731B

DC Reference Standard

Instruction Manual

P/N 405050
October 1974

FLUKE®

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Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 731B DC Reference Standard is an ultra-stable dc power supply which, when standardized, is capable of providing a variety of precision output voltages with standard cell accuracy. The 731B will furnish basic dc voltage outputs of 10V, 1V, ΔE (000 to 999 μV), 1.018 +ΔE, and 1.019 +ΔE.

1-3. The desired voltage mode is selected using a front panel function switch and the value of ΔE is adjustable using a 10-turn linear potentiometer. The front panel ΔE control includes a 3 digit turn counter to indicate the selected value of ΔE, i.e., 000 to 999 μV. The counter is equipped with a locking lever to prevent accidental changing of a selected ΔE setting.

1-4. A front panel guard connection is provided for use in reducing errors caused by common mode voltages. The guarded internal circuitry is isolated from the chassis and earth ground.

1-5. Power to operate the 731B can be derived from either an internal battery pack for field or portable use, or from the ac power line for bench use. A front panel meter indicates the relative charge level of the internal battery pack during portable use. The AC line requirements are 115/230V ac, 50 to 400 Hz.

1-6. The 731B is supplied with non-marring feet for bench or field use. It may also be conveniently mounted in a standard 19" equipment rack using one of the rack mounting accessory kits shown in Table 1-1.

Table 1-1. ACCESSORY RACK MOUNTING KITS

MODEL NUMBER	MOUNTING CONFIGURATION
M03-201-601	One 731B, Offset mounting
M03-202-603	Two 731B's, Side-by-side
M03-206-604	Three 731B's, Side-by-side
M03-205-605	Four 731B's, Side-by-side

1-7. SPECIFICATIONS

Output Voltage

Range	Output
10.0	10.0V dc
1.0	1.0V dc
1.018 +ΔE	1.018 to 1.018999V dc
1.019 +ΔE	1.019 to 1.019999V dc
ΔE	0 to 999 μV dc with 1 μV resolution

Output Accuracy: Absolute accuracy at 23°C ±1°C after 30 minute warm-up

Range	Period		
	30 days	90 Days	1 Year
10V	±10 PPM	±15 PPM	±30 PPM
1V	±10 PPM	±15 PPM	±30 PPM
1.018+ ΔE	±10 PPM	±15 PPM	±30 PPM
ΔE			±2 uV

Transfer Accuracy: 4 Hr

Between standard cells on 1.018V + ΔE or 1.019V + ΔE ranges: 2 ppm

Between standard cell and 1V output: 3 ppm

Between 10V output and standard cell or 1V output: 5 ppm

Temperature Coefficient:

Less than 1 PPM/C°, 10°C to 45°C
Less than 2 PPM/C°, 0°C to 10°C and 45°C to 55°C

Output Current:

10 Volt Range:
The 10 volt range is used in applications where some degree of loading is placed on the Reference Transfer Standard such as a Kelvin Varley Divider or other resistance networks.

Loading Effect on the 10V Range:

Load R.	Output Change (PPM)
100 MΩ	0
10 MΩ	0.005 ≈ 0
1 MΩ	.05
0.1 MΩ	.5
10 KΩ	5

1V, 1.018V, 1.019V Ranges:

The Reference Transfer Standard is designed to perform as a standard cell and therefore is intended to operate into a high impedance on the 1V, 1.018V and 1.019V ranges drawing minute currents. This impedance is usually infinity as in potentiometric circuits, or, in other applications should be at least 100 Megohms to prevent source loading.

Source Resistance:

10V Range	<0.07Ω
1V, 1.018V, 1.019V, ΔE Ranges:	< 1 kΩ

Output Protection:

The output may be shorted indefinitely without damage to instrument.

Line Regulation:

Less than 1 PPM for ±10% line variation.

Ripple & Noise:

Less than 1 PPM P-P dc to 1 Hz
Less than 20 μV RMS 1 Hz to 1 MHz
Except <70 μV RMS @ 10V output

Common Mode Rejection:

120 db at DC
100 db at 60 Hz
85 db at 400 Hz

Isolation:

Output may be floated up to 500 VDC between chassis ground and guard.

Calibration Adjustment:

Separate internal adjustments for the 5 output voltages. Front panel adjustment common to all voltages including the 10.000V output. Basic reference adjustments accessible from the front panel.

Temperature/Humidity:

+0°C to +55°C operating.
−40°C to +60°C non-operating.
Up to 70% RH for temperatures ≤35°C

Shock & Vibration:

Meets requirements of MIL-T-21200L

Terminals:

Four five-way binding posts for positive, negative, ground and guard. Positive and negative are solid copper with gold flash.

Battery Operation:

Rechargeable nickel-cadmium batteries provide at least 30 hours of continuous operation.

Input Power:

115V or 230V ±10V ac, 50 to 400 Hz single phase or internal battery operation.
6 watts maximum, 120 Ma maximum

Size:

3½" high x 4¼" wide x 12" deep. (8.8 x 10.7 x 30.4 (8.8 x 10.7 x 30.4 cm)

Weight:

5 lbs (2.26 kg)

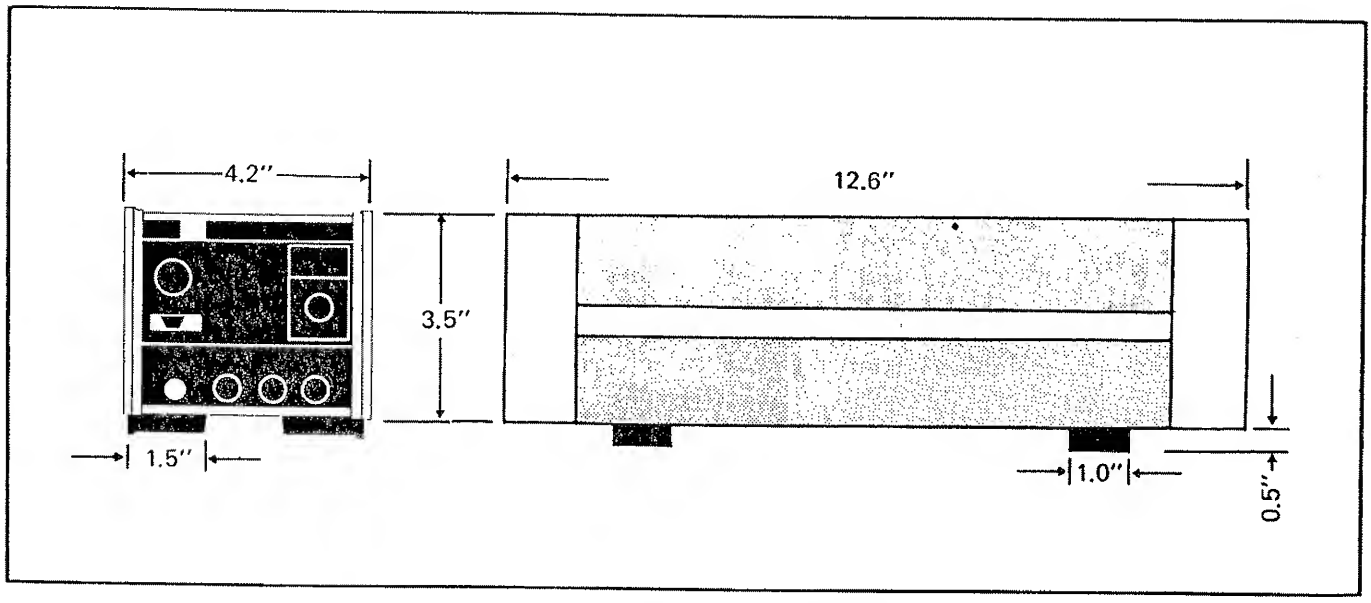

Figure 1-1. 731B OUTLINE DRAWING

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the Model 731B DC Reference Standard. It is recommended that the contents of this section be read and understood before any attempt is made to operate the 731B. Should any difficulties arise during operation, please contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of Sales Representatives is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 731B is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-5. If reshipment of the equipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the equipment model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 731B can be operated from a 115 or 230V ac, 50 to 400 Hz power line. Before connecting the instrument to the power line, check and, if necessary, set the instrument to operate at the local line voltage as follows:

a. Remove the top cover from the 731B and locate the input power selection switch on the inside of the 731B.

b. Set the slide switch to the desired operating voltage, 115(white dot) or 230 (red dot).

c. Install the proper fuse (i.e., AGC ½A for 115V ac and AGC ¼A for 230V ac) in the rear panel fuse holder.

2-8. The rear panel input power connector is a three prong, U-ground connector which permits the instrument to be connected, via the power cord, to the appropriate line power. The offset prong on this connector is connected to the 731B chassis and power supply, and should be connected, via the power cord, to a high quality earth ground.

2-9. RACK INSTALLATION

2-10. The 731B is designed for bench-top use or for installation in a standard 19-inch equipment rack, using one of the optional accessory rack mounting kits. Information regarding rack installation procedures is given in Section 6 of this manual.

2-11. OPERATING FEATURES

2-12. The 731B controls, indicators and connectors are shown in Figure 2-1, and described in Table 2-1.

2-13. OPERATING NOTES

2-14. The following paragraphs describe various conditions which should be considered before operating the 731B.

2-15. Guarded Operation

2-16, The 731B is equipped with a guard that isolates its internal circuitry from the chassis and earth ground. A GUARD terminal is provided on the fornt panel, and when used, greatly reduces errors caused by common mode voltages. In general, guarded operation will be necessary under the following conditions:

a. When a potential exists between equipment power line grounds.

b. When long connecting leads are used to contact a high impedance load.

