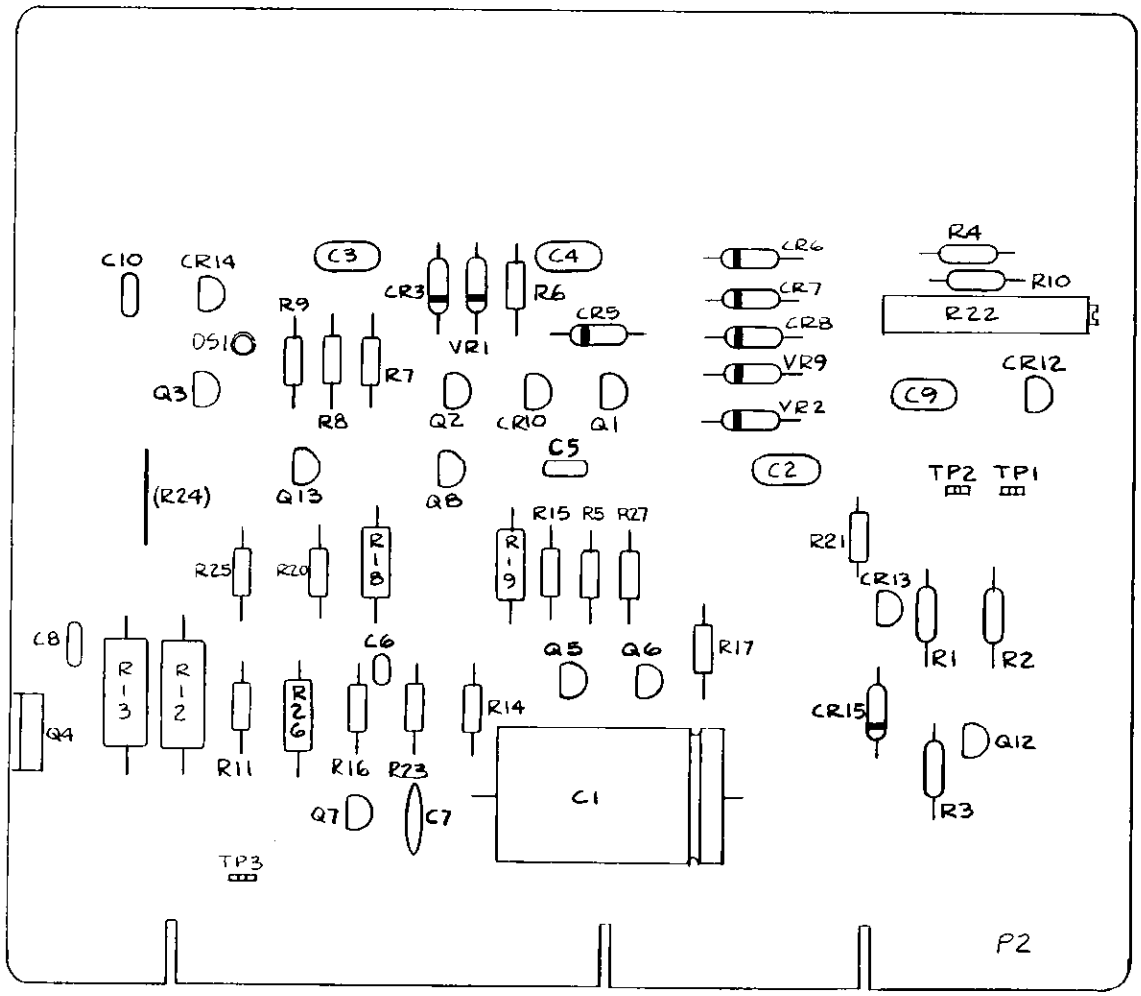


732A-4003

Figure 5-4. A3 Pre-Regulator PCA (cont)

TABLE 5-5. A4 REGULATOR PCA
(SEE FIGURE 5-5.)

REFERENCE DESIGNATOR A->NUMERICS--->	S	----------DESCRIPTION----------	FLUKE STOCK --NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE---	TOT QTY	R S -Q	N O T -E
C 1		CAP,AL,330UF,+75-20%,80V	292862	89536	292862	1		
C 2		CAP,TA,82UF,+-20%,20V	357392	12954	D82GS2D20M	1		
C 3, 4		CAP,TA,10UF,+-20%,35V	417683	56289	196D106X0035KA1	2		
C 5, 8, 10		CAP,CER,0.22UF,+-20%,50V,Z5U	309849	71590	CW30C224K	3		
C 6		CAP,CER,0.047UF,+-20%,50V,Z5U	460733	71590	CW20C473M	1		
C 7		CAP,CER,0.01UF,+80-20%,50V,Y5R	369579	89536	369579	1		
C 9		CAP,TA,22UF,+-20%,35V	394775	56289	196D226X0035TE4	1		
CR 3, 5, 6	*	DIODE,SI,BV= 75.0V,IO=150MA,500 MW	203323	07910	1N4448	3	1	
CR 7, 8	*	DIODE,GER,BV=100.0V,IO= 80MA,80 MW	149187	93332	1N270	2	1	
CR 10	*	DIODE,SI,N-JFET,CURRENT REG,IF=0.43MA	393454	89536	393454	1	1	
CR 12, 14	*	DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	334839	11532	TCR5297	2	1	
CR 13	*	DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	348482	89536	348482	1	1	
CR 15	*	DIODE,SI, 100 PIV, 1.5 AMP	116111	05277	1N4817	1	1	
DS 1		LED,VISBLE RED,PCB MNT,LUM INT=0.5MCD	369777	28480	5082-4480	1		
E 1- 3		TERM,FASTON,TAB,SOLDR,0.110 WIDE	512889	02660	62395	3		
MP 1		SPACER L.E.D.	541284	89536	541284	1	1	
Q 1, 5	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	229898	04713	MPS6522	2		
Q 2	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	218388	07263	2N3645	1	1	
Q 3, 8	*	SMALL SIGNAL NPN DOUBLE DIFF,SILICON	352138	89536	352138	2	1	
Q 4	*	TRANSISTOR,SI,BV=100V, 40W,TO-220	454033	04713	MJE15028	1	1	
Q 6	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	1	1	
Q 7	*	TRANSISTOR,SI,UJT,PNP	268110	03508	2N6027	1	1	
Q 12, 13	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	2	1	
R 1		RES,MF,348,+-1%,0.125W,100PPM	236778	89536	236778	1		
R 2		RES,MF,1.21K,+-1%,0.125W,100PPM	229146	91637	CMF551211F	1		
R 3		RES,MF,24.3,+-1%,0.125W,100PPM	281816	91637	CMF5524R2F	1		
R 4		RES,MF,8.66K,+-1%,0.125W,25PPM	330738	91637	CMF558661F	1		
R 5		RES,CC,3K,+-5%,0.25W	193508	01121	CB3025	1		
R 6		RES,CC,4.3K,+-5%,0.25W	193375	01121	CB4325	1		
R 7		RES,CC,18K,+-5%,0.25W	148122	01121	CB1835	1		
R 8, 9		RES,CC,91K,+-5%,0.25W	193300	89536	193300	2		
R 10		RES,MF,5K,+-0.1%,0.125W,25PPM	340240	91637	CMF5550018	1		
R 11		RES,CC,10K,+-5%,0.25W	148106	01121	CB1035	1		
R 12		RES,MF,0.39,+-5%,2W	219386	89536	219386	1		
R 13		RES,CC,2.7,+-5%,1W	159376	89536	159376	1		
R 14		RES,CC,150K,+-5%,0.25W	182212	01121	CB1545	1		
R 15, 25		RES,CC,51K,+-5%,0.25W	193334	01121	CB5135	2		
R 16		RES,CC,1M,+-5%,0.25W	182204	01121	CB1055	1		
R 17		RES,CC,2.7K,+-5%,0.25W	170720	01121	CB2725	1		
R 18		RES,MF,80.6K,+-1%,0.125W,25PPM	312710	91637	CMF558062F	1		
R 19		RES,CC,18K,+-5%,0.5W	187898	01121	EB1835	1		
R 20		RES,CC,8.2K,+-5%,0.25W	160796	01121	CB8225	1		
R 21		RES,CC,1K,+-5%,0.25W	148023	01121	CB1025	1		
R 22		RES,VAR,CERM,5K,+-20%,0.75W	159905	89536	159905	1	1	
R 23		RES,CC,270K,+-5%,0.25W	220061	89536	220061	1		
R 26		RES,CC,10,+-5%,0.25W	147868	01121	CB1005	1		
R 27		RES,MF,316K,+-1%,0.125W,100PPM	289496	91637	CMF553163F	1		
VR 1	*	ZENER,UNCOMP, 10.0V, 5%, 20.0MA, 0.5W	473744	07910	1N5240	1	1	
VR 2	*	ZENER,COMP, 6.4V, 5%, 5 PPM TC, 1.0MA	330829	07910	1N4571	1	1	
VR 9	*	ZENER,UNCOMP, 10.0V, 5%, 20.0MA, 0.5W	473744	07910	1N5240	1	1	
W 1		WIRE,BUS,22 AWG,TINNED COPPER	115469	89536	115469			



732A-1602

Figure 5-5. A4 Regulator PCA

TABLE 5-6. A5 REFERENCE PCA
(SEE FIGURE 5-6.)

REFERENCE DESIGNATOR A->NUMERICS---->		S	----------DESCRIPTION----------	FLUKE STOCK --NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	NOT -E
A	8		ASSY,PIGGYBACK	751578	89536	751578	1		
C	1, 2, 5,		CAP,CER,0.22UF,+-20%,50V,Z5U	309849	71590	CW3C0C224K	5	1	
C	6, 15			309849					
C	3		CAP,POLYCA,1UF,+-10%,50V	271619	84411	X463UW1029,50W	1		
C	4		CAP,CER,330PF,+-5%,100V,C0G	528620	51406	RPE121	1		
C	7		CAP,CER,0.0047UF,+-20%,50V,Z5U	255471	51642	200-050-601-502M	1		
C	8		CAP,POLYCA,5UF,+-10%,50V	313254	84411	X463UW5.0UF-10P-50	1		
C	9		CAP,POLYCA,0.47UF,+-10%,100V	288860	84411	X463UW	1		
C	10		CAP,POLYCA,4UF,+-20%,50V	340281	89536	340281	1		
C	11		CAP,MICA,270PF,+-5%,500V	148452	72136	DM15F271J	1		
C	12, 13		CAP,MICA,100PF,+-5%,500V	148494	72136	DM15F101J	2		
C	14		CAP,CER,180PF,+-10%,1000V,S3N	105890	56289	C023B102E181M	1		
C	16		CAP,CER,0.047UF,+-20%,50V,Z5U	460733	71590	CW20C473M	1		
C	17		CAP,CER,1200PF,+-20%,100V,X7R	358283	72982	8121-A100-W5R-122M	1		
CR	3, 4, 7	*	DIODE,SI,BV= 75.0V,IO=150MA,500 MW	203323	07910	1N4448	3	1	
E	1- 14		TERM,FASTON,TAB,SOLDR,0.110 WIDE	512889	02660	62395	14		
H	1		SCREW,SET,HH,STL,6-32X3/4	643395	89536	643395	1		
MP	1		TO-5 CASE THERMALLOY #11158	380220	89536	380220	1		
MP	2		SPACER,RND,NYLON,6-32X0.610	643361	89536	643361	1		
MP	3		SPACER,RND,NYLON,6-32X1.200	394262	89536	394262	1		
MP	4		SPACER,RND,SOLUBLE,0.062IDX0.156OD	296319	32559	T0806	16		
MP	5		INSUL PART,TRANS,SILICONE,TO-5	658807	89536	658807	1		
MP	6		CABLE TIE,4"L,0.100"W,0.75 DIA	172080	89536	172080	1		
MP	1	*	REF AMP SET	645010	89536	645010	1	1	1
Q	1, 2	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	2		
Q	3, 4	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	2	1	
Q	5	*	DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	334839	11532	TCR5297	1	1	
Q	5	*	SMALL SIGNAL NPN DOUBLE DIFF,SILICON	352138	89536	352138	1	1	
R	1		RES,CC,200,+-5%,0.25W	193482	80031	CR251-4-5P200E	1		
R	2, 3		MATCHED RESISTOR SET, 10.0V	634824	89536	634824	1	1	
R	4		1.27K	634915	89536	634915	1	1	
R	7, 8		REF AMP DIVIDER SET	715706	89536	715706	1	1	
R	12		20(	634840	89536	634840	1	1	
R	13		W W RESISTOR	711184	89536	711184	1	1	
R	14		RES,WW 250(+/-.06% .5W	238485	89536	238485	1	1	
R	15, 18		RES.WW CARD TYPE 500(	195388	89536	195388	2	1	
R	16, 56		RES,WW CARD, 1/2W, 1K,	131706	89536	131706	2	1	
R	17		RES,WW CARD, 1/2W, 2K,	131714	89536	131714	1	1	
R	19, 48, 49,		RES,WW,35 +/-.5%, 1/4W	634907	89536	634907	5	1	
R	54, 55			634907					
R	20		RES,VAR,CERM,100,+-20%,0.75W	159889	89536	159889	1		
R	22		RES,MF,17.4K,+-1%,0.125W,25PPM	335372	89536	335372	1		
R	23, 26, 64		RES,CC,51,+-5%,0.25W	221879	01121	CB5105	3		
R	24		RES,CC,10,+-5%,0.25W	147868	01121	CB1005	1		
R	25		RES,CC,30K,+-5%,0.25W	193417	01121	CB3035	1		
R	27		RES,MF,10K,+-0.1%,0.125W,25PPM	435065	89536	435065	1		
R	28		RES,MF,7.5K,+-1%,0.125W,25PPM	484881	89536	484881	1		
R	29		RES,MF,19.1K,+-1%,0.125W,25PPM	291518	89536	291518	1		
R	30		RES,MF,2.15K,+-1%,0.125W,50PPM	347039	89536	347039	1		
R	31		RES,MF,1K,+-0.1%,0.125W,25PPM	340380	91637	CMF55	1	1	
R	32		RES,CC,6.2M,+-5%,0.25W	221960	01121	CB6255	1		
R	33		RES,CC,5.1M,+-5%,0.25W	296447	01121	CB5155	1		
R	34		RES,CC,2.4M,+-5%,0.25W	221945	01121	CB2455	1		
R	35, 36		RES,CC,27M,+-5%,0.25W	221994	89536	221994	2		
R	37		RES,CC,1K,+-5%,0.25W	148023	01121	CB1025	1		
R	38, 39, 42		RES,CC,51K,+-5%,0.25W	193334	01121	CB5135	3		
R	40		RES,CC,10K,+-5%,0.25W	148106	01121	CB1035	1		
R	41		RES,CC,6.8M,+-5%,0.25W	394064	01121	CB	1		
R	43		RES,CC,100K,+-5%,0.25W	148189	01121	CB1045	1		
R	57		350(	642801	89536	642801	1	1	
R	58		RES,VAR,CERM,200,+-20%,0.75W	186213	89536	186213	1		
R	59		RES,VAR,WW,200,+-3%,2W,BSH,MTG	542928	89536	542928	1		
R	61		RES,CC,1M,+-5%,0.25W	182204	01121	CB1055	1		
R	62, 63		RES,CC,2.7,+-5%,0.5W	218743	89536	218743	2		
RT	1, 2		THERMISTOR,DISC,NEG.,10K,+-10%,25C	104596	73168	JA41J1	2		
U	1	*	IC,OP AMP,GEN PURPOSE,TO-78 METAL CAN	288928	12040	LM308AH	1		
U	3	*	IC,OP AMP,SELECTED DIFF OUT VOLT=2MV	473777	89536	473777	1	1	
U	4, 5	*	IC,OP AMP,GENERAL PURPOSE,TO-5 CASE	284760	12040	LM308H	2	1	
VR	1	*	ZENER,UNCOMP, 5.2V, 1.0MA, 0.4W	233627	89536	233627	1	1	
VR	2	*	ZENER,COMP, 6.4V, 5%, 5 PPM TC, 1.0MA	330829	07910	1N4571	1	1	
VR	6, 8	*	ZENER,UNCOMP,20.0V,5%,23.0MA,1.0W	276980	12969	UZ8712	2	1	