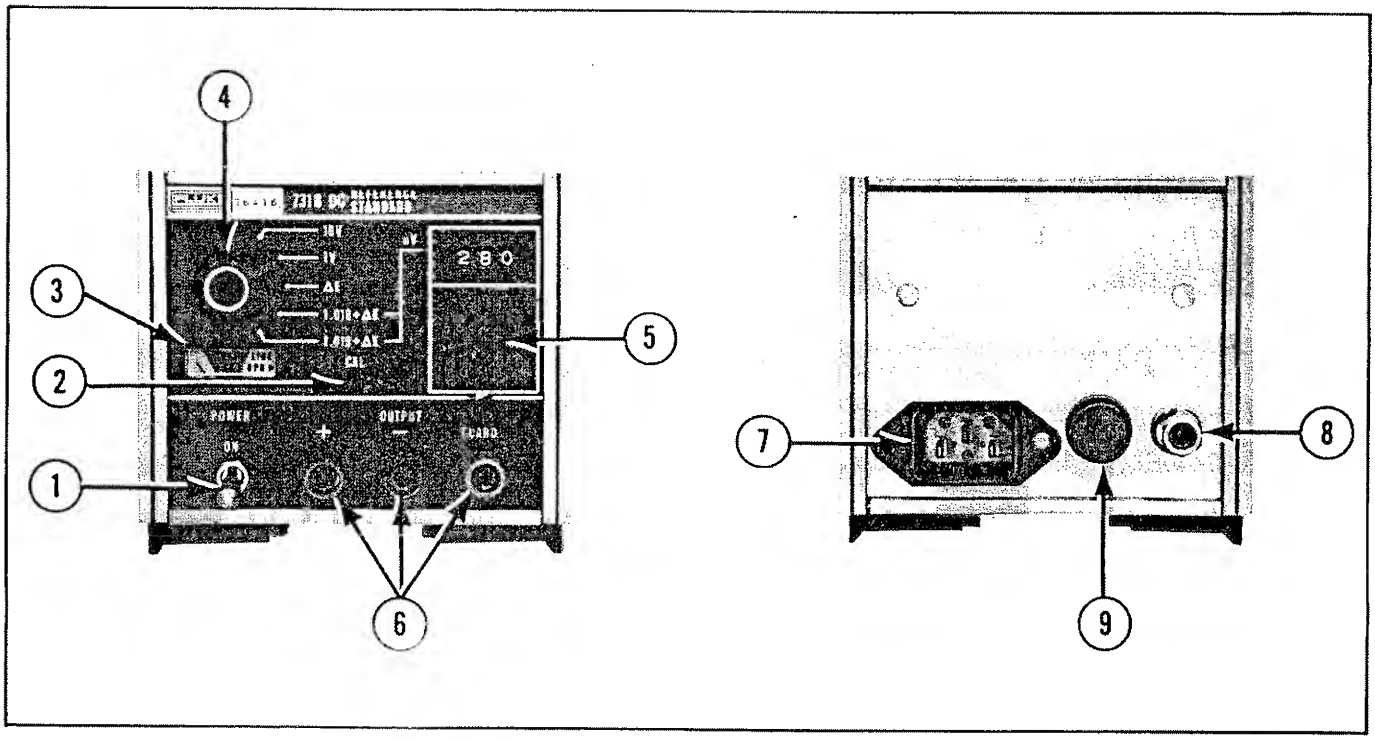

Figure 2-1. 731B CONTROLS, INDICATORS AND CONNECTORS

Table 2-1. 731B CONTROLS, INDICATORS AND CONNECTORS

REF. NO.	NAME	FUNCTION
1	POWER Switch	Switches the instrument on and off. When in the ON position, the Battery Charge Meter indicates line operation or battery charge level. Switch position can only be changed while activator is pulled out.
2	CAL Potentiometer	Provides the adjustment necessary to standardize the 731B (all modes) to an external standard cell.
3	Battery Charge Meter	Indicates power - on (LINE OPR) when the instrument is being operated from the power line. During battery operation, the meter indicates the relative charge level of the internal battery pack.
4	Mode Switch	Selects the operating mode used to supply voltage to the + and – OUTPUT terminals: 10V . . . . Provides a fixed 10V dc output. 1V . . . . Provides a fixed 1V dc output. ΔE . . . . Provides an adjustable+000 to +999 μVdc output in 1 μV steps. 1.018 +ΔE . . Provides an adjustable +1.018000 to +1.018999 Vdc output. This mode is used to standardize to 731B to a standard cell whose voltage falls within the adjustable range. 1.019 + ΔE . . Provides an adjustable +1.019000 to +1.019999V dc output. This mode is used to standardize the 731B to a standard cell whose voltage falls within the adjustable range.
5	ΔE vernier Control	A vernier control which provides the manual ΔE adjustment. The control is equipped with a three decade digital readout to permit exact settings from 000 to 999 μV dc.
6	OUTPUT Terminals	Provides front panel connection to the 731B output and guard circuits. + and – . . . . . Voltage output terminals GUARD . . . . . Provides connection to the internal guard circuit and is used to reduce the effects of common mode voltages.
7	Input Power Connector	Provides the means of connecting the instrument through the power cord to line power.
8	Ground Terminal	Provides a convenient ground point during battery operation.
9	Fuse	Protects the ac input section of the power supply.

c. When operating the instrument in the presence of high level radiated noise, e. g., stay fields at the power line frequency.

2-17. One of the most common cases requiring guarding is that of differences in power line grounds. When the 731B is connected to another instrument, with both instruments grounded through their respective power cords, a potential difference may exist between the power line grounds of these two instruments. This potential difference can cause circulating ground currents which could cause errors in the output voltage. To prevent these errors from occurring, the 731B GUARD terminal should be connected to the load in such a manner as to provide a separate path for circulating ground currents. For proper connection, connect GUARD terminal directly to grounded side of load, at the load. Figure 2-2 illustrates correct GUARD terminal connection and the rerouted ground currents.

2-18. Battery Operation

2-19. The rechargeable nickel-cadmium battery provides at least 30 hours of continuous operation before recharging is required. Batteries are automatically trickle charged whenever the instrument is operating from the ac line. Recharging of completely discharged batteries requires approximately 12 hours.

NOTE

A ground terminal on the rear of the 731B provides a convenient method of grounding the instrument during battery operation.

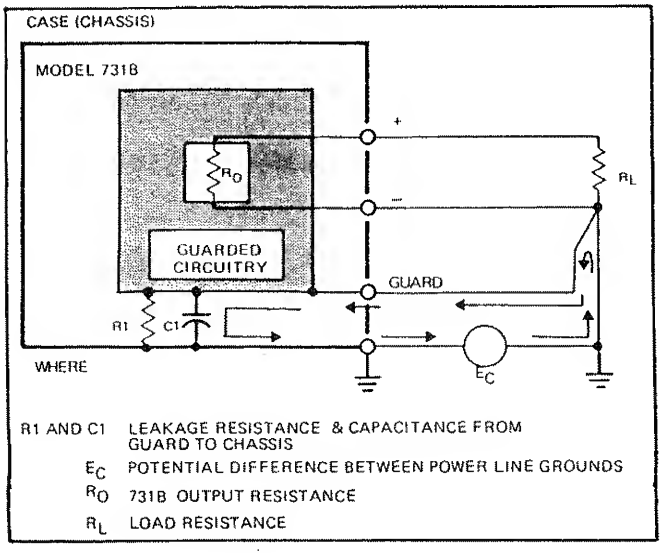

Figure 2-2. GUARD CONNECTION

2-20. OPERATION

2-21. Turn-On Procedure

2-22. Use of the following procedure is suggested for initial turn-on of the 731B:

a. Connect the instrument to ac line power (See paragraph 2-6). This step is not necessary if battery operation is desired.

b. Set the POWER switch to the ON position.

NOTE

The POWER switch actuator must be pulled out before the switch position can be changed.

c. Ensure that the instrument is energized by observing the indication shown on the battery charge meter. For line operation, the meter should indicate BAT OK. If the meter indication falls below BAT OK, the battery pack should be recharged.

2-23. Standard Cell Transfer

2-24. When standardized to an external standard cell, the selected 731B output will be within 2 ppm of the standard cell voltage. Stability is better than 10 ppm per month. Use the following procedure to standardize the 731B.

a. Energize the 731B and allow a 30-minute warm-up period.

b. Obtain a certified standard cell and note its voltage.

c. Set the mode switch to (1.018 + ΔE) or (1.019 + ΔE) whichever includes the equivalent of the standard cell voltage.

d. Connect the standard cell and a null detector (Fluke 845AB or equivalent) to the 731B as shown in Figure 2-3.

e. Adjust the ΔE control so that the mode switch setting pluse the ΔE setting is equal to the standard cell voltage.

f. Adjust the front panel CAL potentiometer for an optimum null.

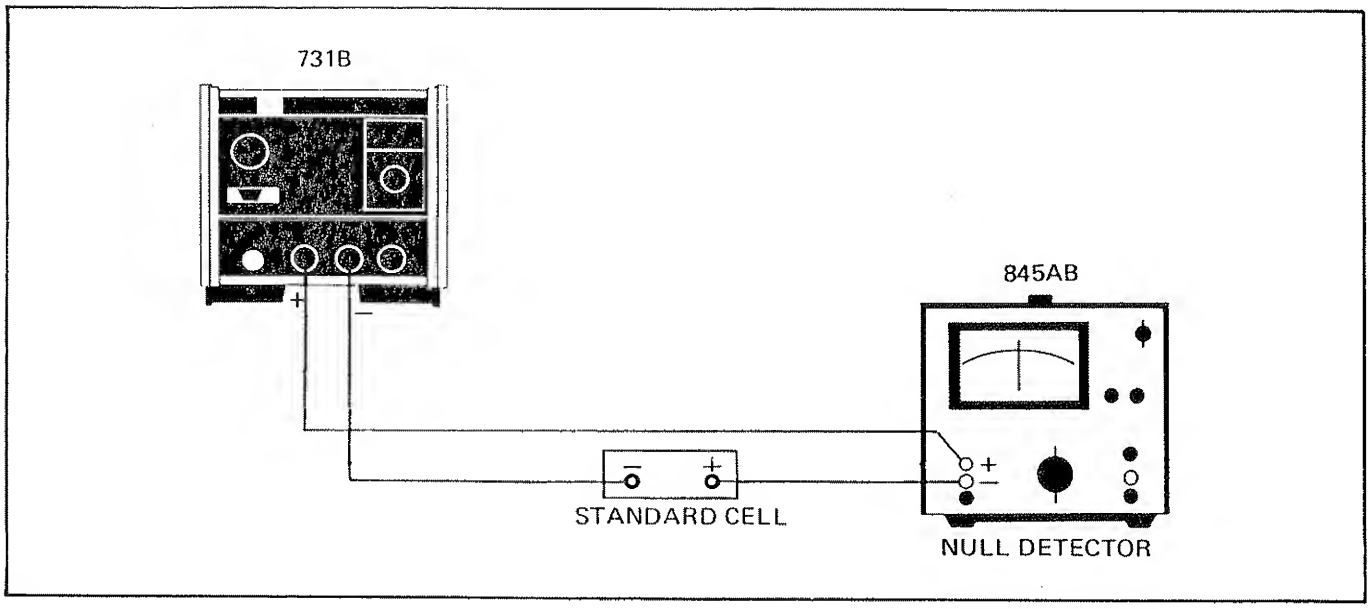

Figure 2-3. STANDARDIZING THE 731B.

g. Disconnect the standard cell and the null detector form the 731B OUTPUT terminals.

2-25. Reference Voltage Modes

2-26. A standardized 731B can be used to provide either a ΔE, a 1 volt or a 10 volt output with standard cell transfer accuracies of 2 ppm, 3 ppm or 5 ppm, respectively. For example, standardizing the 731B to a standard cell having an absolute accuracy of 3 ppm would provide a 10 volt reference output which is accurate to 8 ppm (3 ppm standard cell accuracy + 5 ppm 731B transfer accuracy) or 0.0008%.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description followed by a detailed block diagram analysis of the Model 731B DC Reference Standard. Simplified block diagrams and circuit diagrams are included as necessary, to supplement the text.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The 731B, is an ultra-stable dc power supply which, when standardized, is capable of providing either a standard 1 volt, 10 volt or 000 to 999 microvolt output. The desired output voltage is selected by the Mode switch, and in the ΔE mode the output is adjustable using the ΔE vernier control. The resistor networks in the Output Divider scale a fixed precision dc voltage from the Reference Supply to provide the output voltage selected by the Mode switch setting. Operating voltage for the Reference Supply is derived from the Charging Circuit. Either ac line power or the battery pack can be used to provide the unregulated operating voltage to the Reference Supply. When using the ac line, the charging circuits also charge the battery pack.

3-5. BLOCK DIAGRAM ANALYSIS

3-6. General

3-7. A block diagram analysis of the functional circuits of the 731B is given in the following paragraphs. The circuits described correspond to the functional blocks defined in Figure 3-1. Detailed schematics are included in Section 8 of this manual.

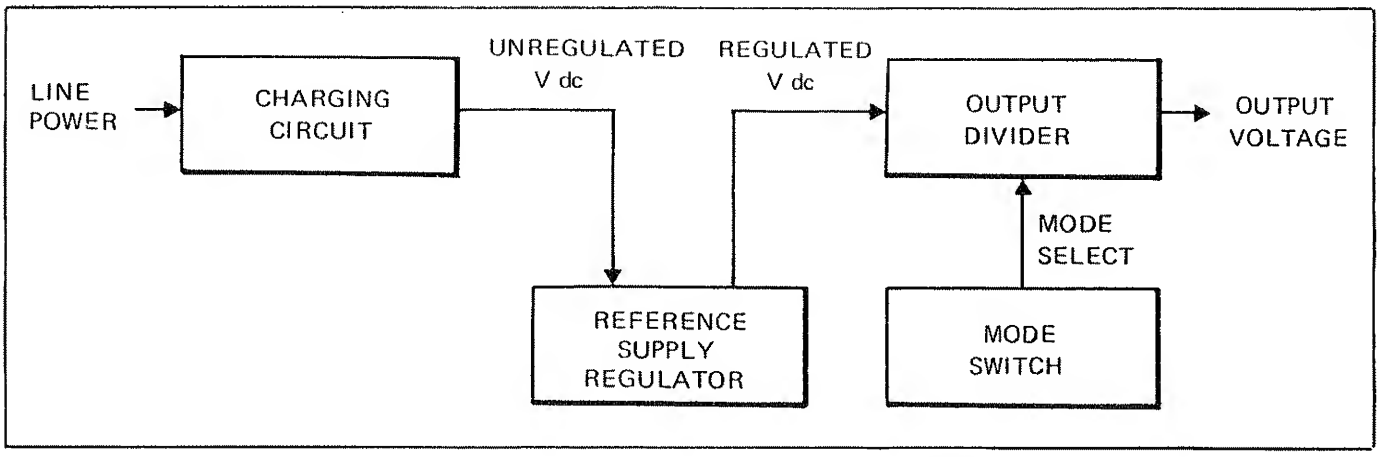

Figure 3-1. 731B SIMPLIFIED BLOCK DIAGRAM.

3-8. Charging Circuit

3-9. The Charging Circuit is included on the A3 Power Supply PCB and consists of a full wave rectifier CR12, series pass transistor Q3 and the associated components. The function of the charging circuit is two-fold, and depends on whether the 731B is being operated from the ac power line or the battery pack. In the line power configuration, the output of transformer A4T1 is rectified by CR12 before being used to supply the raw input voltage to the series-pass regulator Q3. Since the rectified output of CR12 exceeds the battery pack voltage, a trickle charge is delivered to the batteries, through CR5 and R30. When the 731B is disconnected from the ac power line, it is operated from the internal Ni-cad battery pack. In this configuration, the series regulator is by-passed and the battery output is delivered directly to the output of the charging circuit via diode CR8.

3-10. The meter circuit is calibrated to indicate the relative battery charge level during battery operation, and full scale during line operation. Resistors R31 and R32 are used to set the meter indication during battery operation. For line operation diode CR7 and R34 provide the extra drive necessary for a full scale indication.

3-11. Reference Supply

3-12. The Reference Supply (included on the Reference Regulator PCB) consists of a compensated zener reference amplifier U2, operational amplifier U1, transistors Q1 and Q2, and their associated circuitry. The function of the Reference Supply is to regulate the output voltage supplied by the charging circuit, and to provide a precisely regulated +10V dc output signal. Reference amplifier U2 functions as the primary element in the Reference Supply and is shown in Figure 3-2. It contains a silicon NPN transistor connected in series with a zener diode and both are mounted on a common substrate which is enclosed in a single envelope. The reference voltage, V ref, is the sum of the zener voltage, V_Z, and the transistor's base-to-emitter voltage V_{be}. Temperature variations affecting V_Z are compensated for by corresponding changes in V_{be}.

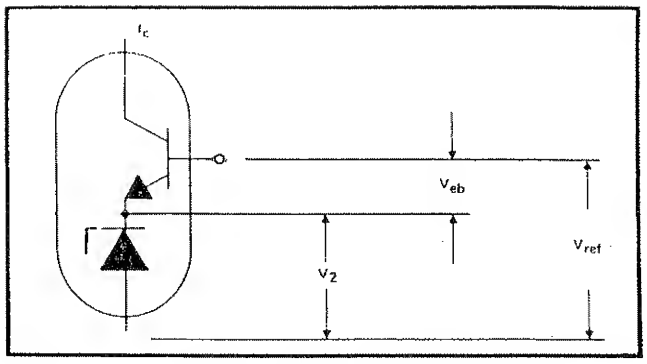

Figure 3-2. REFERENCE AMPLIFIER

3-13. In operation, the Reference Supply acts as a simple series pass regulator, with Q1 acting as the series pass element. Regulation is accomplished by the action of U2 which compares its internal reference voltage with the output voltage and adjusts the base drive of Q1, via amplifier U1, until both voltages are equal. Short circuit protection is provided by current sensing resistor R28 and transistor Q2. Potentiometer R11 is the front panel CAL adjust used to standardize the reference supply. The output of the supply, when standardized, is exactly +10V dc.

3-14. Output Divider

3-15. The 731A output voltage is selected by means of the front panel mode switch and a series of resistive dividers attached to the Reference Supply output. In the 10V mode the Reference Supply output is connected directly to the OUTPUT terminals. In all other modes the +10V reference voltage is reduced by a voltage divider before being made available at the OUTPUT terminals. Separate calibration potentiometers are provided for each of the selectable modes. The 1V output is adjusted by R19 and the 1.018 and 1.019 V outputs are adjusted by R17 and R15, respectively. The ΔE output is calibrated by R24, and is adjustable from 000 to 999 μV using the front panel ΔE vernier control (A1R1). In the 1.018 +ΔE and 1.019 + ΔE modes the ΔE divider is operated in conjunction with the 1.018 and 1.019 dividers. In the ΔE mode, the ΔE divider operates independently.

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information for the Model 731B DC Reference Standard. This includes service information, general maintenance, performance test, calibration and troubleshooting information. The performance test is recommended as a preventative maintenance tool, and should be executed every 90 days to verify proper instrument operation within the specifications given in Section 1. A calibration interval of 90 days is recomended to ensure that the instrument remains within these specifications. Table 4-1 lists the equipment required for the performance test and calibration.

4-3. SERVICE INFORMATION

4-4. Each instrument that is manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is given on the back of the title page located in the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these service centers is included with the

Table 4-1. REQUIRED TEST EQUIPMENT

EQUIPMENT NOMENCLATURE	RECOMMENDED EQUIPMENT
Null Detector	Fluke Model 845AB
DC Differential Voltmeter	Fluke Model 895A
True RMS Differential Voltmeter	Fluke Model 931B
DC Voltage Source	Fluke Model 341A DVM Calibrator
Standard Cell	Guildline Instruments Model 9152/P4
X1000 Amplifier	– – – – – – –
Voltage Divider	Fluke Model 720A Kelvin-Varley Voltage Divider
Low-Thermal Switch	Leeds & Northrup Type 3702 Tapping Key
Autotransformer	General Radio W5MT3A or W10MT3A

WARRANTY. Shipping information is given in the operating instructions section of this manual. If requested, an estimate will be provided to the customer before work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Access Information

4-8. Use the following procedure to gain access to the interior of the instrument (See Figure 4-1):

a. Remove the top dust cover.

b. Remove the guard cover.

c. Remove the bottom dust cover.

4-9. Cleaning

4-10. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

a. Clean the surface of all PCB's using clean dry air at low pressure ($\leqslant$ 120 psi). If grease is encountered, spray with Freon T.F. Degreaser and remove grime with clean dry air at low pressure.

b. Clean the front panel with a soft cloth dampened with a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel of the 731B.

4-11. Fuse Replacement

4-12. The power fuse F1 is located on the rear panel of the Model 731B. If replacement is necessary, use the following rated fuses:

a. 115 Volt operation – AGC ½ Ampere

b. 230 Volt Operation – AGC ¼ Ampere

4-13. Service Tools

4-14. No special tools are required to maintain or repair the 731B.

4-15. PERFORMANCE TEST

4-16. The performance test is designed to verify the overall operation of the 731B. This test can be used as an acceptance check and/or periodic maintenance check. Table 4-1 lists the equipment required to perform this test. If the unit fails any part of the performance test, corrective action is indicated. Tests should be conducted at an ambient temperature of 25°C ±5°C and a relative humidity of less than 70%. Allow a 30 minute warm-up period prior to conducting the performance test.

4-17. Line Regulation

a. Connect equipment as shown in Figure 4-2.

b. Adjust the autotransformer for an output voltage of 115V ac.

c. Zero the 845AB on the 1 microvolt range, then set it to the 10 microvolt range.

d. With the test switch open, adjust 731B output to equal the standard cell voltage.

e. Close the switch and adjust 731B output for null on the 845AB.

f. Vary autotransformer output from 115 to 105V ac and from 115 to 125V ac. The 845AB indication should not change more than ±1 microvolt.

g. Set the variac output to 115V ac.

4-18. Output Noise, DC to 1 Hz.

a. Connect equipment as shown in Figure 4-2.

b. Zero the 845AB on the 1 microvolt range, then set it to the 10 microvolt range.

c. Adjust 731B output for null on 845AB.

d. Observe the random voltage excursions indicated on the 845AB over a 10 second period. Excursions should be less than 1 microvolt peak to peak.

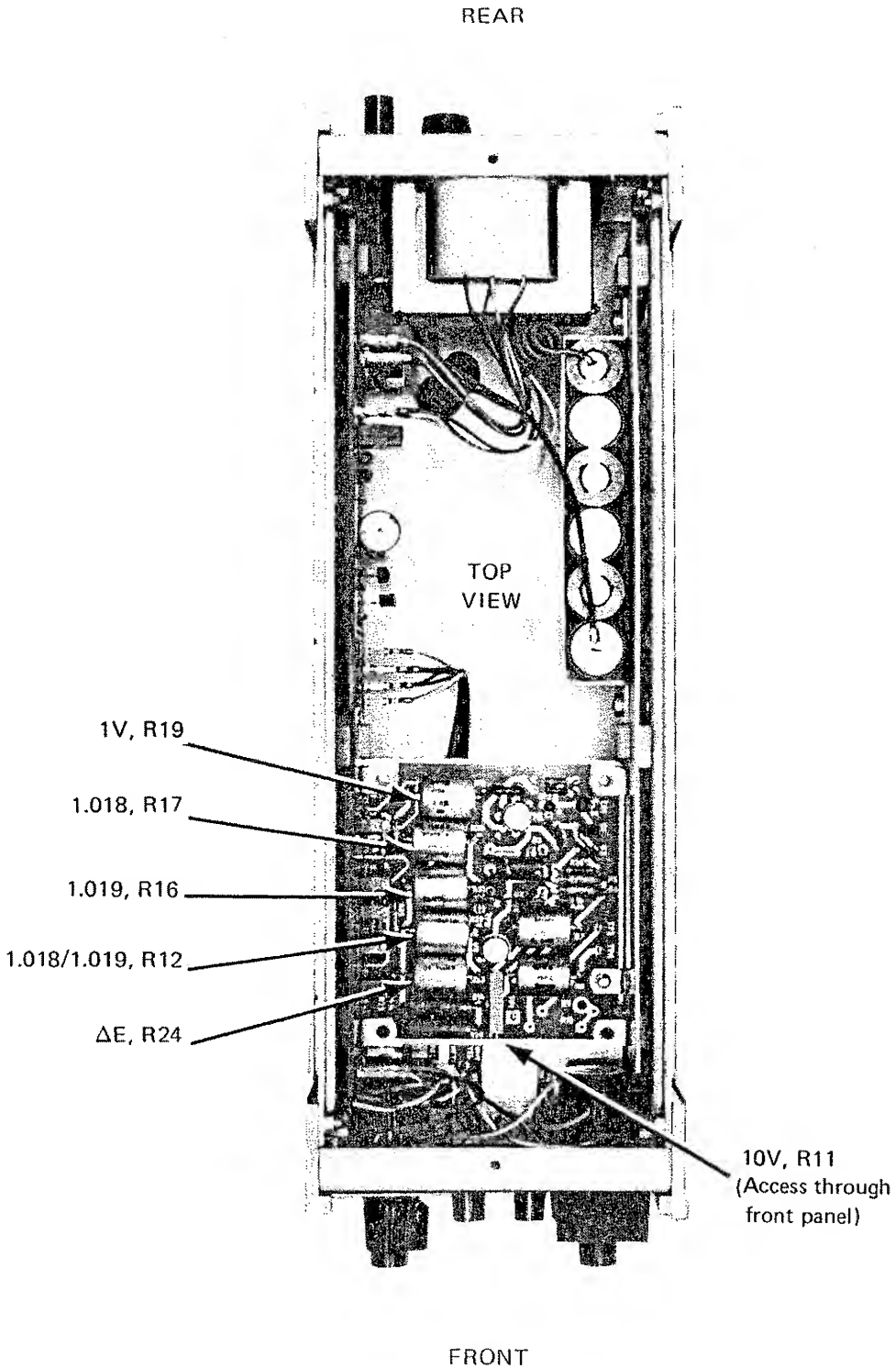

Figure 4-1. ADJUSTMENT LOCATIONS.