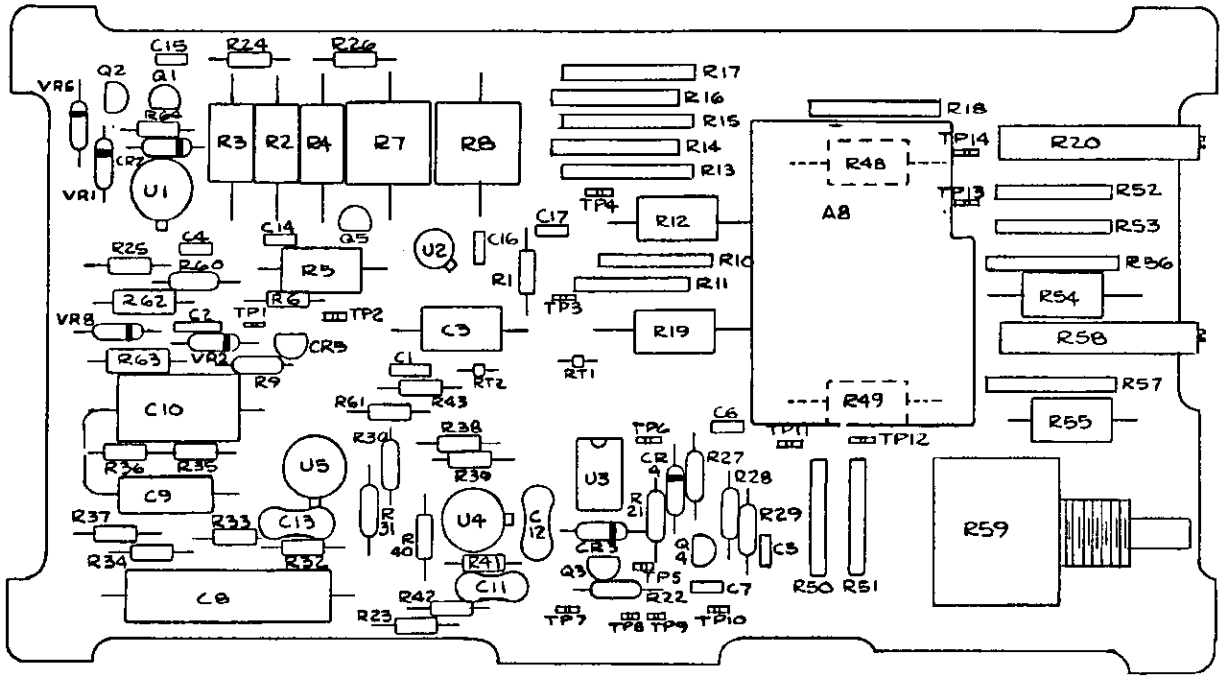


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Figure 5-6. A5 Reference PCA

TABLE 5-7. A5A8 PIGGYBACK PCA
(SEE FIGURE 5-7.)

REFERENCE DESIGNATOR A--)NUMERICS----)	S	----------DESCRIPTION----------	FLUKE STOCK ---NO---	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	NOT -E
J 1-- 5		PIN,SINGLE,PWB,0.025 SQ	267633	00779	86144-1	5		
MP 1		SPACER,SWAGED,RND,BRASS,2-56X0.375	342956	89536	342956	1	1	
R 44, 46		MATCHED RESISTOR SET, 1.0V	751917	89536	751917	1		
R 45, 47		MATCHED RESISTOR SET, 1.018V	751925	89536	751925	1	1	

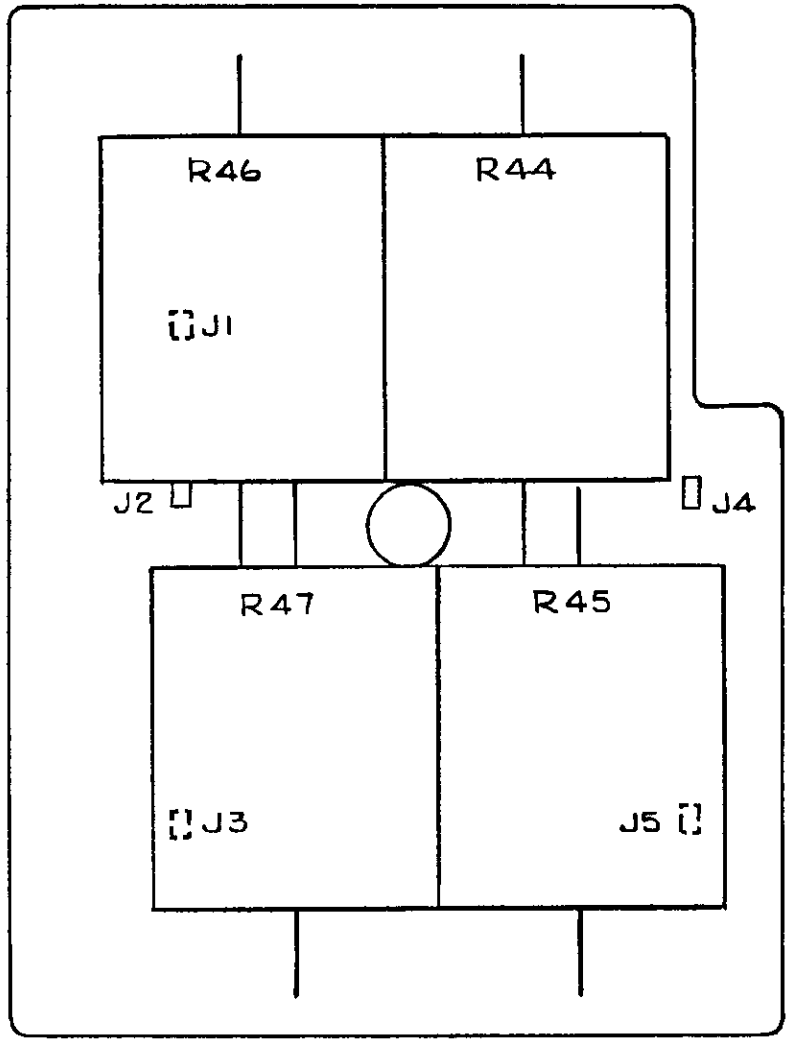

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Figure 5-7. A5A8 Piggyback PCA

TABLE 5-8. A6 BATTERY MODULE PCA
(SEE FIGURE 5-8.)

REFERENCE DESIGNATOR A-)NUMERICS---)		S	----------DESCRIPTION----------	FLUKE STOCK --NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
BT	1- 4		BATTERY,LEAD-ACID,GEL,6.0V,4.0AH	739961	89536	739961	4		
CR	1	*	DIODE,SI, 100 PTV, 1.5 AMP	116111	05277	1N4817	1	1	
DS	1		LAMP,END CAPS,13.5V,520MA	643346	89536	643346	1		
E	9, 11, 13,		WIRE ASSY, BLUE	738385	89536	738385	4		
E	15			738385					
E	10, 12, 14,		WIRE ASSY, RED	738377	89536	738377	4		
E	16			738377					
H	1		RIVET PLATED BRASS, 1/8 X 5/32 L	161315	89536	161315	2		
H	2		SCREW,THD FORM,PHP,S STL,8-18X5/8	574673	89536	574673	4		
H	3		SCREW,THD CUT,PHP,S.STL,4-24X3/8	183574	89536	183574	3		
H	4		SCREW,MACH,PHP,STL,6-32X1/4	152140	89536	152140	12		
H	5		SCREW,MACH,FHUP,S.STL,6-32X1/4	320093	89536	320093	13		
H	6		SCREW,MACH,PHP,STL,6-32X3/8	152165	89536	152165	2		
H	7		WASHER,FLAT,MYLAR,#8,0.010 THK	197426	89536	197426	2		
J	10		CONNECTOR	720844	89536	720844	1		
MP	1		BANANA JACK,PANEL,RED	162065	89536	162065	1		
MP	2		BANANA JACK,PANEL,BLACK	162073	89536	162073	3		
MP	3		FRONT END, BATTERY ENCLOSURE	644682	89536	644682	1		
MP	4		REAR END, BATTERY ENCLOSURE	644732	89536	644732	1		
MP	5		TOP, BATTERY ENCLOSURE	644690	89536	644690	1		
MP	6		BOTTOM, BATTERY ENCLOSURE	644708	89536	644708	1		
MP	7		INBD SIDE, BATTERY ENCLOSURE	644716	89536	644716	1		
MP	8		PANEL, BATTERY	644591	89536	644591	1		
MP	9		OUTBD SIDE, BATTERY ENCLOSURE	644724	89536	644724	1		
MP	10		NUT,INSULATOR	279398	89536	279398	4		
MP	11		TAPE,FOAM,VINYL,1/2 W,1/8 THK	330449	89536	330449	1		
MP	12		ROUND, L=1.750, THREAD 6-32, BLACK	650242	89536	650242	1		
MP	13		BATTERY PANEL	732602	89536	732602	1		
R	1		RES,CC,51K,+-5%,0.25W	193334	01121	CB5135	1	1	
RT	1, 2		THERMISTOR,DISC,NEG.,10K,+-10%,25C	104596	73168	JA41J1	2		
XDS	1		HLDR,COMPONENT,13/32,PWB MT	103028	89536	103028	2		