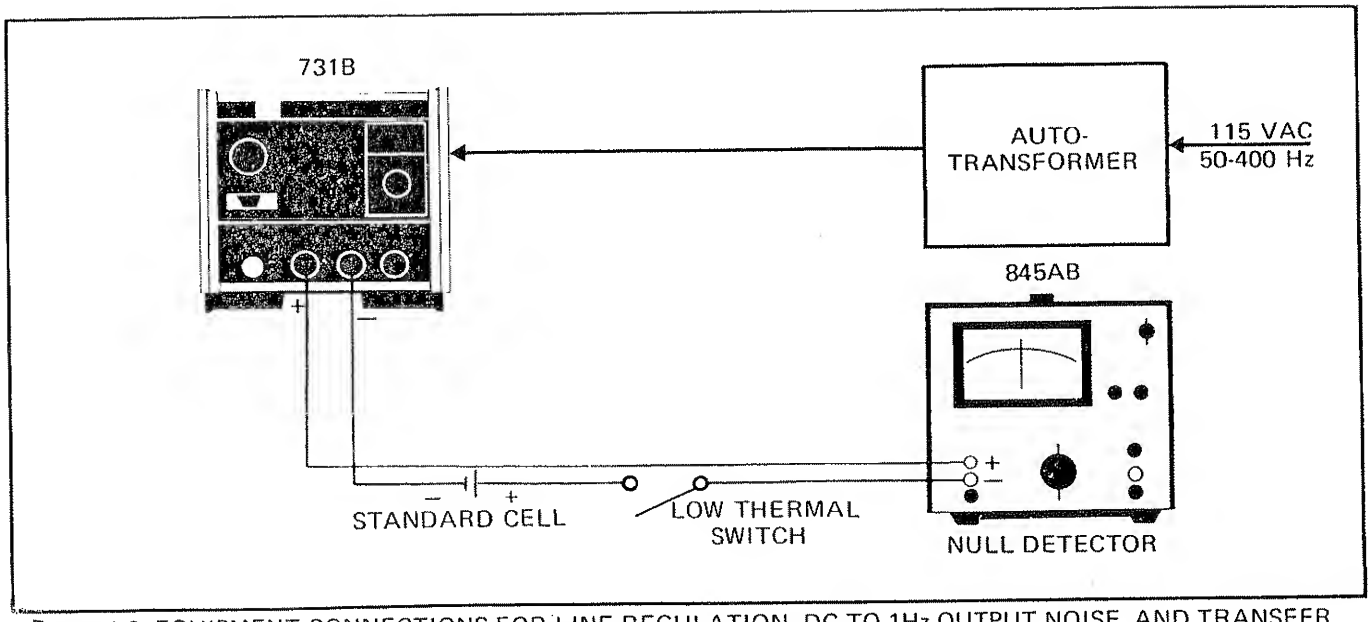

Figure 4-2. EQUIPMENT CONNECTIONS FOR LINE REGULATION, DC TO 1Hz OUTPUT NOISE, AND TRANSFER ACCURACY TESTS.

4-19. Output Noise, 1 Hz to 1 MHz

a. Connect equipment as shown in Figure 4-3.

b. Set 931B range to 100 millivolts, mode switch to TVM X1.

c. Set 731B output to 1.018000 volts. The 931B should indicate less than 20 millivolts rms, which represents 20 microvolts output from the 731B.

4-20. Common-Mode Rejection

a. Connect equipment as shown in Figure 4-4.

b. Set 341A for zero volts output.

c. Set 731B output to 1.018000 volts.

d. Set 895A range to 1 volt,null sensitivity to 100 microvolts, and readout dials for null indication.

e. Set 341A output to 100 volts. The 895A meter indication should be zero ±100 microvolts.

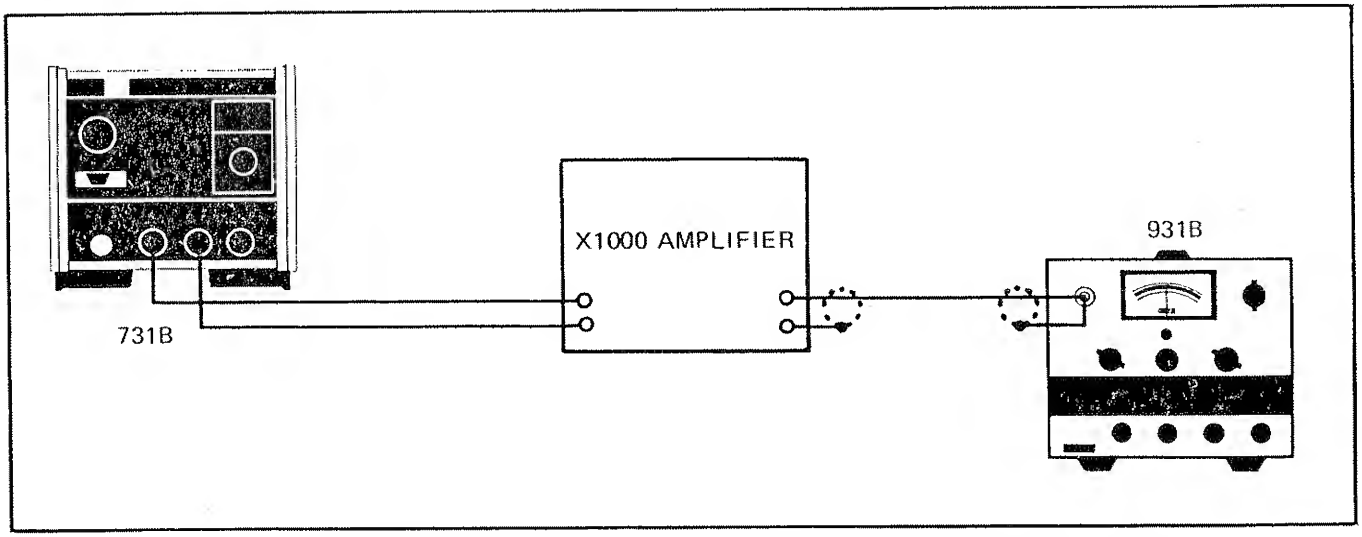

Figure 4-3. EQUIPMENT CONNECTIONS FOR 1 HZ TO 1 MHZ OUTPUT NOISE TEST.

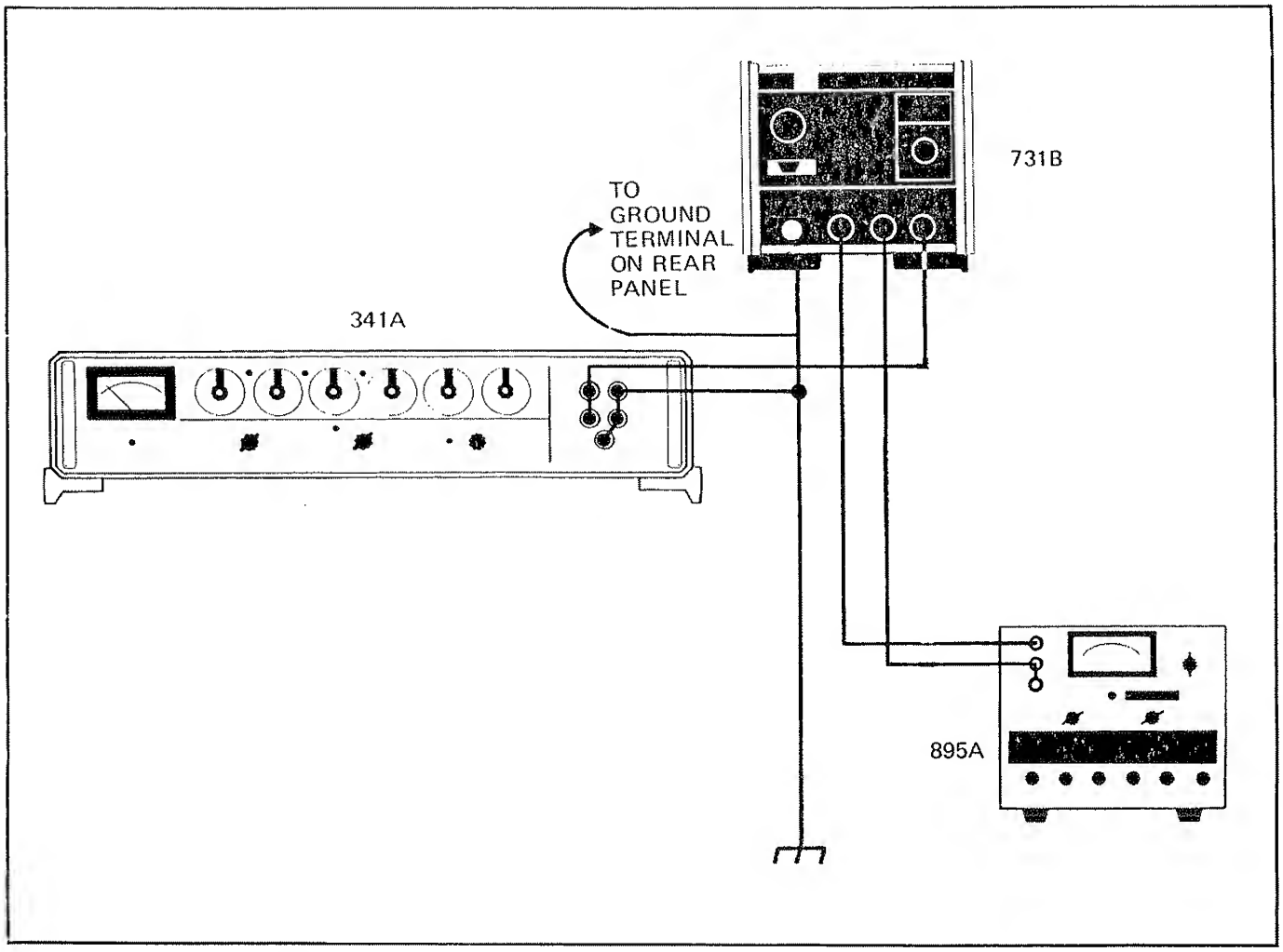

Figure 4-4. EQUIPMENT CONNECTIONS FOR COMMON-MODE REJECTION TEST.

4-21. Isolation

a. Turn off the 731B and disconnect it from the power line.

b. Connect the negative output terminal of the 341A to the guard terminal of the 731B and the positive output terminal of the 341A to case (ground) of the 731B.

c. Set 341A output to 500 volts. The 341A meter should indicate no discernable current flow.

d. Repeat steps (b) and (c) for the positive output terminal of the 731B.

e. Repeat steps (b) and (c) for the negative output terminal of the 731B.

4-22. Transfer Accuracy

a. Connect equipment as shown in Figure 4-2.

b. Zero 845AB on the 1 microvolt range, then set it to the 10 microvolt. range.

c. With the switch open, adjust 731B output to equal standard cell voltage.

d. Close the switch and adjust 731B output for null on the 845AB.

e. Lock the ΔE control on the 731B.

f. Open the test switch, remove all test leads from the setup, and allow the 731B to operate for 20 minutes.

g. Reconnect equipment and check 731B output for null against standard cell. The 845AB should indicate less than ±2 microvolts deviation from null (zero).

Table 4-2. 731B CALIBRATION

STEP	EQUIPMENT CONNECTIONS	731B CONTROL SETTINGS		720A DIAL SETTINGS	845 AB RANGE	341A OUTPUT (VDC)	CALIBRATION INSTRUCTIONS
		FUNCTION	ΔE				
1	Figure 4-5	10V	Any	1.0000000	10 uV	11	Adjust 341A output for zero (± 10 uV) on the 845AB
2		1V		.1000000	1 uV	As set in step (1).	Adjust the "1V Cal" control (R19) for zero (±1 uV) on the 845AB.
3		1V		1.0000000	1 uV	1.1	Adjust 341A output for zero (± 1 uV) on the 845AB
4		1.018 + ΔE	000	1.0180000	1 uV	As set in step (3)	Adjust the "1.018 Cal" control (R17) for zero (±1 uV) on the 845AB.
5		1.019 + ΔE		1.0190000	1 uV	As set in step (3).	Adjust the "1.019 Cal" control (R15) for zero (±1 uV) on the 845AB.
6		1.019 + ΔE	999	1.0199999	1 uV	As set in step (3).	Adjust the "1.018/1.019 + ΔE Cal" control (R12) for zero (±1 uV) on the 845AB.
7		ΔE		.000999	1 uV	As set in step (3).	Adjust "ΔE Cal" control (R24) for zero (±1 uV) on the 845AB.
8	Figure 4-6	Set to standard cell voltage.		-----	1 uV	----	Adjust front panel "CAL" control (R11) for zero (±1 uV) on the 845AB.

4-23. CALIBRATION

4-24. The calibration procedure for the 731B is given in Table 4-2. A description of equipment required for calibration is given in Table 4-1. Calibration should be performed with ambient temperature at +23°C ±1°C and relative humidity less than 70%. Adjustment locations are shown in Figure 4-1.