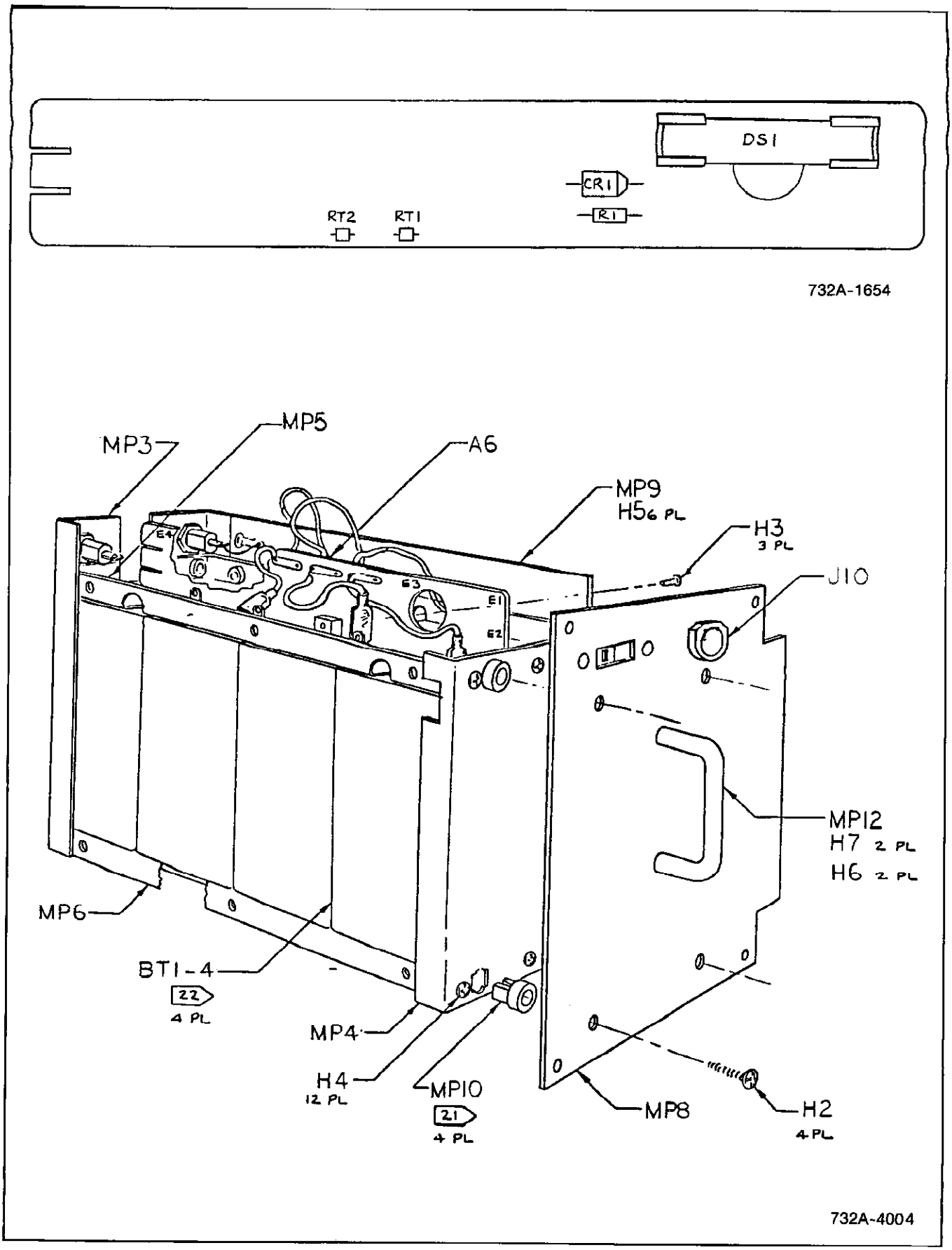
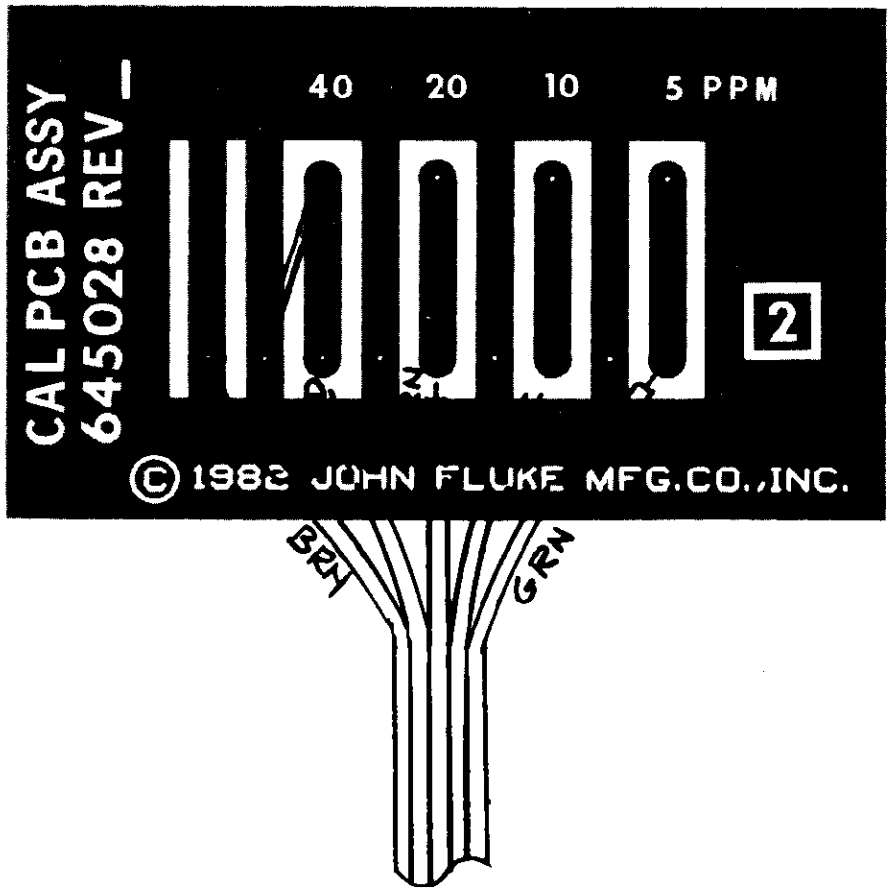


Figure 5-8. A6 Battery Module PCA

TABLE 5-9. A7 CALIBRATION PCA
(SEE FIGURE 5-9.)

REFERENCE DESIGNATOR A-->NUMERICS<---	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	NOTE --
F 1		CABLE ASSY, CALIBRATION	644989	89536	644989	1		



732A-4007

Figure 5-9. A7 Calibration PCA

TABLE 5-10. A8 PREHEATER PCA
(SEE FIGURE 5-10.)

REFERENCE DESIGNATOR A-)NUMERICS---)	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS CODE-	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
F 1		FUSE THERMAL 136F +-2.5F	715110	89536	715110	1		
R 1, 2		RES,CC,2K,+-5%,0.25W	202879	01121	CB2025	2		

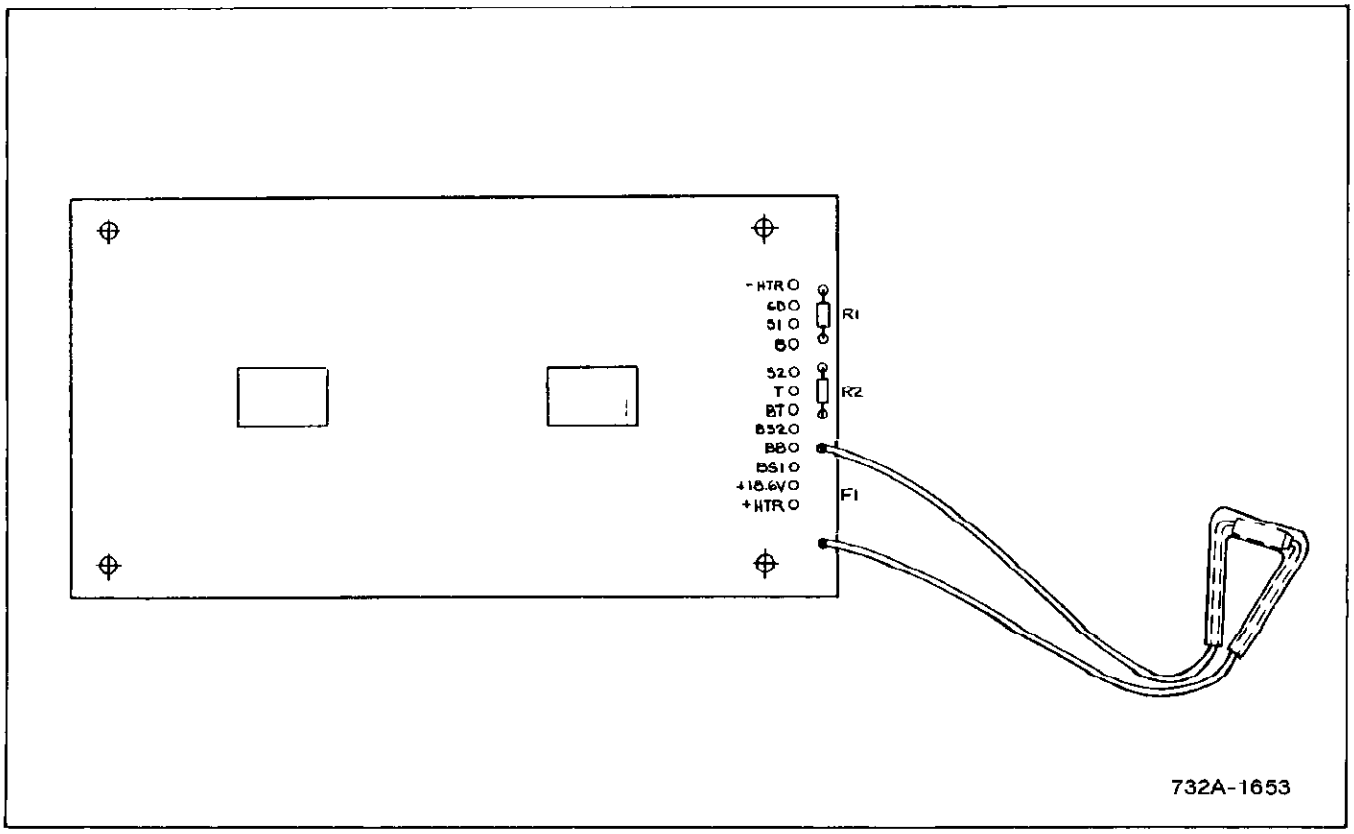


Figure 5-10. A8 Preheater PCA

Section 6
Accessories and Options

6-1. INTRODUCTION

6-2. This section describes accessories and options available with the model 732A.

6-3. DUAL-MOUNTING FASTENER (M00-800-523)

6-4. The Dual-Mounting Fastener is a 8-32 threaded fastener designed for bolting two half-rack-width instruments together. The Dual-Mounting Fasteners may be used for either dual rack mounting applications (as used in the M07-200-603 Full-Width Rack Mount Kit) or dual table top applications. Four M00-800-523 fasteners are required for each pair of half-rack width instruments.

6-5. HALF-WIDTH RACK MOUNT KIT (M07-203-601)

6-6. The Half-Width Rack Mounting kit permits the 732A to be rack mounted. A blank filler panel is supplied, allowing left or right hand offset mounting. Assembly instructions are supplied with the kit.

6-7. FULL-WIDTH RACK MOUNT KIT (M07-200-603)

6-8. The Full-Width Rack Mounting kit permits the 732A to be rack mounted side-by-side with another half-rack-width instrument. This rack mounting method requires the 732A to be bolted to the adjacent instrument. To facilitate bolting the instruments together, four M00-800-523, Dual Mounting Fasteners are included with the kit. Assembly instructions are supplied with the kit.

6-9. LOW THERMAL EMF CABLE SET (5440A-7002)

6-10. This set of three dual-conductor, shielded cables is terminated in low thermal emf banana-plug-type connectors. The set consists of one 4-foot long cable and two 2-foot long cables. Individual cables are identified as P/N 750133 for the 2-foot cable and P/N 750141 for the 4-foot cable.

6-11. BATTERY PACK (732A-7005)

6-12. The Battery Pack is a replacement module for the rear panel Battery Module on the 732A. It may be used as an additional auxiliary source or as a spare.

6-13. TRANSIT CASE (732A-7002)

6-14. The Transit Case provides a means of transporting the 732A while it is continuously powered by a battery source contained within the Transit Case. This allows continuity of standardization during transportation over long distances.

6-15. BATTERY CHARGER (732A-7003)

6-16. The Battery Charger provides the capability to charge up to four battery packs at once. This unit is designed to be used with the transit case for extended battery operation during transit.

6-17. RACK TRAY KIT (732A-7004)

6-18. The 732A-7004 Rack Tray Kit provides for mounting the 732A DC Reference Standards and/or the 752A Reference Divider in a standard 19-inch equipment rack. The Rack Tray Kit holds up to two instruments.

6-19. SPECIAL CALIBRATION (732A-000)

6-20. The 732A-000 Special Calibration option provides output voltage calibration of a new 732A in the Fluke Standards Lab, a Traceability Test Report and shipment of the unit under power to maintain traceability.

6-21. SPECIAL CALIBRATION (732A-000R)

6-22. The 732A-000R Special calibration option provides the same calibration (or recalibration) as 732A-000, but for a previously purchased instrument.

6-23. SPECIAL CALIBRATION AND DRIFT RATE CHARACTERIZATION (732A-100)

6-24. The 732A-100 option provides output voltage calibration and drift rate characterization of a new 732A for a period of sixty days in the Fluke Standards Lab, a Traceability Test Report, and shipment of the instrument under power.

6-25. SPECIAL CALIBRATION AND DRIFT RATE CHARACTERIZATION (732A-100R)

6-26. The 732A-100R option provides the same calibration (or recalibration) as 732A-100, but for a previously purchased instrument.

6-27. DIRECT VOLTAGE MAINTENANCE PROGRAM (732A-200)

6-28. The 732A-200 option provides 10V reference certification of a 732A at the customer's facility. It includes 1-week use of a Fluke owned and certified 732A (for on-site calibration of a 10V reference) and a Traceability Report.

6-29. ADDITIONAL 10V REFERENCE CERTIFICATION (732A-201)

6-30. The 732A-201 option provides for certification of additional 10V references at the same site of a 732A-200 option, using the Fluke owned 732A. This option may only be ordered with option 732A-200.

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.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(-) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

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00199
Marcon Electronics Corp
Kearny, New Jersey

00213
Nytronics Comp. Group Inc.
Darrlington, South Carolina

00327
Welwyn International Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors Inc.
Passaic, New Jersey

00779
AMP, Inc.
Harrisburg, Pennsylvania

01121
Allen Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronics & Defense Sector
Lawndale, California

01295
Texas Instruments Inc.
Semiconductor Group
Dallas,Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics/Shallcross Inc.
Electro Components Div.
Manchester, New Hampshire

01884
Sprague Electric Co.
(Now 56289)

01961
Varian Associates Inc.
Pulse Engineering Div.
Convoy, Connecticut

02111
Spectrol Electronics Corp.
City of Industry, California

02114
Amperex Electronic Corp.
Ferrox Cube Div.
Saugerties, New York

02131
General Instrument Corp.Government
Systems Div.
Westwood, Massachusetts

02395
Sonar Radio Corp.
Hollywood, Florida

02533
Leigh Instruments Ltd.
Frequency Control Div.
Don Mills, Ontario, Canada

02606
Fenwal Labs
Division of Travenal Labs
Morton Grove, Illinois

0266
Bunker Ramo-Eltra Corp.
Amphenol NA Div.
Broadview, Illinois

02735
RCA-Solid State Div.
Somerville, New Jersey

02799
Arco Electronics Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products& Batteries
Auburn, New York

03797
Genisco Technology Corp.
Eltronics Div.
Rancho Dominquez, Calif.

03877
Gilbert Engineering Co.Inc
Incon Sub of Transitron
Electronic Corp.
Glendale, Arizona

03888
KDI Electronics Inc.
Pyrofilm Div.
Whippany, New Jersey

03911
Clairex Corp.
Clairex Electronics Div.
Mount Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Cooper Industries, Inc.
Arrow Hart Div.
Hartford, Connecticut

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Midland-Ross Corp.
Midtex Div.
N. Mankato, Minnesota

04222
AVX Corp.
AVX Ceramics Div.
Myrtle Beach, S. Carolina

04423
Telonic Berkley Inc.
Laguna Beach, California

04713
Motorola Inc.
Semiconductor Group
Phoenix, Arizona

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Corcom Inc.
Libertyville, Illinois

05276
ITT Pomona
Electronics Div.
Pomona, California

05277
Westinghouse Elec. Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05397
Union Carbide Corp.
Materials Systems Div.
Cleveland. Ohio

05571
Sprague Electric Co.
(Now 56289)

05574
Viking Connectors Inc
Sub of Criton Corp.
Chatsworth, Calif.

05820
EG & G Wakefield Engineering
Wakefield, Massachusetts

05972
Loctite Corp.
Newington, Connecticut

06001
General Electric Co.
Electric Capacitor Product Section
Columbia, S. Carolina

06141
Fairchild Weston Systems Inc.
Data Systems Div.
Sarasota, Florida

06192
La Deau Mfg. Co.
Glendale, California

06229
Electrovert Inc.
Elmsford, New York

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol NA Div.
SAMS Operation
Chatsworth, California

06555
Boode Electrical Instrument
Penacook, New Hampshire

06665
Precision Monolithics
Sub of Bourns Inc.
Santa Clara, California

06666
General Devices Co. Inc.
Indianapolis, Indiana

06739
Electron Corp.
Littleton, Colorado

06743
Gould Inc.
Foil Div.
Eastlake, Ohio

06751
Components Inc.
Semcor Div.
Phoenix, Arizona

06776
Robinson Nugent Inc.
New Albany, Indiana

06915
Richco Plastic Co.
Chicago, Illinois

06961
Vernitron Corp.
Piezo Electric Div.
Bedford, Ohio

06980
Varian Associates Inc.
Eimac Div.
San Carlos, California

07047
Ross Milton Co., The
Southampton, Penna.

07138
Westinghouse Electric Corp.
Industrial & Government
Tube Div.
Horseheads, New York

07233
Benchmark Technology Inc.
City of Industry, Calif.

07239
Biddle Instruments
Blue Bell, Penna.

07256
Silicon Transistor Corp.
Sub of BBF Inc.
Chelmsford, Massachusetts

07261
Avnet Corp.
Culver City, California

07263
Fairchild Camera & Instrument
Semiconductor Div.
Mountain View, California

07344
Bircher Co. Inc., The
Rochester, New York

Federal Supply Codes for Manufacturers (cont)

07557
Campion Co. Inc.
Philadelphia, Penna.

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07716
TRW Inc. (Can use 11502)
IRC Fixed Resistors/
Burlington
Burlington, Iowa

07792
Lenna Engineering Corp.
Northampton, Massachusetts

07810
Bock Corp.
Madison, Wisconsin

07933
Raytheon Co.
Semiconductor Div.
Mountain View, Calif.

08235
Industro Transistor Corp.
Long Island City, New York

08261
Spectra-Strip
An Eltra Co.
Garden Grove, Calif.

08530
Reliance Mica Corp.
Brooklyn, New York

08718
ITT Cannon Electric
Phoenix Div.
Phoenix, Arizona

08806
General Electric Co.
Minature Lamp Products
Cleveland, Ohio

08863
Nylomatic
Fallsington, Penna.

08988
Skottie Electronics Inc.
Archbald, Pennsylvania

09021
Airco Inc.
Airco Electronics
Bradford, Penna.

09023
Cornell-Dublier Electronics
Fuquay-Varina, N. Carolina

09214
General Electric Co.
Semiconductor Products Dept.
Auburn, New York

09353
C and K Components Inc.
Newton, Massachusetts

09423
Scientific Components Inc.
Santa Barbara, California

09579
CTS of Canada, Ltd
Streetsville, Ontario

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, South Dakota

09975
Burroughs Corp.
Electronics Components
Detroit, Michigan

10059
Barker Engineering Corp.
Kenilworth, New Jersey

10389
Illinois Tool Works Inc.
Licon Div.
Chicago, Illinois

10582
CTS of Asheville
Skyland, N. Carolina

11236
CTS Corp.
Berne Div.
Berne, Indiana

11237
CTS Corp of California
Paso Robles Div.
Paso Robles, California

11295
ECM Motor Co.
Schaumburg, Illinois

11358
Columbia Broadcasting System
CBS Electronic Div.
Newburyport, Massachusetts

11403
Vacuum Can Co.Best Coffee Maker Div.
Chicago, Illinois

11502
TRW Inc.
TRW Resistive Products Div.
Boone, North Carolina

11503
Keystone Columbia Inc.
Freemont, Indiana

11532
Teledyne Relays Teledyne
Industries Inc.
Hawthorne, California

11711
General Instrument Corp.
Rectifier Div.
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Naperville, Illinois

12040
National Semiconductor Corp.
Danbury, Connecticut

12060
Diodes Inc.
Northridge, California

12136
PHC Industries Inc.
Formerly Philadelphia Handle Co.
Camden, New Jersey

12300
AMF Canada Ltd.
Potter-Brumfield
Guelph, Ontario, Canada

12323
Practical Automation Inc.
Shelton, Connecticut

12327
Freeway Corp.
Cleveland, Ohio

12443
Budd Co.,The
Plastics Products Div.
Phoenixville, Pennsylvania

12581
Hitachi Metals International Ltd.
Hitachi Magna-Lock Div.
Big Rapids, Missouri

12615
US Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co. Inc.
Dover, New Hampshire

12749
James Electronic Inc.
Chicago, Illinois

12856
MicroMetals Inc.
Anaheim, California

12881
Metex Corp.
Edison, New Jersey

12895
Cleveland Electric Motor Co.
Cleveland, Ohio

12954
Microsemi Corp.
Components Group
Scottsdale, Arizona

12969
Unitrode Corp.
Lexington, Massachusetts

13050
Potter Co.
Wesson, Mississippi

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Bunker-Ramo Corp.
Amphenol Cadre Div.
Los Gatos, California

13606
Sprague Electric Co.
(Use 56289)

13689
SPS Technologies Inc.
Hatfield, Pennsylvania

13919
Burr-Brown Research Corp.
Tucson, Arizona

14099
Semtech Corp.
Newbury Park, California

14140
McGray-Edison Co.
Commercial Development Div.
Manchester, New Hampshire

14193
Cal-R-Inc.
Santa Monica, California

14298
American Components Inc.
an Insilco Co. RPC Div.
Conshohocken, Pennsylvania

14298
ACIC Inc.
Sub of Insilco Corp.
Research Triangle Park, NC

14329
Wells Electronics Inc.
South Bend, Indiana

14482
Watkins-Johnson Co.
Palo Alto, California

14552
Microsemi Corp.
Santa Ana, California

14655
Cornell-Dublier Electronics
Div. of Federal Pacific
Electric Co. Govt Cont Dept.
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

14704
Crydom Controls
(Division of Int Rectifier)
El Segundo, California

14752
Electro Cube Inc.
San Gabriel, California

14936
General Instrument Corp.
Discrete Semi Conductor Div.
Hicksville, New York

14949
Trompeter Electronics
Chatsworth, California

15412
Amtron
Midlothian, Illinois

15542
Scientific Components Corp.
Mini-Circuits Laboratory Div.
Brooklyn, New York

15636
Elec-Trol Inc.
Saugus, California

15782
Bausch & Lomb Inc.
Graphics & Control Div.
Austin, Texas

15801
Fenwal Eletronics Inc.
Div. of Kidde Inc.
Framingham, Massachusetts

15818
Teledyne Inc. Co.
Teledyne Semiconductor Div.
Mountain View, California

15849
Useco Inc.
(Now 88245)

15898
International Business
Machines Corp.
Essex Junction, Vermont

16245
Conap Inc.
Olean, New York

16258
Space-Lok Inc.
Burbank, California

16352
Codi Corp.
Linden, New Jersey

16469
MCL Inc.
LaGrange, Illinois

16473
Cambridge Scientific Industries
Div. of Chemed Corp.
Cambridge, Maryland

16733
Cablewave Systems Inc.
North Haven, Connecticut

16742
Paramount Plastics
Fabricators Inc.
Downey, California

16758
General Motors Corp.
Delco Electronics Div.
Kokomo, Indiana

17069
Circuit Structures Lab
Burbank, California

17117
Electronic Molding Corp.
Woonsocket, Rhode Island

17338
High Pressure Eng. Co. Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors Inc.
Asbury Park, New Jersey

17745
Angstrohm Precision, Inc.
Hagerstown, Maryland

17856
Siliconix Inc.
Santa Clara, California

18178
E G & Gvactee Inc.
St. Louis, Missouri

18324
Signetics Corp.
Sacramento, California

18520
Sharp Electronics Corp.
Paramus, New Jersey

18542
Wabash Inc.
Wabash Relay & Electronics Div.
Wabash, Indiana

18565
Chomerics Inc.
Woburn, Massachusetts

18612
Vishay Intertechnology Inc.
Vishay Resistor Products Group
Malvern, Pennsylvania

18632
Norton-Chemplast
Santa Monica, California

18677
Scanbe Mfg. Co.
Div. of Zero Corp.
El Monte, California

18736
Voltronics Corp.
East Hanover, New Jersey

18927
GTE Products Corp.
Precision Material Products
Business Parts Div.
Titusville, Pennsylvania

19315
Bendix Corp., The
Navigation & Control Group
Teterboro, New Jersey

19451
Perine Machinery & Supply Co..
Kent, Washington

19613
Minnesota Mining & Mfg. Co.
Textool Products Dept.
Electronic Product Div.
Irving, Texas

19647
Caddock Electronics Inc.
Riverside, California

19701
Mepco/Centralab Inc.
A N. American Philips Co.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Cosar Corp.
Dallas, Texas

21317
Electronics Applications Co.
El Monte, California

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Semiconductor Group
Rivera Beach, Florida

22526
DuPont, El DeNemours & Co. Inc.
DuPont Connector Systems
Advanced Products Div.
New Cumberland, Pennsylvania

22767
ITT Semiconductors
Palo Alto, California

22784
Palmer Inc.
Cleveland, Ohio

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Applied Sciences Inc.
Rockville, Maryland

23880
Stanford Applied Engineering
Santa Clara, California

23936
William J. Purdy Co.
Pamotor Div.
Burlingame, California

24347
Penn Engineering Co.
S. El Monte, California

24355
Analog Devices Inc.
Norwood, Massachusetts

24444
General Semiconductor
Industries, Inc.
Tempe, Arizona

24655
Genrad Inc.
Concord, Massachusetts

24759Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

24796
AMF Inc.
Potter & Brumfield Div.
San Juan Capistrano, Calif.

24931
Specialty Connector Co.
Greenwood, Indiana

25088
Siemen Corp.
Isilen, New Jersey

25099
Cascade Gasket
Kent, Washington

25403
Amperex Electronic Corp.
Semiconductor & Micro-Circuit Div.
Slatersville, Rhode Island

25706
Daburn Electronic & Cable Corp.
Norwood, New Jersey

26629
Frequency Sources Inc.
Sources Div.
Chelmsford, Massachusetts

26806
American Zettler Inc.
Irvine, California

27014
National Semiconductor Corp.
Santa Clara, California

27167
Corning Glass Works Corning
Electronics
Wilmington, North Carolina

27264
Molex Inc.
Lisle, Illinois

27440
Industrial Screw Products
Los Angeles, California

Federal Supply Codes for Manufacturers (cont)

27745
Associated Spring Barnes Group Inc.
Syracuse, New York

27956
Relcom (Now 14482)

28198
Positronic Industries
Springfield, Missouri

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
3M Center
Saint Paul, Minnesota

28425
Serv-O-Link
Euless, Texas

28478
Deltrol Corporation
Deltrol Controls Div.
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28484
Emerson Electric Co.
Gearmaster Div.
McHenry, Illinois

28520
Heyco Molded Products
Kenilworth, New Jersey

29083
Monsanto Co.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

29907
Omega Engineering Inc.
Stamford, Connnecticut

30035
Jolo Industries Inc.
Garden Grove, California

30146
Symbex Corp.
Painesville, Ohio

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30161
Aavid Engineering Inc.
Laconia, New Hampshire

30315
Itron Corp.
San Diego, California

30323
Illinois Tool Works Inc.
Chicago, Illinois

30800
General Instrument Corp.
Capacitor Div.
Hicksville, New York

31019
Solid State Scientific Inc.
Willow Grove, Pennsylvania

31091
Alpha Industries Inc.
Microelectronics Div.
Hatfield, Pennsylvania

31323
Metro Supply Company
Sacramento, California

31448
Army Safeguard Logistics Command
Huntsville, Alabama

31746
Cannon Electric
Woodbury, Tennessee

31827
Budwig
Ramona, California

31918
ITT-Schadow
Eden Prairie, Minnesota

32293
Intersil
Cupertino, California

32539
Mura Corp.
Westbury, Long Island, N.Y.

32559
Bivar
Santa Ana, California

32767
Griffith Plastics Corp.
Burlingame, California

32879
Advanced Mechanical Components
Northridge, California

32897
Murata Erie North America Inc.
Carlisle Operations
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Div.
Riverside, California

33096
Colorado Crystal Corp.
Loveland, Colorado

33173
General Electric Co.
Owensboro, Kentucky

33246
Epoxy Technology Inc.
Billerica, Massachusetts

33297
NEC Electronics USA Inc.
Electronic Arrays Inc. Div.
Mountain View, California

33919
Nortek Inc.
Cranston, Rhode Island

34333
Silicon General Inc.
Garden Grove, California

34225
Advanced Micro Devices
Sunnyvale, California

34359
Minnesota Mining & Mfg. Co.
Commercial Office Supply Div.
Saint Paul, Minnesota

34371
Harris Corp.
Harris Semiconductor
Products Group
Melbourne, Florida

34649
Intel Corp.
Santa Clara, California

34802
Electromotive Inc.
Kenilworth, New Jersey

34848
Hartwell Special Products
Placentia, California

35009
Renfrew Electric Co. Ltd.
IRC Div.
Toronto, Ontario, Canada

36665
Mitel Corp.
Kanata, Ontario, Canada

37942
Mallory Capacitor Corp.
Sub of Emhart Industries
Indianapolis, Indiana

39003
Maxim Industries
Middleboro, Massachusetts

40402
Roderstein Electronics Inc.
Statesville, North Carolina

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.(Now 53342)