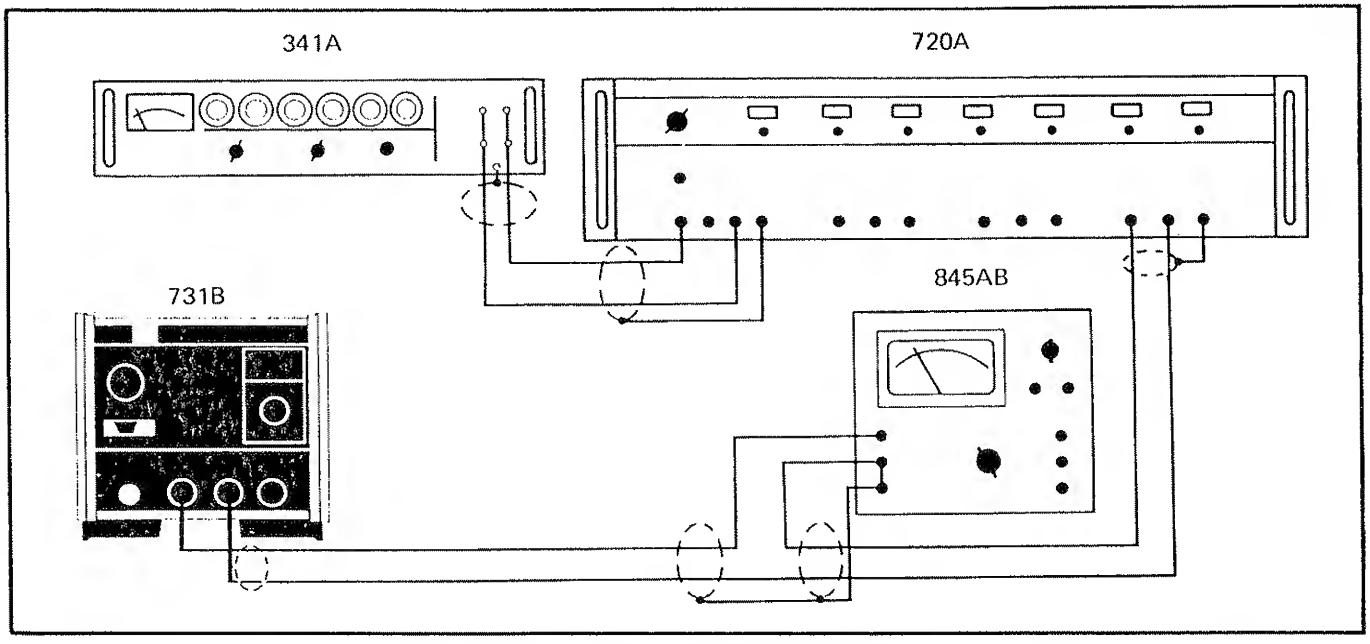

Figure 4-5. EQUIPMENT CONNECTIONS FOR DIVIDER ADJUSTMENT

4-25. TROUBLESHOOTING

4-26. Before attempting to troubleshoot the 731B, it should be verified that the trouble is actually in the instrument and is not caused by faulty external equipment or connections. Then the performance test should be executed to localize the problem.

4-27. Check output voltages at each position of the function switch. The 10V output must be correct or all voltages will be incorrect. If the 10V output is correct but one or more other outputs are incorrect, check calibration of the divider associated with the faulty output and check for proper resistance values in the divider.

4-28. The voltage at the collector of Q1 should be approximately 17V dc for line operation and 14V dc for battery operation. If these voltages are correct but the 10V output is incorrect, either U1 or U2 in the Reference Supply is defective.

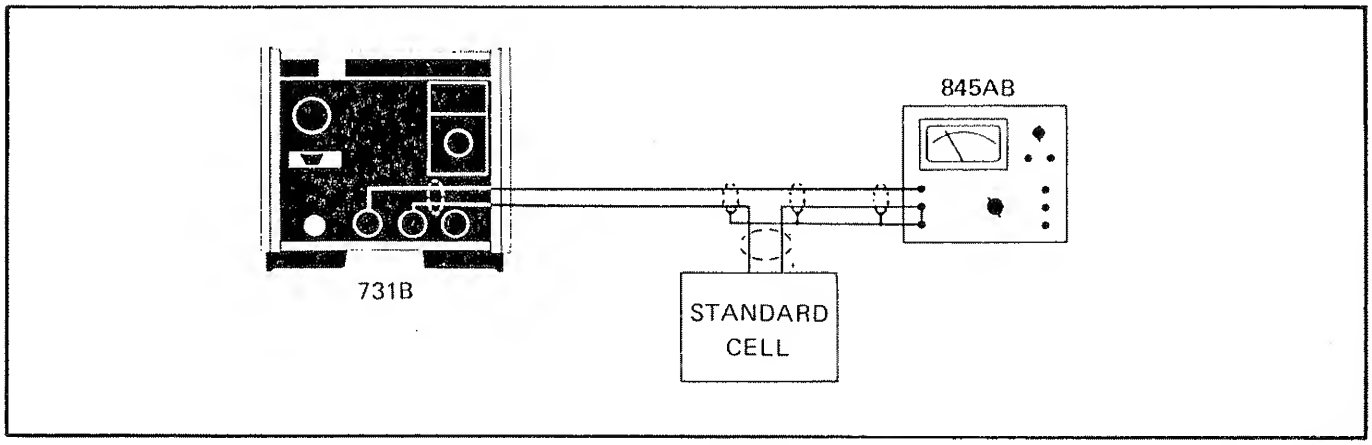

Figure 4-6. EQUIPMENT CONNECTIONS FOR ABSOLUTE VOLTAGE ADJUSTMENT

Section 5

Lists of Replaceable Parts

TABLE OF CONTENTS

5-1. INTRODUCTION

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

5-3. Parts lists include the following information:

a. Reference Designation or Item Number.

b. Description of each part.

c. Fluke Stock Number.

d. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)

e. Manufacturer's part Number or Type.

f. Total Quantity per assembly or component.

g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.

h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

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

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

a. Quantity

b. FLUKE Stock Number

c. Description

d. Reference Designation or Item Number

e. Printed Circuit Board Part Number

f. Instrument model and serial number.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSEMBLY, Model 731B Figure 5-1						
A 2	Reference, Regulator Assembly	390195	89536	390195	1		
A3	Power Supply & Adjustment Assembly	390187	89536	390187	1		
BT1	Battery pack	306134	89536	306134	1		
F1	Fuse, ½ amp, fast acting	153858	71400	Type AGC	1		
J1	Binding post, red	380147	32767	820 - 55	1		
J2	Binding post, black	380154	32767	820 - 65	1		
J3	Binding post, blue	275578	32767	820 - 45	1		
M1	Meter, 0 - 1 mA	266494	32539	Type TS10	1		
R1	Res, var, ww, 5k ±5%, 2W	295626	80294	3509S9-502	1		
S1	Switch, rotary	284414	89536	284414	1		
S2	Switch, toggle	402537	83979	MSTL206N	1		
T1	Xfmr	390872	89536	390872	1		
XF1	Fuseholder	100107	71400	HKP	1		
J4	Binding post, grounding	155911	58474	GP30NC	1		
1	Corner	295972	89536	295972	4		
2	Cover, reference regulator	390351	89536	390351	1		
3	Decal, front	357970	89536	357970	1		
4	Dial, counting	295642	13511	1381	1		
5	Guard, right side	390344	89536	390344	1		
6	Knob	341453	89536	341453	1		
7	Panel, front	296814	89536	296814	1		
8	Panel, rear	390377	89536	390377	1		
9	Receptacle, conn.	267542	00779	367542	16		

FINAL ASSEMBLY

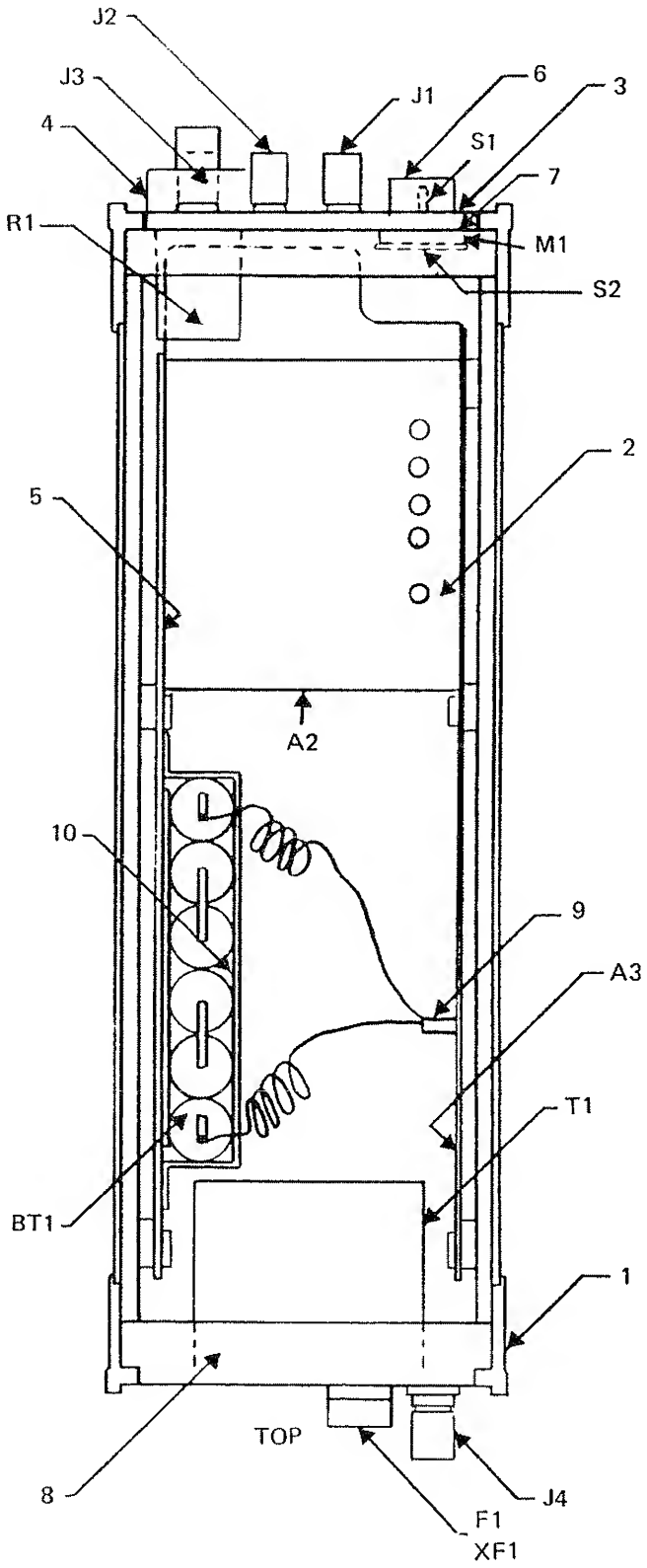

Figure 5-1 731B FINAL ASSEMBLY

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
10	Strap, battery	296822	89536	296822	1		
	Chassis, side	390385	89536	390385	2		
	Cover, bottom	301572	89536	301572	1		
	Cover, top	390385	89536	390385	2		
	Foot	292870	89536	292870	1		
	Retainer, meter	307322	89536	307322	1		