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Executive Offices
Lexington, Massachusetts

50088
Thomson Components-Mostek Corp.
Carrollton, Texas

50120
Eagle-Picher Industries Inc.
Electronics Div.
Colorado Springs, Colorado

50157
Midwest Components Inc.
Muskegon, Mississippi

50541
Hypertronics Corp.
Hudson, Massachusetts

50579
Litronix Inc.
Cupertino, California

51167
Aries Electronics Inc.
Frenchtown, New Jersey

51372
Verbatim Corp.
Sunnyvale, California

51406
Murata Erie, No. America Inc.
(Also see 72982)
Marietta, Georgia

51499
Amtron Corp.
Boston, Massachusetts

51605
CODI Semiconductor Inc.
Kenilworth, New Jersey

51642
Centre Engineering Inc.
State College, Pennsylvania

51791
Statek Corp.
Orange, California

51984
NEC America Inc.
Falls Church, Virginia

52063
Exar Integrated Systems
Sunnyvale, California

52072
Circuit Assembly Corp.
Irvine, California

52152
Minnesota Mining & Mfg.
Saint Paul, Minnesota

52333
API Electronics
Haugpauge,Long Island,New York

Federal Supply Codes for Manufacturers (cont)

52361
Communication Systems
Piscataway, New Jersey

52525
Space-Lok Inc.
Lerco Div.
Burbank, California

52531
Hitachi Magnetics
Edmore, Missouri

52745
Timco
Los Angeles, California

52763
Stettner-Electronics Inc.
Chattanooga, Tennessee

52769
Sprague-Goodman Electronics Inc.
Garden City Park, New York

52771
Moniterm Corp.
Amatrom Div.
Santa Clara, California

52840
Western Digital Corp.
Costa Mesa, California

53021
Sangamo Weston Inc.
(See 06141)

53217
Technical Wire Products Inc.
Santa Barbara, California

53342
Opt Industries Inc.
Phillipsburg, New Jersey

53944
Glow-Lite
Pauls Valley, Oklahoma

54294
Shallcross Inc.
Smithfield, North Carolina

54453
Sullins Electronic Corp.
San Marcos, California

54473
Matsushita Electric Corp.
(Panasonic)
Secaucus, New Jersey

54583
TDK
Garden City, New York

54869
Piher International Corp.
Arlington Heights, Illinois

54937
DeYoung Mfg.
Bellevue, Washington

54590
RCA Corp.
Electronic Components Div.
Cherry Hill, New Jersey

55026
American Gage & Machine Co.
Simpson Electric Co. Div.
Elgin, Illinois

55112
Plessey Capacitors Inc.
(Now 60935)

55261
LSI Computer Systems Inc.
Melville, New York

55285
Bercquist Co.
Minneapolis, Minnesota

55576
Synertek
Santa Clara, California

55680
Michicon/America/Corp.
Schaumburg, Illinois

56282
Utek Systems Inc.
Olathe, Kansas

56289
Sprague Electric Co.
North Adams, Massachusetts

56365
Square D Co.
Corporate Offices
Palatine, Illinois

56375
DAL Industries Inc.
Wescorp Div.
Mountain View, California

56481
Shugart Associates
Sub of Xerox Corp.
Sunnyvale, California

56708
Zilog Inc.
Campbell, California

56856
Varistor Corp. of Tennessee
Sevierville, Tennessee

56880
Magnetics Inc.
Baltimore, Maryland

57026
Endicott Coil Co. Inc.
Binghamton, New York

57053
Gates Energy Products
Denver, Ohio

58014
Hitachi Magnalock Corp.
(Now 12581)

58104
Simco
Atlanta, Georgia

58474
Superior Electric Co.
Bristol, Connecticut

59124
KOA-Speer Electronics Inc.
Bradford, Pennsylvania

59640
Supertex Inc.
Sunnyvale, California

59660
Tusonix Inc.
Tucson, Arizona

59730
Thomas and Betts Corp.
Iowa City, Iowa

59831
Semtronics Corp.
Watchung, New Jersey

60395
Xicor Inc.
Milpitas, California

60399
Torin Engineered Blowers
Div. of Clevepak Corp.
Torrington, Connecticut

60705
Cera-Mite Corp.
(formerly Sprague)
Grafton, Wisconsin

60935
Westlake Capacitor Inc.
Tantalum Div.
Greencastle, Indiana

61804
M/A Com Inc.
Burlington, Massachusetts

61857
SAN-O Industrial Corp.
Bohemia, Long Island, NY

61935
Schurter Inc.
Petaluma, California

62351
Apple Rubber
Lancaster, New York

62793
Lear Siegler Inc.
Energy Products Div.
Santa Ana, California

63743
Ward Leonard Electric Co.Inc.
Mount Vernon, New York

64154
Lamb Industries
Portland, Oregon

64155
Linear Technology
Milpitas, California

64834
West M G Co.
San Francisco, Calif.

65092
Sangamo Weston Inc.
Weston Instruments Div.
Newark, New Jersey

65940
Rohm Corp & Whatney
Irvine, California

65964
Evox Inc.
Bannockburn, Illinois

66150
Entron Inc.
Winslow Teltronics Div.
Glendale, New York

66608
Bering Industries
Fremont, California

70290
Almetal Universal Joint Co.
Cleveland, Ohio

70485
Atlantic India Rubber Works Inc.
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Bimbach Co. Inc.
Farmingdale, New York

71034
Bliley Electric Co.
Erie, Pennsylvania

71183
Westinghouse Electric Corp.
Bryant Div.
Bridgeport, Connecticut

71400
Bussman Manufacturing
Div. McGraw-Edison Co.
St. Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Div. of ITT
Fountain Valley, California

71482
General Instrument Corp.
Clare Div.
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

71590
Mepco/Centralab
A North American Philips Co.
Fort Dodge, Iowa

71707
Coto Corp.
Providence, Rhode Island

71744
General Instrument Corp.
Lamp Div/Worldwide
Chicago, Illinois

71785
TRW Inc.
Cinch Connector Div.
Elk Grove Village, Illinois

71984
Dow Corning Corp.
Midland, Michigan

72005
AMAX Specialty Metals Corp.
Newark, New Jersey

72136
Electro Motive Mfg. Corp.
Florence, South Carolina

72228
AMCA International Corp.
Continental Screw Div.
New Bedford, Massachusetts

72259
Nytronics Inc.
New York, New York

72619
Amperex Electronic Corp.
Dialight Div.
Brooklyn, New York

72653
G C Electronics Co.
Div. of Hydrometals Inc.
Rockford, Illinois

72794
Dzus Fastner Co. Inc.
West Islip, New York

72928
Gulton Industries Inc.
Gudeman Div.
Chicago, Illinois

72982
Murata Erie N. America Inc.
Erie, Pennsylvania

73138
Beckman Industrial corp.
Helipot Div.
Fullerton, California

73168
Fenwal Inc.
Ashland, Massachusetts

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carlingswitch Inc.
Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cold Spring, Kentucky

73893
Microdot
Mt. Clemens, Mississippi

73899
JFD Electronic Components
Div. of Murata Erie
Oceanside, New York

73905
FL Industries Inc.
San Jose, California

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quam Nichols Co.
Chicago, Illinois

74217
Radio Switch Co.
Marlboro, New Jersey

74306
Piezo Crystal Co.
Div. of PPA Industries Inc.
Carlisle, Pennsylvania

74542
Hoyt Elect.Instr. Works Inc.
Penacook, New Hampshire

74840
Illinois Capacitor Inc.
Lincolnwood, Illinois

74970
Johnson EF Co.
Waseca, Minnesota

75042
TRW Inc.
IRC Fixed Resistors
Philadelphia, Pennsylvania

75297
Litton Systems
Kester Solder Div.
Chicago, Illinois

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
(Now 83330)
Mount Vernon, New York

75915
Tracor Littlefuse
Des Plaines, Illinois

76854
Oak Switch Systems Inc.
Crystal Lake, Illinois

77122
TRW Assemblies & Fasteners Group
Fastener Div.
Moutainside, New Jersey

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77542
Ray-O-Vac Corp
Madison, Wisconsin

77638
General Instrument Corp.
Rectifier Div.
Brooklyn, New York

77900
Shakeproof Lock Washer Co.
(Now 78189)

77969
Rubbercraft Corp. of CA Ltd.
Torrance, California

78189
Illinois Tool Works Inc.
Shakeproof Div.
Elgin, Illinois

78277
Sigma Instruments Inc.
South Braintree, Mass.

78290
Struthers Dunn Inc.
Pitman, New Jersey

78553
Eaton Corp.
Engineered Fastener Div.
Cleveland, Ohio

78592
Stoeger Industries
South Hackensack, New Jersey

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Co.
Goshen, Indiana

79727
C - W Industries
Southampton, Pennsylvania

79963
Zierick Mfg. Corp.
Mount Kisco, New York

80009
Tektronix
Beaverton, Oregon

80031
Mepco/Electra Inc.
Morristown, New Jersey

80032
Ford Aerospace & Communications Corp.
Western Development
Laboratories Div.
Palo Alto, California

80145
LFE Corp.
Process Control Div.
Clinton, Ohio

80183
Sprague Products
(Now 56289)

80294
Bourns Instruments Inc.
Riverside, California

80583
Hammerlund Mfg. Co. Inc.
Paramus, New Jersey

80640
Computer Products Inc.
Stevens-Arnold Div.
South Boston, Mass.

81073
Grayhill Inc.
La Grange, Illinois

81312
Litton Systems Inc.
Winchester Electronics Div.
Watertown, Connecticut

81439
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Electronics Inc.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82227
Airpax Corp.
Cheshire Div.
Cheshire, Connecticut

82240
Simmons Fastner Corp.
Albany, New York

Federal Supply Codes for Manufacturers (cont)

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Sub of Raytheon Co.
Chicago, Illinois

82415
Airpax Corp
Frederick Div.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Custom Div.
Woodstock, New York

82879
ITT
Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83014
Hartwell Corp.
Placentia, California

83055
Signalite Fuse Co.
(Now 71744)

83058
TRW Assemblies & Fasteners Group
Fasteners Div.
Cambridge, Massachusetts

83259
Parker-Hannifin Corp.
O-Seal Div.
Culver City, California

83298
Bendix Corp.
Electric & Fluid Power Div.
Eatonville, New Jersey

83315
Hubbell Corp.
Mundelein, Illinois

83330
Kulka Smith Inc.
A North American Philips Co.
Manasquan, New Jersey

83478
Rubbercraft Corp. of America
West Haven, Connecticut

83553
Associated Spring Barnes Group
Gardena, California

83740
Union Carbide Corp.
Battery Products Div.
Danbury, Connecticut

84171
Arco Electronics
Commack, New York

84411
American Shizuki
TRW Capacitors Div.
Ogallala, Nebraska

84613
FIC Corp.
Rockville, Maryland

84682
Essex Group Inc.
Peabody, Massachusetts

85367
Bearing Distributing Co.
San Fransisco, California

85372
Bearing Sales Co.
Los Angeles, California

85480
W. H. Brady Co.
Industrial Product
Milwaukee, Wisconsin

85932
Electro Film Inc.
Valencia, California

86577
Precision Metal Products Co.
Peabody, Massachusetts

86684
Radio Corp. of America
(Now 54590)

86928
Seastrom Mfg. Co. Inc.
Glendale, California

87034
Illuminated Products Inc.
(Now 76854)

88219
GNB Inc.
Industrial Battery Div.
Langhorne, Pennsylvania

88245
Winchester Electronics
Litton Systems-Useco Div.
Van Nuys, California

88486
Triangle PWC Inc.
Jewitt City, Connecticut

88690
Essex Group Inc.
Wire Assembly Div.
Dearborn, Michigan

89020
Amerace Corp.
Buchanan Crimptool Products Div.
Union, New Jersey

89265
Potter-Brumfield
(See 77342)

89536
John Fluke Mfg. Co., Inc.
Everett, Washington

89597
Fredericks Co.
Huntingdon Valley, Penna.

89709
Bunker Ramo-Eltra Corp.
Amphenol Div.
Broadview, Illinois

89730
General Electric
Lamp Div.
Newark, New Jersey

90201
Mallory Capacitor Co.
Sub of Emhart Industries Inc.
Indianapolis, Indiana

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Duracell Inc.
Technical Sales & Marketing
Bethel, Connecticut

91094
Essex Group Inc.
Suflex/IWP Div.
Newmarket, New Hampshire

91247
Illinois Transformer Co.
Chicago, Illinois

91293
Johanson Mfg. Co.
Boonton, New Jersey

91462
Alpha Industries Inc.
Logansport, Indiana

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91507
Froeliger Machine Tool Co.
Stockton, California

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
A Gulf Western Mfg. Co.
Connector Div.
Huntingdon, Pennsylvania

91737
ITT Cannon/Gremar
(Now 08718)

91802
Industrial Devices Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co. Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co.
Woonsocket, Rhode Island

91984
Maida Development Co.
Hampton, Virginia

91985
Norwalk Valve Co.
S. Norwalk, Connecticut

92914
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94144
Raytheon Co.
Microwave & Power Tube Div.
Quincy, Massachusetts

94222
Southco Inc.
Concordville, Pennsylvania

94988
Wagner Electric Corp.
Sub of Mcgraw-Edison Co.
Whippany, New Jersey

95146
Alco Electronic Products Inc.
Switch Div.
North Andover, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
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Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
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Rolling Meadows, Illinois

Federal Supply Codes for Manufacturers (cont)

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Detroit, Michigan

95712
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Franklin, Indiana

95987
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(Now 85480)

96733
SFE Technologies
San Fernando, California

96853
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Measurement & Controls Div.
Manchester, New Hampshire

96881
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Port Washington, New York

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Santa Ana, California

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Master Mobile Mounts Div.
Fort Meyers, Florida

97913
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97945
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SS White Industrial Products
Piscataway, New Jersey

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Danvers, Massachusetts

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98278
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98291
Sealectro Corp.
BICC Electronics
Trumbill, Connecticut

98372
Royal Industries Inc.(Now 62793)

98388
Lear Siegler Inc.
Accurate Products Div.
San Deigo, California

99120
Plastic Capacitors Inc.
Chicago, Illinois

99217
Bell Industries Inc.
Elect. Distributor Div.
Sunnyvale, California

99378
ATLEE of Delaware Inc.
N. Andover, Massachusetts

99392
Mepco/Electra Inc.
Roxboro Div.
Roxboro, North Carolina

99515
Electron Products Inc.
Div. of American Capacitors
Duarte, California

99779
Bunker Ramo- Eltra Corp.
Barnes Div.
Lansdown, Pennsylvania

99800
American Precision Industries
Delevan Div.
East Aurora, New York

99942
Mepco/Centralab
A North American Philips Co.
Milwaukee, Wisconsin

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FAX: 61-2-733663

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Elmeasco Instruments Pty, Ltd.
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FAX: (61) (9) 322-2075

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Vertrieb KG
Obachgasse 28
1220 Vienna, Austria
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TLX: (847) 134759
FAX: 43-222-25-72-75

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Basma W.L.L.
P.O. Box 5701
Manama, Bahrain
Tel: 973-251364; TLX: (955) 9003
FAX: (965) 245218

Bangladesh •
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Dacca-3, Bangladesh
Tel: 257249
TLX: (950) 642022 PCO BJ
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Tlx: 35000 phtc nl
Fax: 040-785651

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Casilla 7295
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Alphaville, 06400, Barueri
Sao Paulo, Brazil
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TLX: (391) 1171413 HITK BR

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Mile 1 Jalan Tutong
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Fax: (416) 890-6866

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Fax: (613) 723-9458

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Casilla 16228 (Mail)
Santiago 9, Chile
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TLX: (332) 346351 INTRON CK

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Carrera 13, No. 37-43, Of. 401
Ap. Aereo 29583
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Tel: 57-232-4532
TLX: (396) 45787 COASN CO

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Chris Radiovision, Ltd.
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Tel: 357-21-66121; TLX: (826) 2395

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2C & 2D Muftu Ziyai Street
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Fax: 44-9328-61919

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2750 Ballerup
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P.O. Box 228-A
Ave. 12 de Octubre 2285
y Orellana
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Tel: 593-2-529684
TLX: (393) 22085 ESIND

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11361 Heliopolis, Cairo
Egypt
Tel: 20-2-695705, TLX: (927) 22782

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Fax: 040-785651

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Awa New Zealand Limited
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Walu Bay, P.O. Box 858
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FAX: 679-314379

Finland ■
Instrumentarium Elektroniika
P.O. Box 64
02631 Espoo 63
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FAX: (358) 0-5021073
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France ■
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INDEX

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Section 7A
Manual Change Information

7A-1. INTRODUCTION

7A-2. Table 7A-1 defines the assembly revision levels documented in this manual. To identify the configuration of the pca's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pca.

7A-3. NEWER INSTRUMENTS

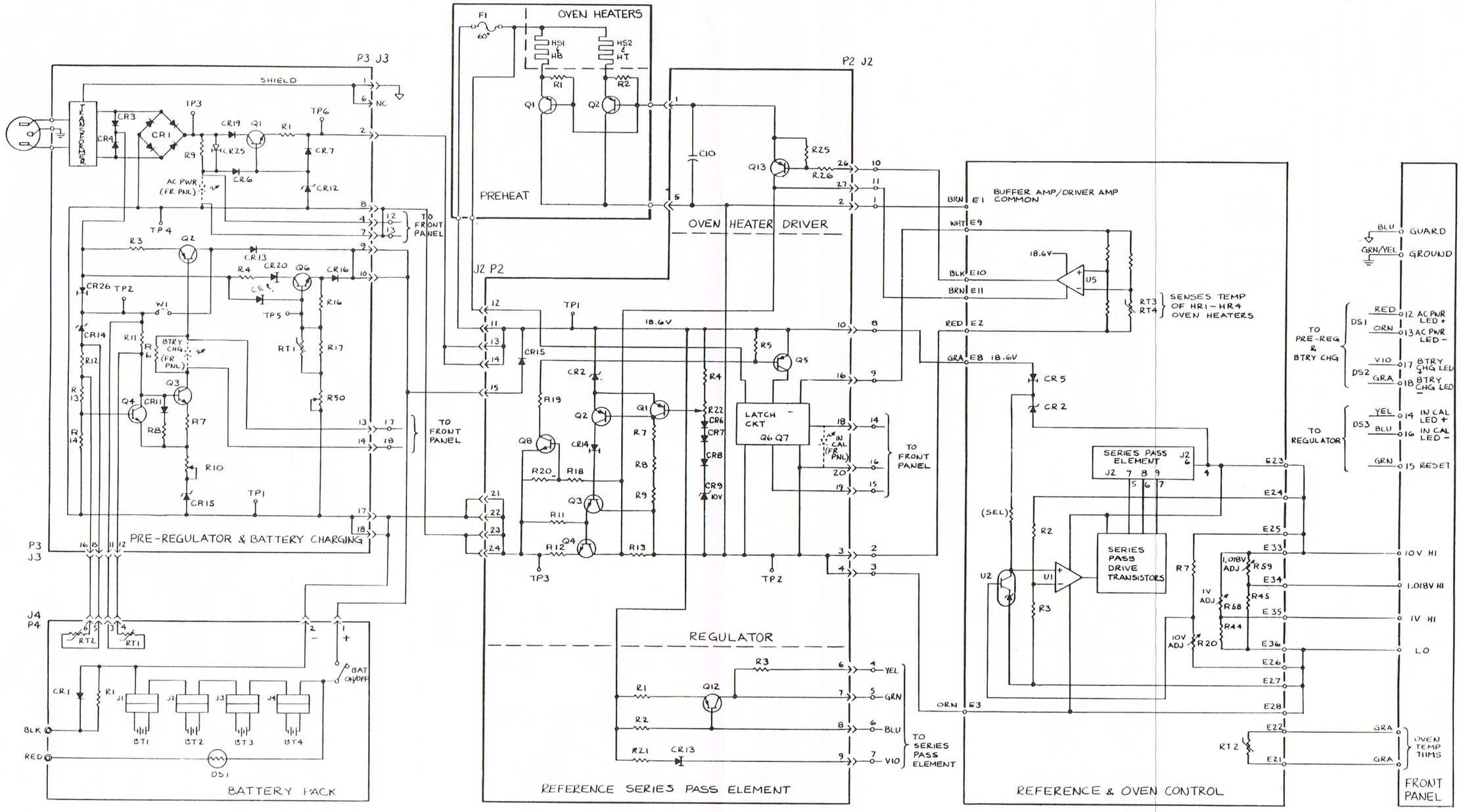
7A-4. As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pca assembly. These changes are documented on a supplemental change/ errata sheet which, when applicable, is inserted at the front of the manual.

Table 7A-1. Manual Status

Ref Or Option No.	Assembly Name	Fluke Part No.	X = The PCB revision levels documented in this manual.																						
			–	A	B	C	D	E	F	G	H	J	K	L	M	N	P								
A1	LED PCA	642280	X																						
A2	Motherboard PCA	650994			X																				
A3	Pre-Regulator PCA	642264								X															
A4	Regulator PCA	642256					X																		
A5	Reference PCA	642272						X																	
A5A8	Piggyback PCA	751578		X																					
A6	Battery Module PCA	732628						X																	
A7	Calibration PCA	645028	X																						
A8	Preheater PCA	788323	X																						