REFERENCE-REGULATOR PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	REFERENCE-REGULATOR PCB ASSEMBLY (731B-4011) Figure 5 - 2	390195	89536	390195	REF		
C1	Cap, ta, 1 uF ±20%, 35V	161919	56289	196D105X0035	1		
C2	Cap, mica, 100 pF ±5%, 100V	148494	14655	CD15FD101J03	1		
C3 C4	Cap, cer, 0.01 uF ±20%, 100V	149153	56289	C023B101F103M	1		
C4	Cap, mylar, 0.01 uF ±10%, 250V	161992	73445	C280AEA100K	1		
CR1	Diode, zener, 5.6V	277236	07910	1N752A	1		
CR2	Diode, FET, current regulator	348482	17856	E505	1		
Q1,Q2	Xstr, Si, PNP	218396	04713	2N3904	2		
R1	Res, comp, 100 ±5%, ¼W	147926	01121	CB1015	1		
R2	Res, ww, 4.22k ±5%, ½W	311761	89536	311761	1		
R3	Res, ww, 10k ±0.05%, ½W	195776	89536	195776	1		
R4	Res, ww, 1.27k ±1%, ½W	341628	89536	341628	1		
R5, R6, U2	Ref Amplifier set	346270	89536	346270	1		
R7, R8	Ref Amplifier Divider set	346304	89536	346304	1		
R11	Res, var, 100 ±20%, ½W	267823	71450	190PC101B	1		
R13	Res, ww, 412k ±5%, ½W	311753	89536	311753	1		
R14	Res, met film, 845k ±1%, 1/8W	221671	91637	MFF1-88453F	1		
R16	Res, met film, 31.6k ±1%, 1/8W	312660	91637	MFF1-83162F	1		
R18, R26	Res, met film, 4.5M ±1%, ½W	346981	91637	MFF1-24504F	2		
R20 thru R23	Res, divider set	391417	89536	391417	1		
R25	Res, met film, 845 ±1%, 1/8W	320408	91637	MFF1-88450F	1		

REFERENCE - REGULATOR PCB ASSEMBLY

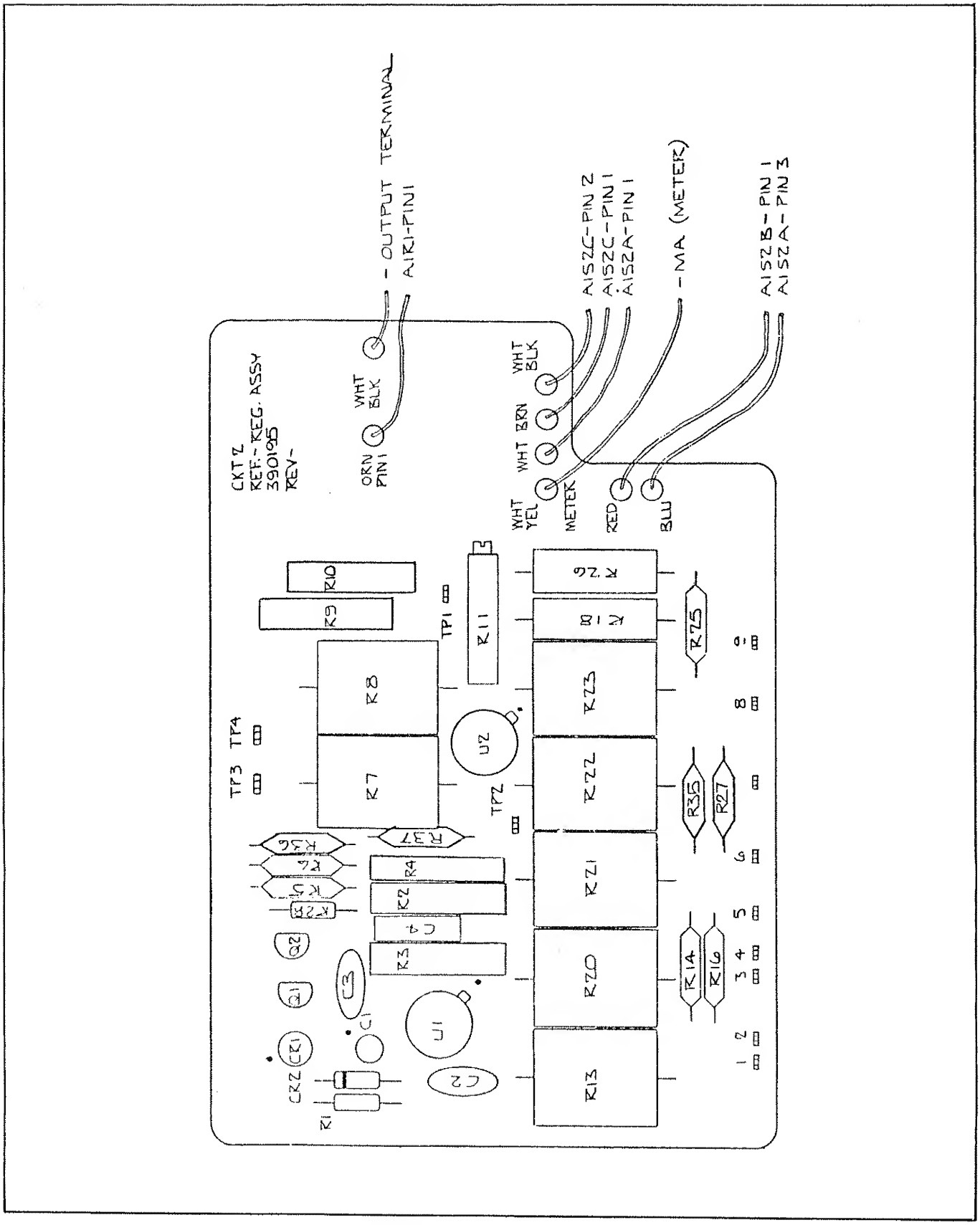

Figure 5-2. REFERENCE - REGULATOR PCB ASSEMBLY.

REFERENCE-REGULATOR PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R27	Res, met film, 4.53k ±1%, 1/8W	376921	91637	MFF1-84531F	1		
R28	Res, comp, 62 ±5%, ¼W	261842	01121	CB6205	1		
R35	Res, met film, 681k ±1%, 1/8W	387043	01637	MFF1-86813F			
R36, R37	Res, met film, 10 ±1%, 1/8W	268789	91637	MFF1-8100F	2		
U1	IC, Operational Amplifier	284760	12040	LM308	1		
	Connector, amp pins	267500	00779	86144-2	21		

POWER SUPPLY AND ADJUSTMENT PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	POWER SUPPLY AND ADJUSTMENT PCB ASSEMBLY (731B - 4012) Figure 5- 3	390187	89536	390187	REF		
C5	Cap, elect, 150 uF +50/—10%, 63V	170274	25403	ET151X063A01	1		
CR5 thru CR9	Diode, Si hi-speed switch	203323	07910	TD8253	5		
CR10	Diode, FET, current regulator	348482	17856	E505	1		
CR11	Diode, zener, 18V	327973	07910	1N967B	1		
CR12	Rectifier, bridge	296509	51605	FB100	1		
Q3	Xstr, Si, NPN	218396	04713	2N3904	1		
R12	Res, var, cermet, 1k ±20%, ½W	267856	71450	190PC102B	1		
R15, R17	Res, var, cermet, 10k ±20%, ½W	267880	71450	190PC103B	2		
R19	Res, var, cermet, 200k ±20%, ½W	381509	80031	ET34P204	1		
R24	Res, var, cermet, 100 ±20%, ½W	267823	71450	190PC101B	1		
R30	Res, comp, 510 ±5%, ½W	108951	01181	EB5115	1		
R31	Res, met film, 4.22k ±1%, 1/8W	168245	91637	MFF1-84221F	1		
R32	Res, met film 16.9k ±1%, 1/8W	267146	91637	MFF1-81692F	1		
R33	Res, comp, 180 ±5%, ½W	108944	01121	CB1815	1		
R34	Res, comp, 8.2k ±5%, ¼W	160796	01121	CB8225	1		
S2	Switch, slide, DPDT	234278	82389	XW1649	1		
	Socket, Amp	267617	00779	85863-5	9		
	Pins, Amp	267500	00779	86144-2	24		

POWER SUPPLY AND ADJUSTMENT PCB ASSEMBLY

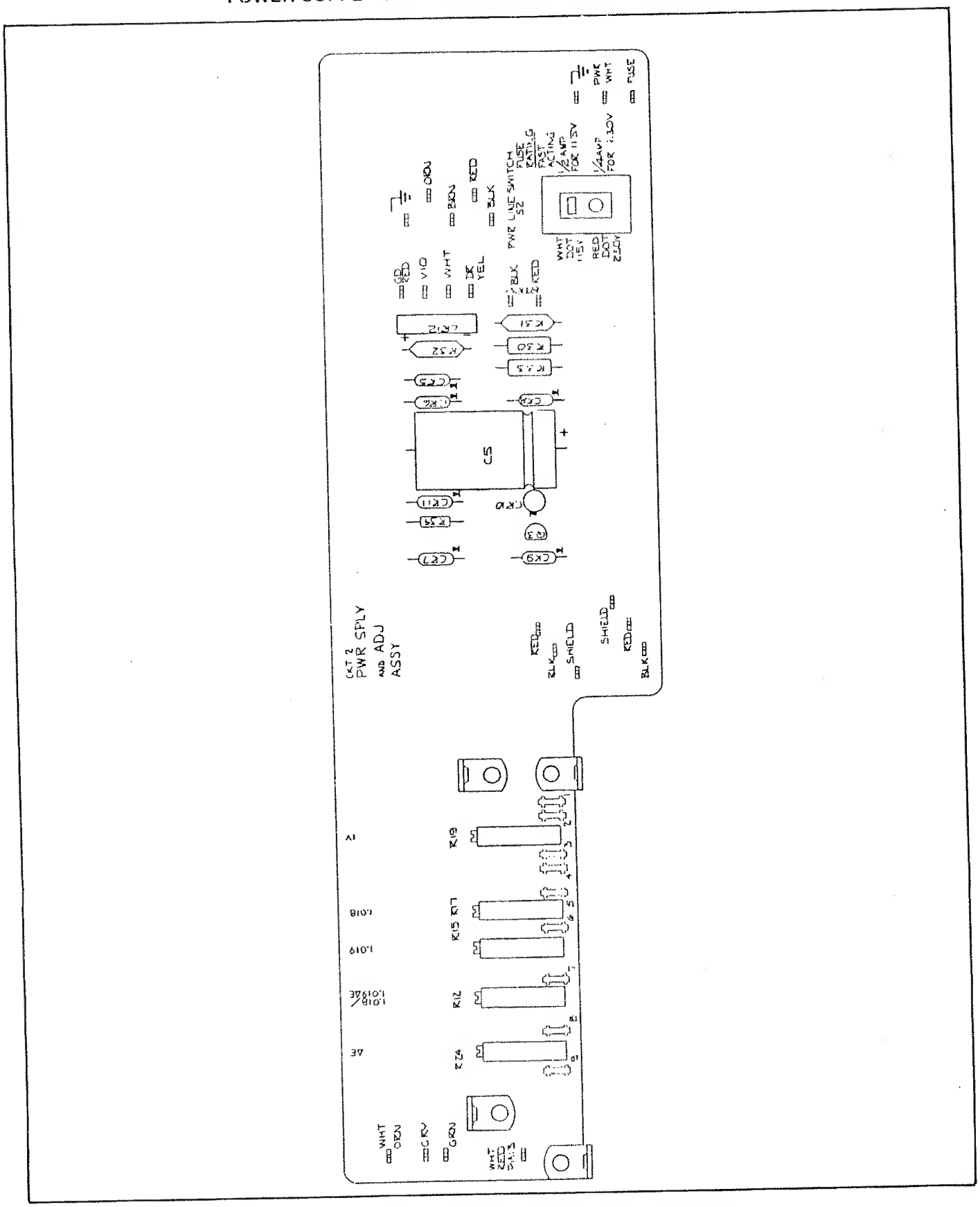

Figure 5-3. POWER SUPPLY AND ADJUSTMENT PCB ASSEMBLY.

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the options and accessories available for use with the 731B. Each option and/or accessory, if any, is described under separate major headings. The descriptions include the applicable operating instructions, maintenance instructions, and field installation procedures.

6-3. RACK MOUNTING KITS

6-4. Rack mounting kits for the 731B are available in four difference configurations. Each of the configurations as shown in Figure 6-1, is designed for installation in a standard 19-inch equipment rack. The kits contain all of the hardware necessary for installation and each can be assembled to offset the 731B ('s) to either the left or right side of the equipment rack.