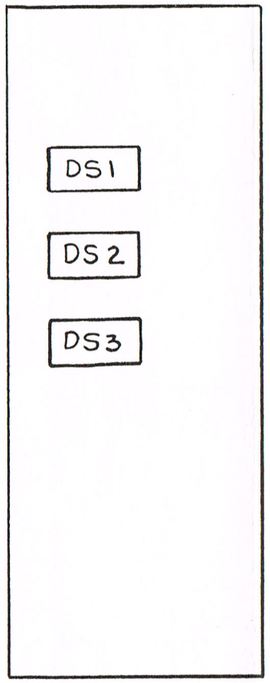
Section 8
Schematic Diagrams

NOTES



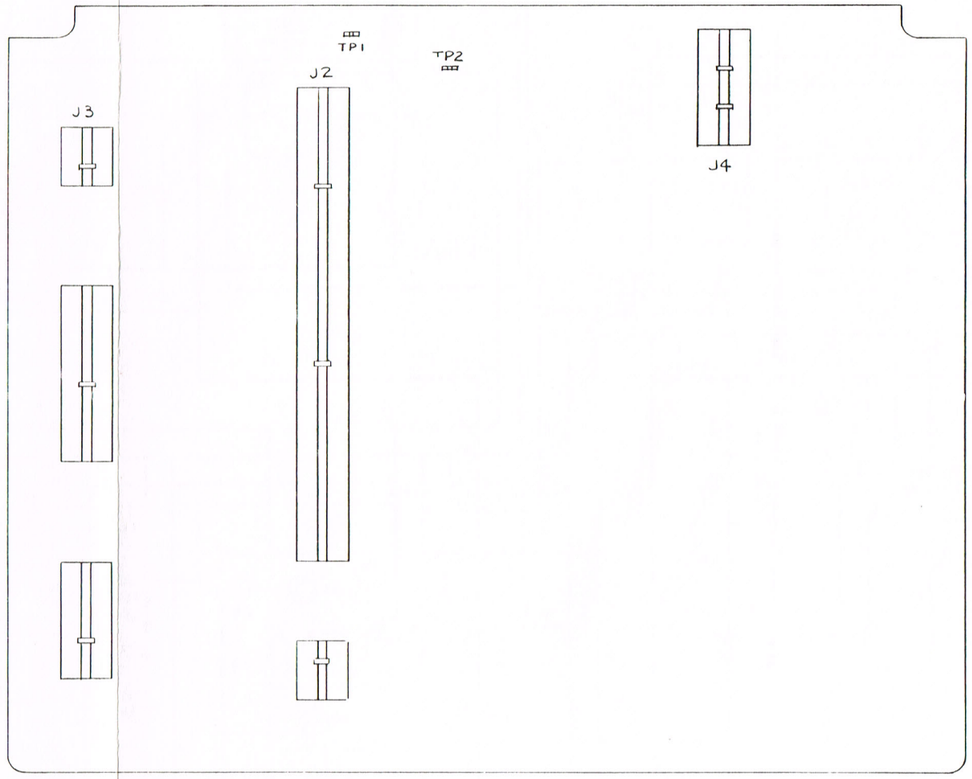
732A-1301

Figure 8-1. Interconnect Diagram



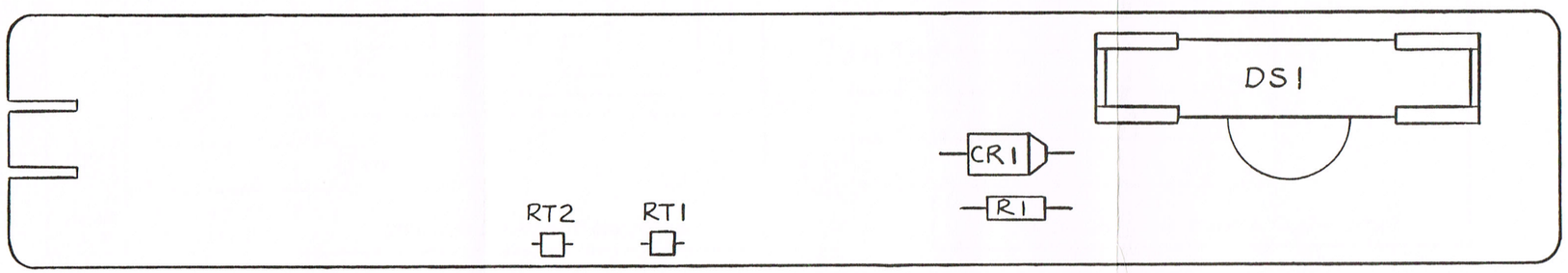
A1 LED

732A-1606



A2 Motherboard

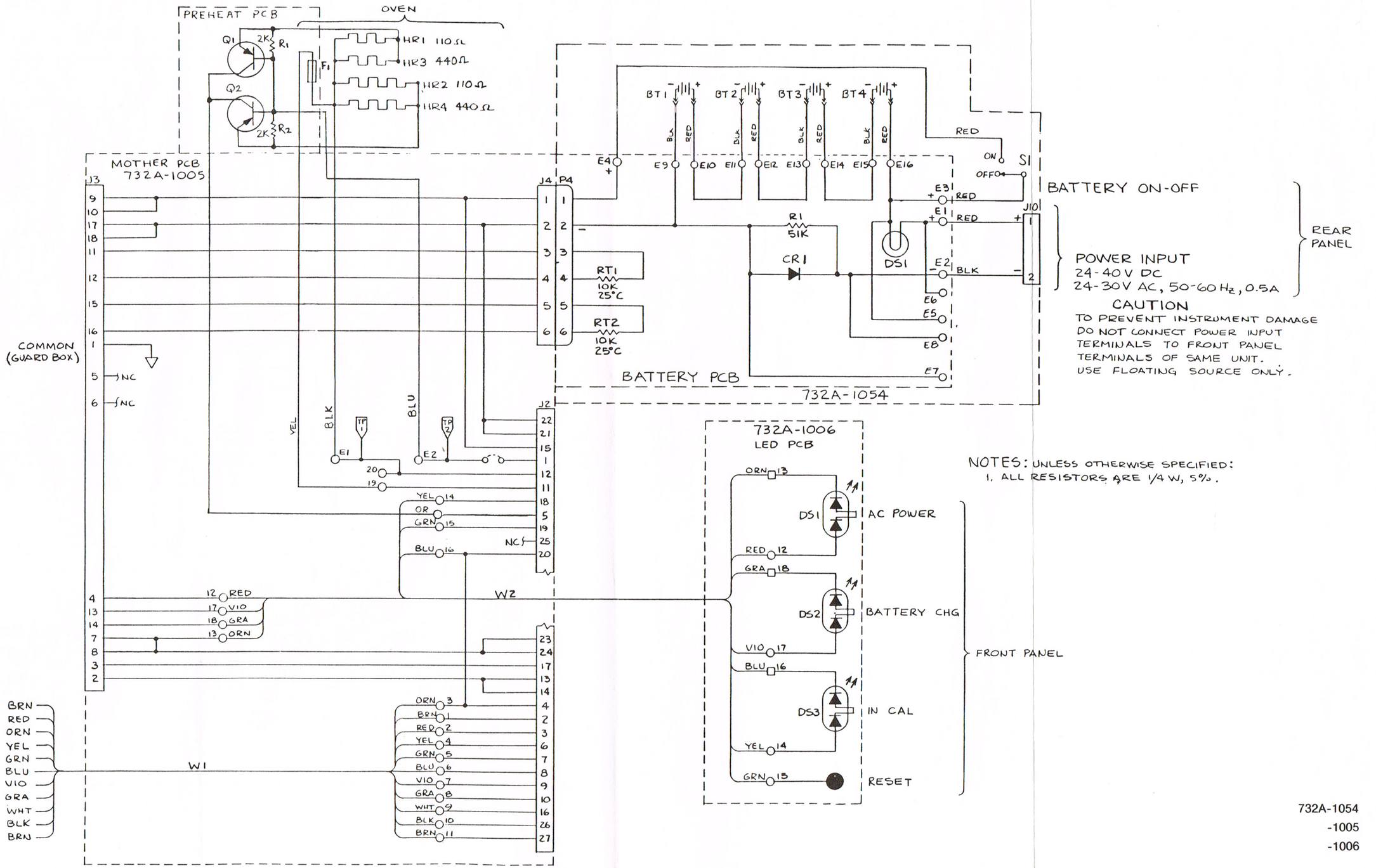
732A-1605



A6 Battery Module

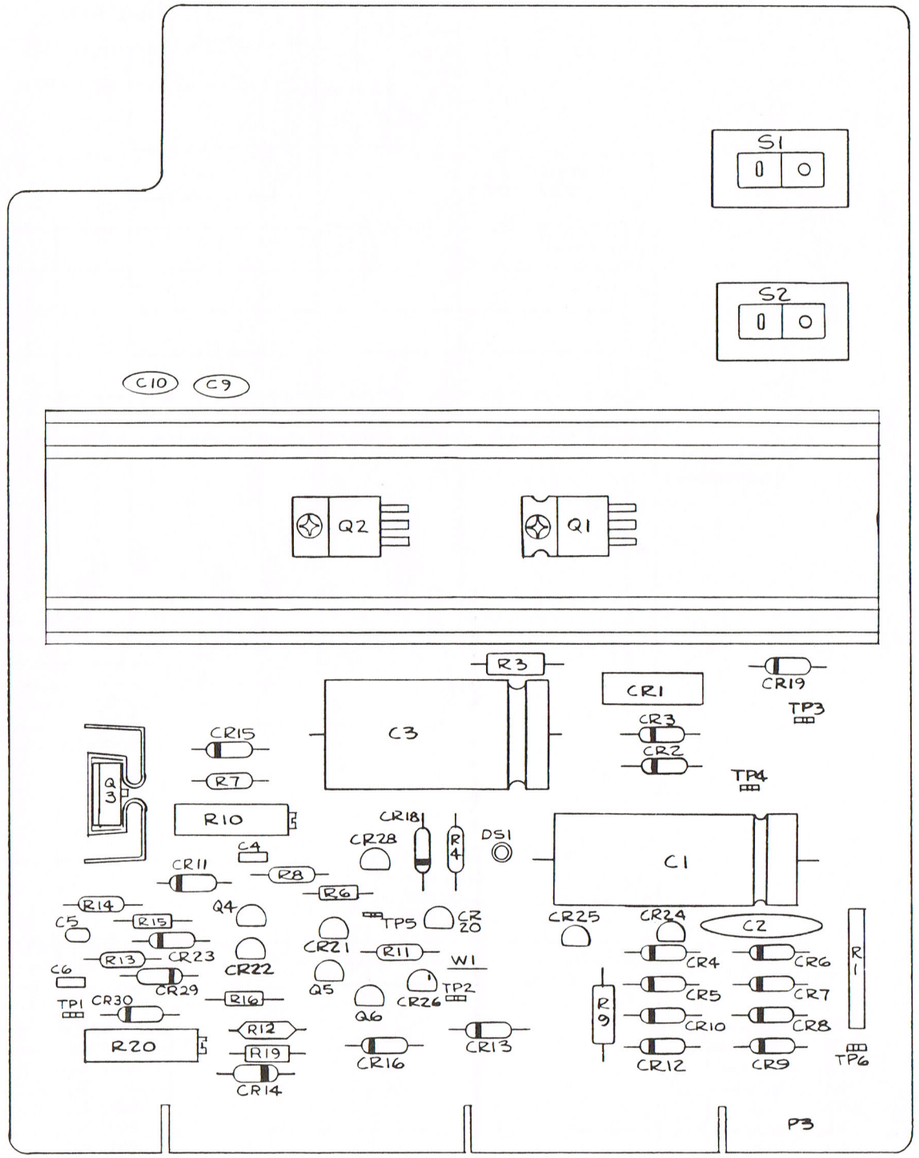
732A-1654

Figure 8-2. A1 LED, A2 Motherboard and A6 Battery Module PCAs



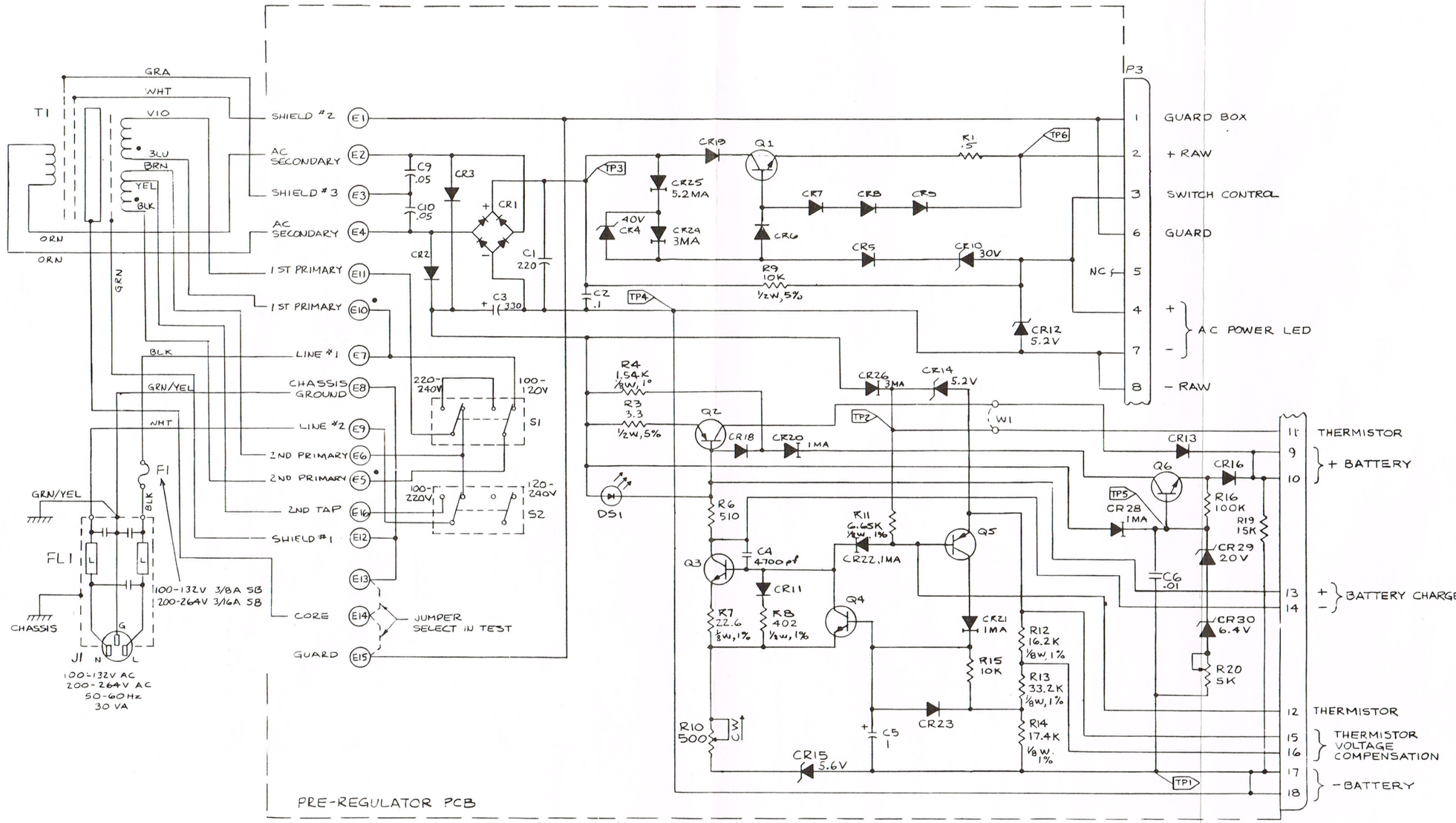
732A-1054
-1005
-1006

Figure 8-2. A1 LED, A2 Motherboard and A6 Battery Module PCAs (cont)



732A-1603

Figure 8-3. A3 Pre-Regulator



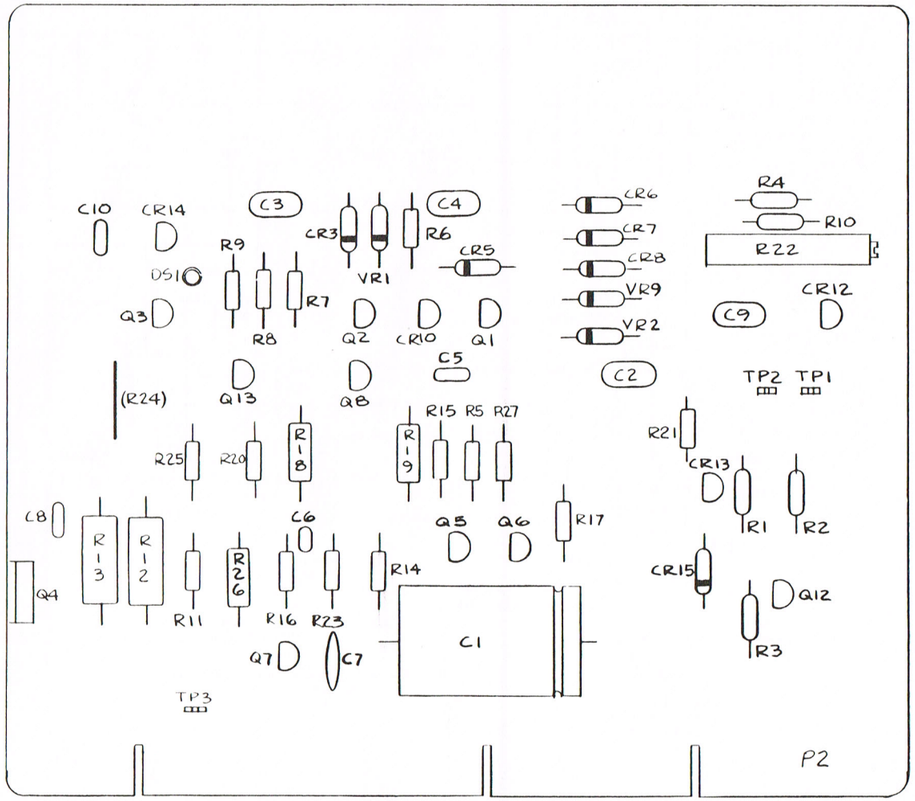
REF. DESIG.	
LAST USED	NOT USED
R20	
C10	C7, 8
CR28	CR27, 17
Q6	
S2	
DS1	

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCE ARE IN MICROFARADS
2. ALL RESISTORS ARE 1/4 W 5% CC.

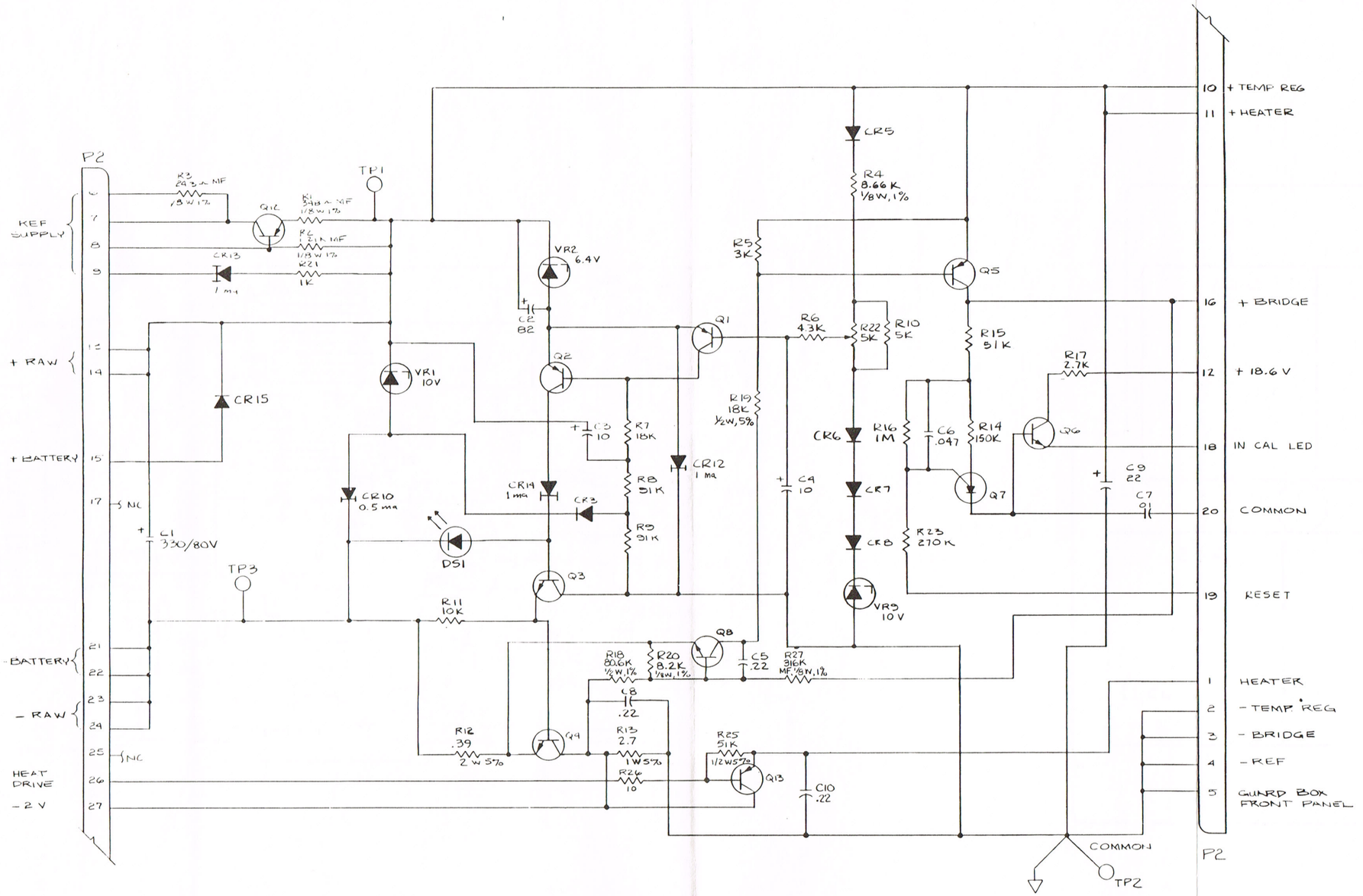
732A-1003

Figure 8-3. A3 Pre-Regulator (cont)



732A-1602

Figure 8-4. A4 Regulator PCA



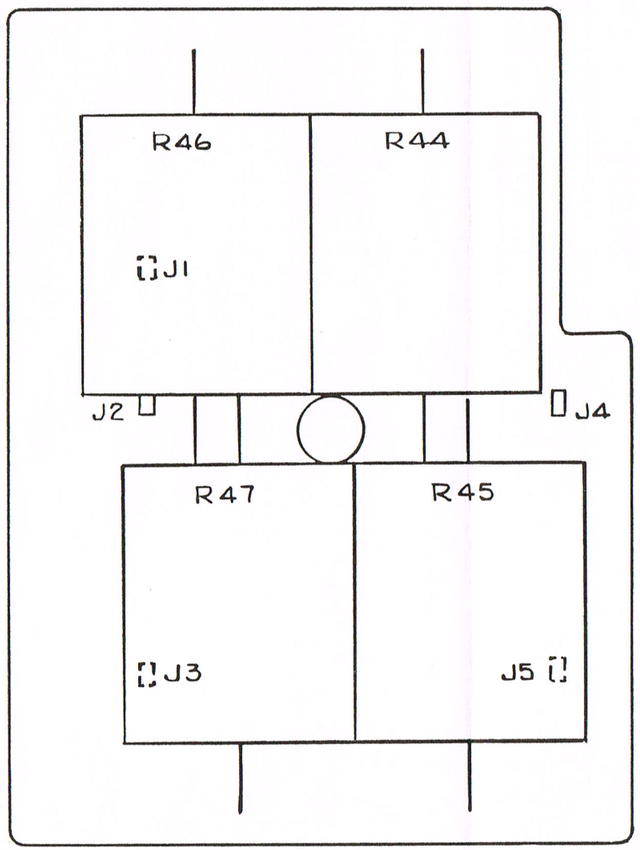
NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCE ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4 W 5% CC.

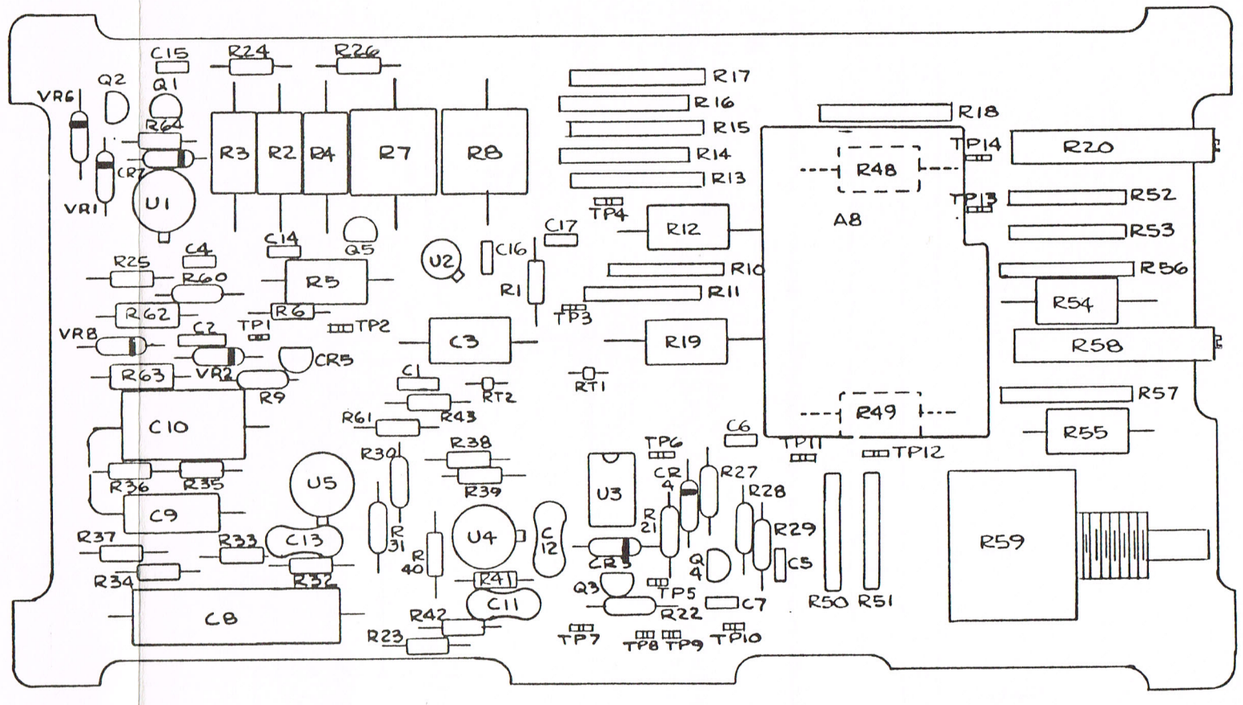
REF DES	
LAST USED	NOT USED
R27	R24
C10	
CR-15	CR1,2,4,5,9,11
Q13	Q9-11,14
DS1	
VR9	VR3-8

732A-1002

Figure 8-4. A4 Regulator PCA (cont)



732A-1608



732A-1601

Figure 8-5. A5 Reference and A5A8 Piggyback PCAs

OVEN
RT4 10K, 25°C
RT3 10K, 25°C
732A-1001 REFERENCE PCB
TO MOTHER PCB 732A-1005
WHT E90
RED E2
BRN E1
BRN E11
BLK E10
GRA E8
YEL E4
GRN E5
VIO E7
BLU E6
ORN E3
R21 SEL
R27 10K
C6 .22
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Q3 2N3906
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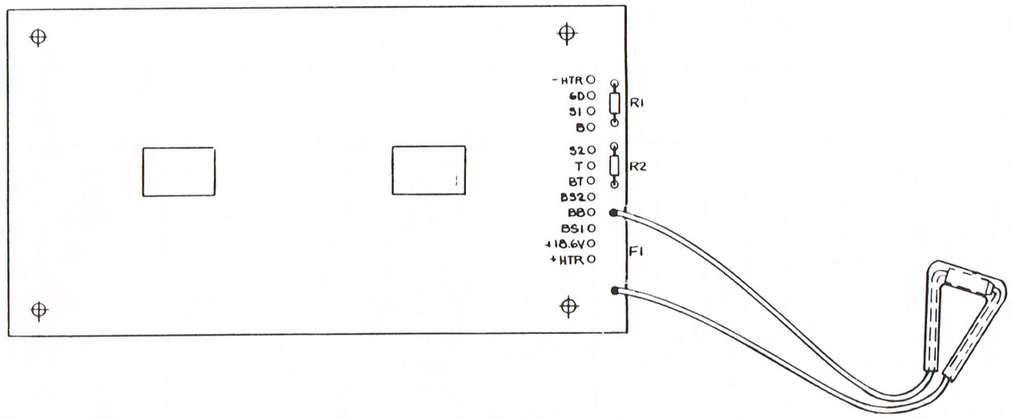
U3A
R30 2.15K
C11 270pf
R41 6.8M
R40 10K
LM308H U4
C10 .4
C12 100pf
R23 51
R42 51K
R38 51K
R39 51K
R36 27M
R35 27M
C9 .47
R61 1M
LM308H U5
R31 1K
C8 5
C13 100pf
R34 2.4M
R32 6.2M
R33 5.1M
R37 1K
R62 2.7 ½W, 5%
VR6 12V
R24 10
C15 .22
R2 4.22K
R5 *
R6 SEL
R60 SEL
CR5 1MA
R9 *
VR2 6.4V
C2 .22
VR8 12V
R63 2.7 ½W, 5%
R43 100K
C1 .22
RT2 10K 25°C
Q2 2N3904
VR1 5.2V
U1 LM308A
C14 180pf
R4 1.27K
U2 *
R26 51
R7 6.2K
R8 11.42K
R11 SEL
R10 SEL
C4 330pf
Q1 2N3904
R25 50K
R3 10K
C3 1
R1 200
R64 51
CR7
Q5 EN2484
C16 .047
C17 1200pf
R12 20
R13 125
R14 250
R15 500
R16 1K
R17 2K
R19 35
R20 100
R18 500
E18
E19 E15 E16 E17
40 20 10 5
BRN BRN RED GRN YEL GRN
140 20 10 5PPM
R57 350
R55 35
R54 35
R58 200
R59 200
R56 1K
R50 SEL
R53 SEL
R51 SEL
R49 35
R48 35
R52 SEL
R47 8.7K
R46 8.9K
R45 1K
R44 1K
AB 732A-1008 PIGGYBACK PCB
J5 J4 J2 J3 J1
E33 10V HI
E34 1.018V HI
E35 1V HI
E36 LO
E23 10V HI
E22 THERMISTOR
E21 THERMISTOR
E24 10V HI
E25 10V HI
E26 LO
E27 LO
E28 LO
FRONT PANEL
R1 2Ω
C1 .02
CR1 RV1 DS1
TERM STRIP INSIDE FRT PAN.
732A-1007 CAL PCB

NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCES ARE IN OHMS.
2. ALL CAPACITANCES ARE IN MICROFARADS.
3. * = REF AMP SET 732A-4502.

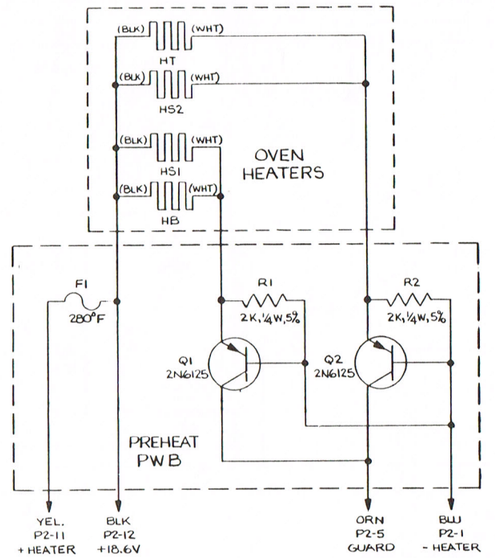
REF DESIGNATIONS	
HIGHEST	NOT USED
C17	
CR7	CR1, 2, 6 & 8
E36	E12, 13, 19, 20, 29-32
Q5	
R64	
RT2	
TP14	
U5	
VR8	

732A-1001
-1007

Figure 8-5. A5 Reference and A5A8 Piggyback PCAs (cont)



732A-1653



732A-1053

Figure 8-6. A8 Preheater PCA

CHANGE/ERRATA INFORMATION

ISSUE NO: 1 6/86

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The revision letter stamped on the indicated PCB is equal to or higher than that given with each change.

2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: 732A & 732A/AN
Print Date: May 1986
Rev.- Date: ---

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	6/86

ERRATA #1

On page 4-9, paragraph 4-38, following step 6, add the following NOTE:

NOTE

The 10V calibration potentiometer (accessable through a hole in the front panel) has a range of approximately +/-5 ppm. If this range is insufficient to calibrate the 732A 10V output to your standards, the appropriate jumpers on the A7 Calibration PCA must be made or opened. The A7 Calibration PCA is shown in Figure 5-1. Access the A7 Calibration PCA by first removing the top dust cover, then the top guard cover and finally the top foam block. With the 10V calibration potentiometer centered, note the deviation of the 732A 10V output from your standards in ppm. Cutting a jumper increases the 732A 10V output the amount labeled above the jumper. Likewise, completing a jumper decreases the output the amount of the jumper lable. After 10V output has been calibrated to your standards, the 1V and 1.018V outputs must also be calibrated.