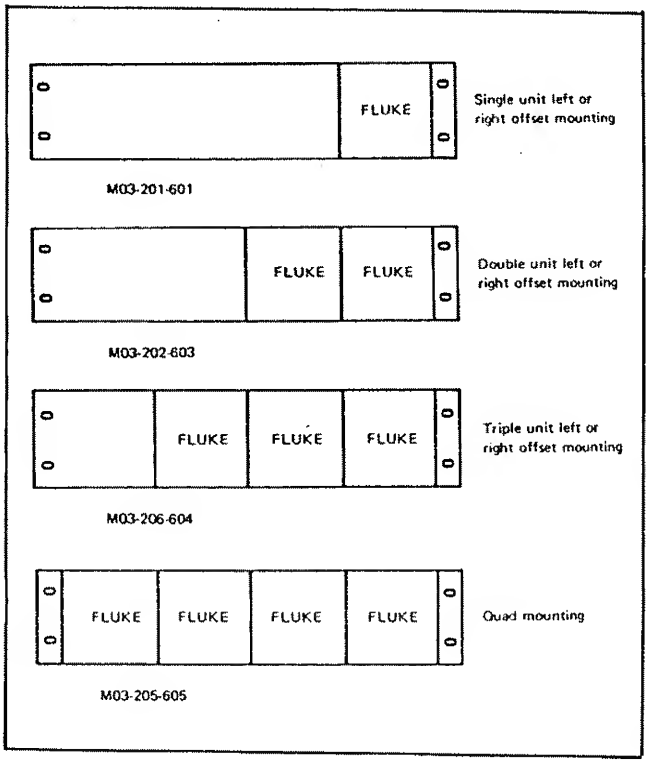

Figure 6-1. RACK MOUNTING CONFIGURATIONS.

6-5. Installation instructions for the 731B rack mounting kits are given in the following procedure. Use the same procedure for all configurations of the 731B rack mounting kits.

a. Remove the four molded plastic feet and the bail from the bottom of the instrument (s).

b. Peel off name plate decals from the corner of the instrument (s).See Figure 6-2.

c. Refer to the kit shown in Figure 6-1 and select the instruments to which each of the rack ears will be attached.

d. Remove the screws which match the rack ear patterns from the appropriate front corners of the selected instruments.

e. Attach the rack ears using the pan head screws supplied with the kit.

f. If the single-unit rack mounting kit (M03-201-601) is being installed, the unit can be mounted in the instrument rack at this point. Otherwise, proceed with steps g through k.

g. Remove top and bottom covers from all 731B's.

h. Remove the top and bottom corner screws from the front and rear of the instruments. Do not remove these screws on the rack ear side of the instruments.

i. Assemble the instruments on a flat surface in the order in which they are to be installed.

j. Insert the dual–rack-mounting fasteners through the front and rear corner nut locations which were vacated in step h. See Figure 6-3.

k. Reinstall the top and bottom covers on all of the instruments.

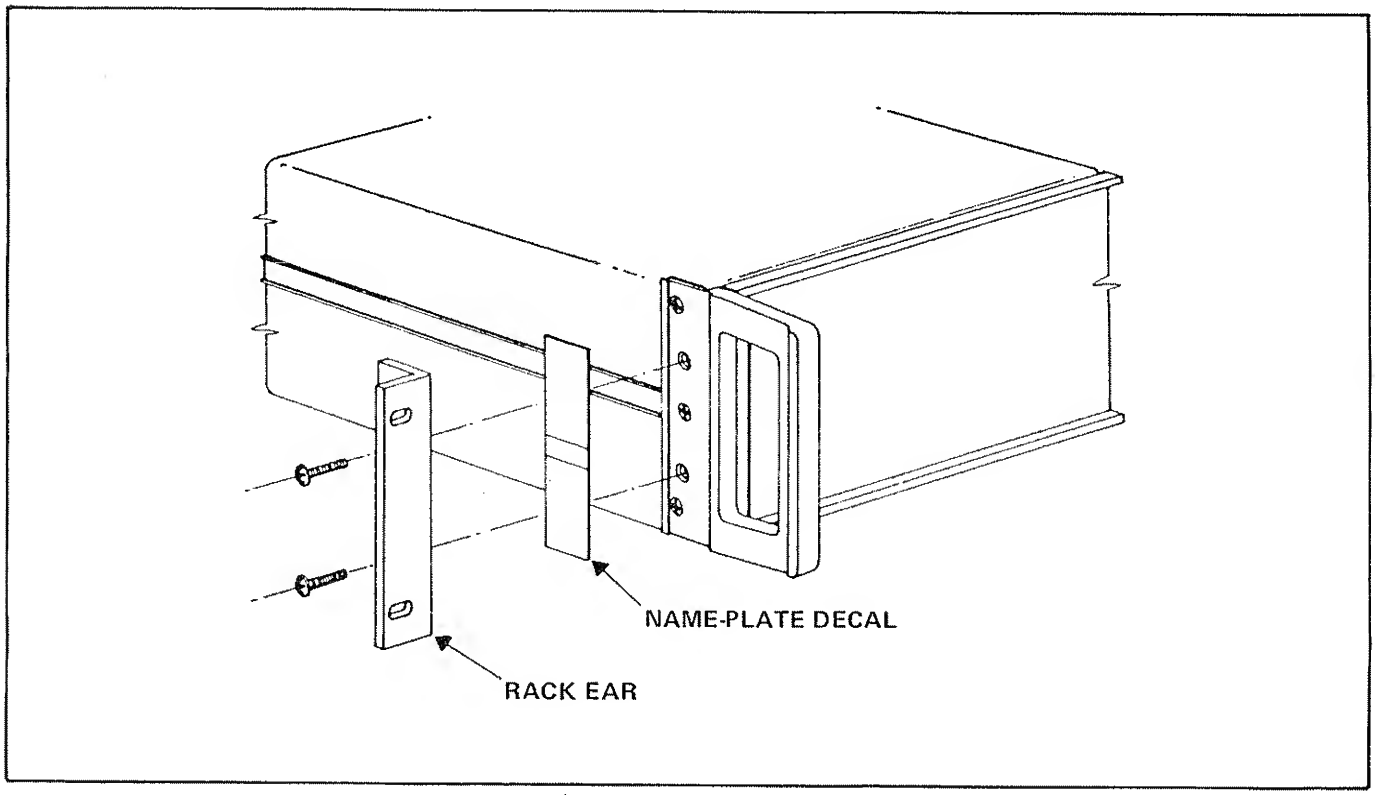

Figure 6-2. RACK EAR INSTALLATION.

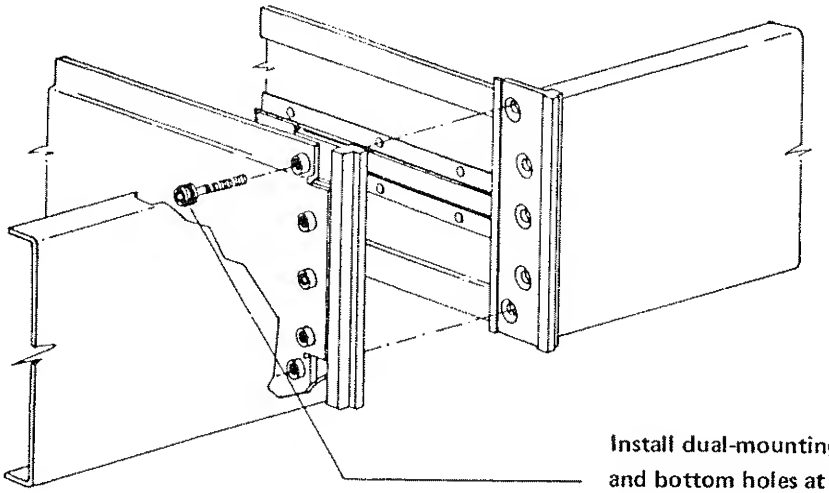

Figure 6-3. DUAL, TRIPLE, AND QUAD MOUNTING

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	programmablle 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

D9816
Westermann Wilhelm Augusta-Anlage
Mannheim-Nackarau Germany

00199
Marcon Electronics Corp
Kearny, New Jersey

00213
Nytronics Comp. Group Inc.
Darrlingon, 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
Beede 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

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
Comell-Dublier Electronics
Fuquay-Varina, N. Carolina

09214
General Electric Co.
Semiconductor Products Dept.
Aubum, 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
Comell-Dublier Electronics
Div. of Federal Pacific
Electric Co. Govt Cont Dept.
Newark, New Jersey

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
Terboro, 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, EI 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
Dabum 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

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
Vamistor 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.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

Federal Supply Codes for Manufacturers (cont)

95573
Campion Laboratories Inc.
Detroit, Michigan

95712
Bendix Corp.
Electrical Comp. Div.
Franklin, Indiana

95987
Weckesser Co. Inc.
(Now 85480)

96733
SFE Technologies
San Fernando, California

96853
Gulton Industries Inc.
Measurement & Controls Div.
Manchester, New Hampshire

96881
Thomson Industries Inc.
Port Washington, New York

97525
EECO Inc.
Santa Ana, California

97540
Whitehall Electronics Corp.
Master Mobile Mounts Div.
Fort Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Pennwalt Corp.
SS White Industrial Products
Piscataway, New Jersey

97966
CBS
Electronic Div.
Danvers, Massachusetts

98094
Machlett Laboratories Inc.
Santa Barbara, California

98159
Rubber-Teck Inc.
Gardena, California

98278
Malco A Microdot Co.
South Pasadena, California

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

Section 8
Schematic Diagrams

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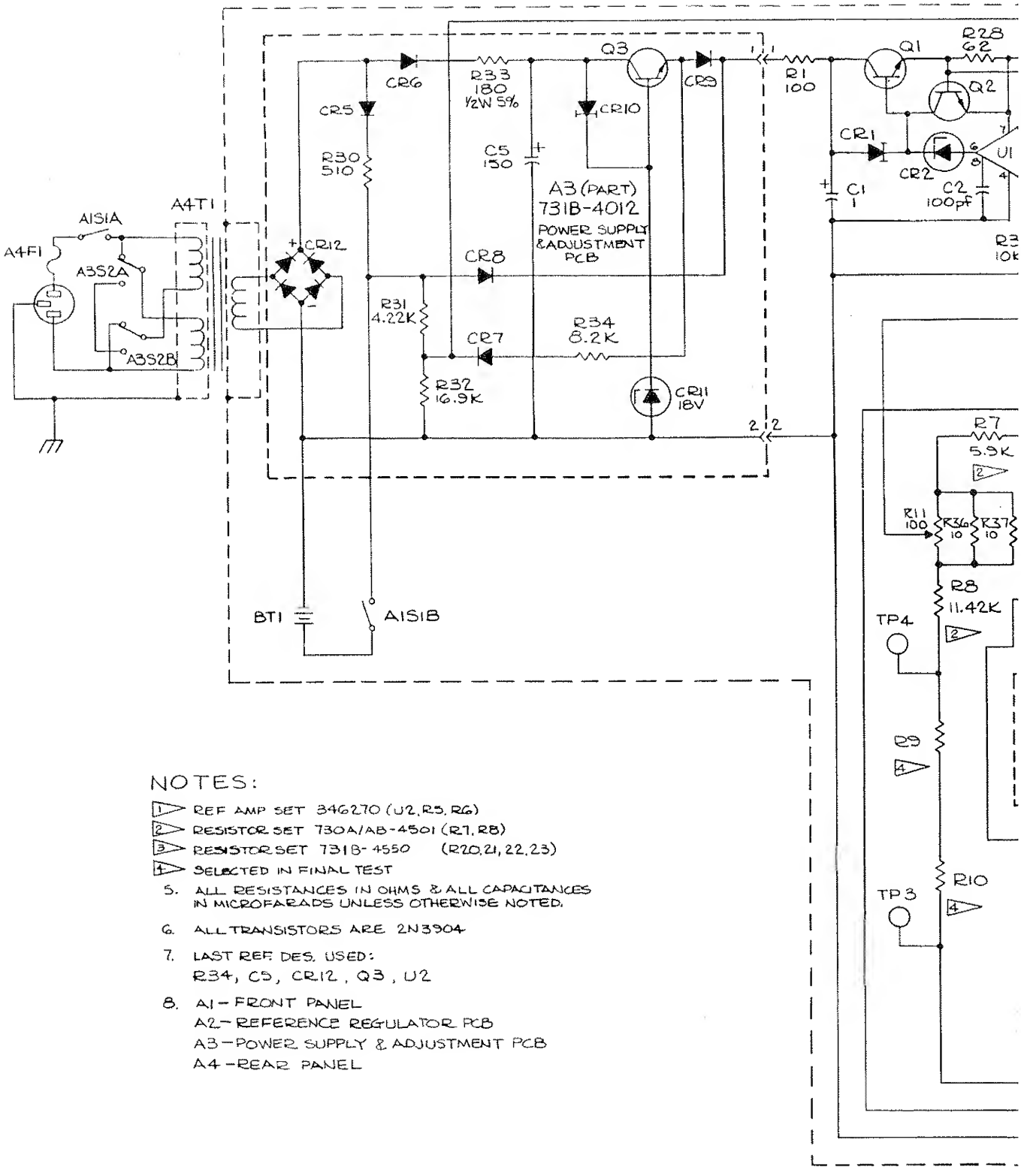
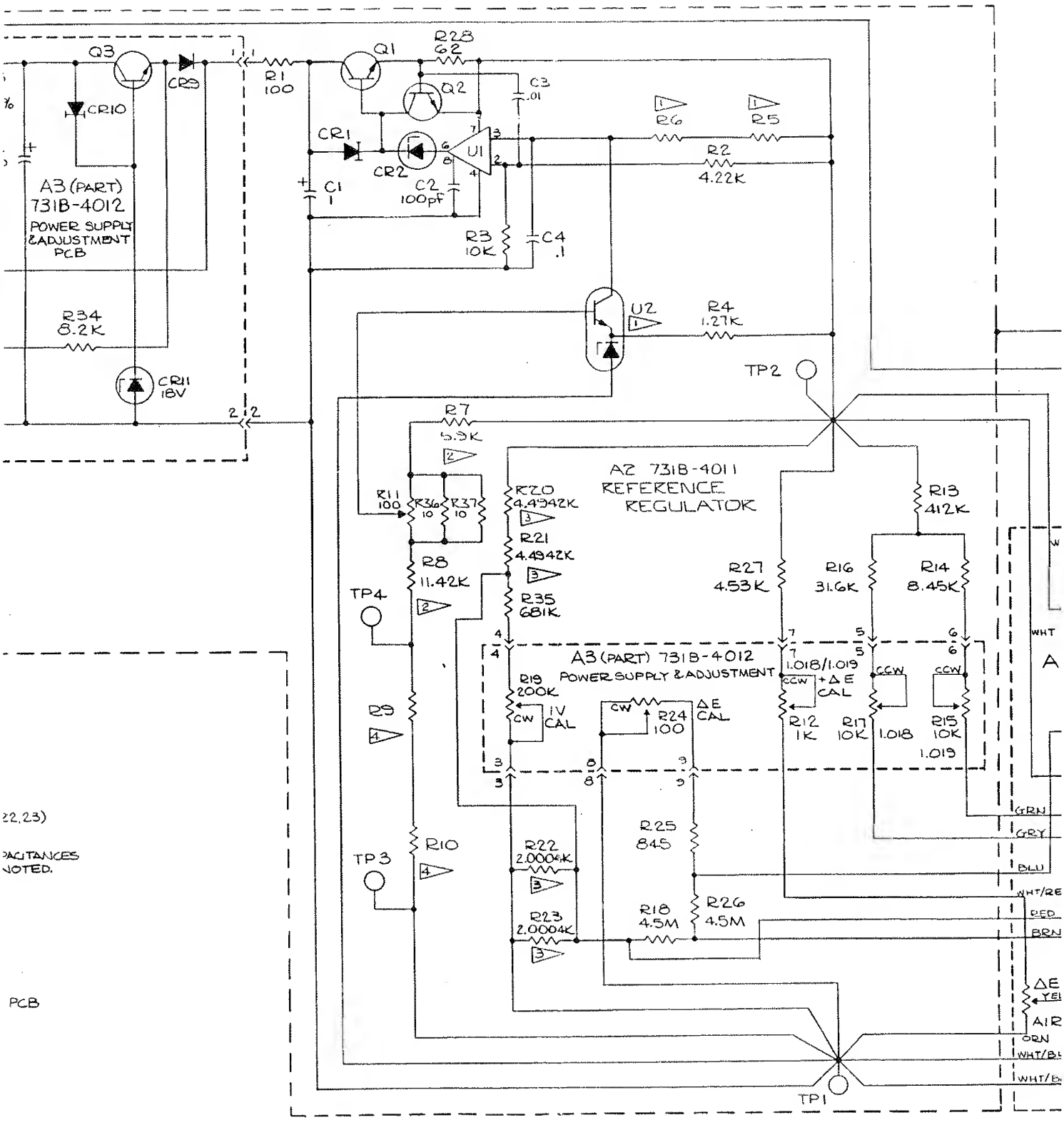
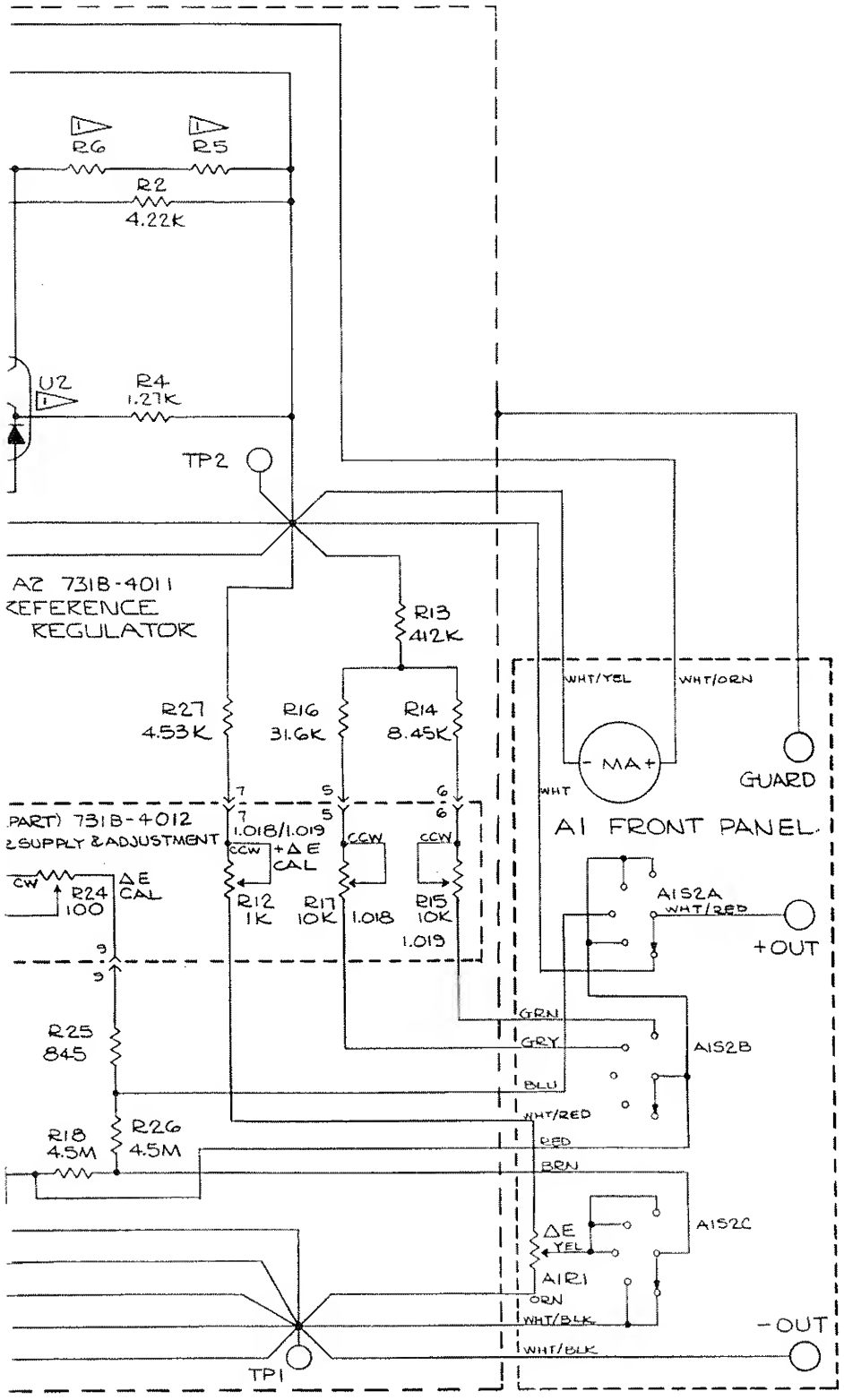


NOTES:

1. REF AMP SET 346270 (U2, R5, R6)
2. RESISTOR SET 730A/AB-4501 (R7, R8)
3. RESISTOR SET 731B-4550 (R20, 21, 22, 23)
4. SELECTED IN FINAL TEST
5. ALL RESISTANCES IN OHMS & ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE NOTED.
6. ALL TRANSISTORS ARE 2N3904
7. LAST REF. DES. USED:
   R34, C5, CR12, Q3, U2
8. A1 – FRONT PANEL
   A2 – REFERENCE REGULATOR PCB
   A3 – POWER SUPPLY & ADJUSTMENT PCB
   A4 – REAR PANEL


A3 (PART) 7318-4012
POWER SUPPLY &ADJUSTMENT PCB
Q3
CR9
CR10
R1 100
Q1
R28 62
Q2
C3 .01
CR1
CR2
U1
C1 1
C2 100pf
R3 10K
C4 .1
R6
R5
R2 4.22K
U2
R4 1.27K
R34 8.2K
CR11 18V
TP2
R7 5.9K
A2 7318-4011 REFERENCE REGULATOR
R11 100
R36 10
R37 10
R20 4.4942K
R21 4.4942K
R35 681K
R8 11.42K
R13 412K
R27 4.53K
R16 31.6K
R14 8.45K
TP4
A3 (PART) 7318-4012 POWER SUPPLY & ADJUSTMENT
R19 200K
1V CAL
R24 100
ΔE CAL
R12 1K
R17 10K
1.018
R15 10K
1.019
1.018/1.019
+ΔE CAL
CCW
CW
R9
R10
TP3
R22 2.0004K
R23 2.0004K
R25 845
R18 4.5M
R26 4.5M
TP1
GRN
GRY
BLU
RED
BRN
ΔE
AIR
ORN
WHT/BL
WHT/BL
WHT
A
PCB



A

REV	CHANGE DESCRIPTION	DR	CHK	APPR
—	REL. TO PRODUCTION		TO [illegible]	[illegible]
B	DWG # WAS 731A-1011 WAS 731A-9512	H.H. 5/20/94		
A	ADDED R56,K57 MOVED R11	T.R. 5/26/94	TO [illegible]	TO [illegible]

FIGURE 8-1. 731B DC REFERENCE STANDARD
(731B-1011)

Change/Errata Information

Issue No: 5 6/79

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 instrument's pcb revision letter is equal to or higher than that which is indicated at the beginning of the change.

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

MANUAL

Title: MODEL 731B DC REFERENCE STANDARD
Print Date: OCTOBER 1974
Rev and Date: -----

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	6/79

CHANGE #1 – 8434

On page 5-9, change the description, Fluke stock no, and mfg part no of R32
From: 16.9k, 267146, MFF1-81692F
To: 14k, 379057, MFF1-81402F.

On page 7-3/7-4, change the value of resistor R32 from 16.9k to 14k.

CHANGE #2 – 10856

On page 5-3, change the description, mfg fed sply code and mfg part no of item #4:
From: 295642, 13511, 1381
To: 380808, 02111, 15-1-11.

CHANGE #3 – 11193

On page 5-3, change the Fluke Stock no and mfg part no for item 1 (Corner) from 295972 to 394338.

CHANGE #4 – 11194

On page 5-5, add the following new entry:
Decal, corner; 394379; 89536; 394379; 4

CHANGE #5 – 11351

On Figure 7-1, change the value of R7 from 5.9k to 6.2k.

CHANGE #6-11424

On page 1-2, Temperature Coefficient, change the 10°C temperature on both lines to 18°C.

CHANGE #7 – 12054

On page 5-3, make the following changes:

FROM: 3/Decal, Front/375970/89536/375970/1
TO: 3/Decal, Front/507384/89536/507384/1

ERRATA #1

On page 1-2, under SPECIFICATIONS, add the following information:

Protection Class . . . . . #1 (Relates solely to insulation or grounding properties further defined in IEC 348.)