JOHN FLUKE MFG. CO., INC.

P. O. Box 7428

Seattle, Washington 98133

MODEL

731A

DC TRANSFER STANDARD

SERIAL NO._____AND ON.

APRIL, 1971

warranty

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects *in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an* instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

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

1. Notify the John Fluke Mfg. Co., Inc., 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 forewarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. 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

The instrument should be thoroughly inspected immediately upon receipt. 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 fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P.O. BOX 7428, SEATTLE, WASHINGTON 98133.

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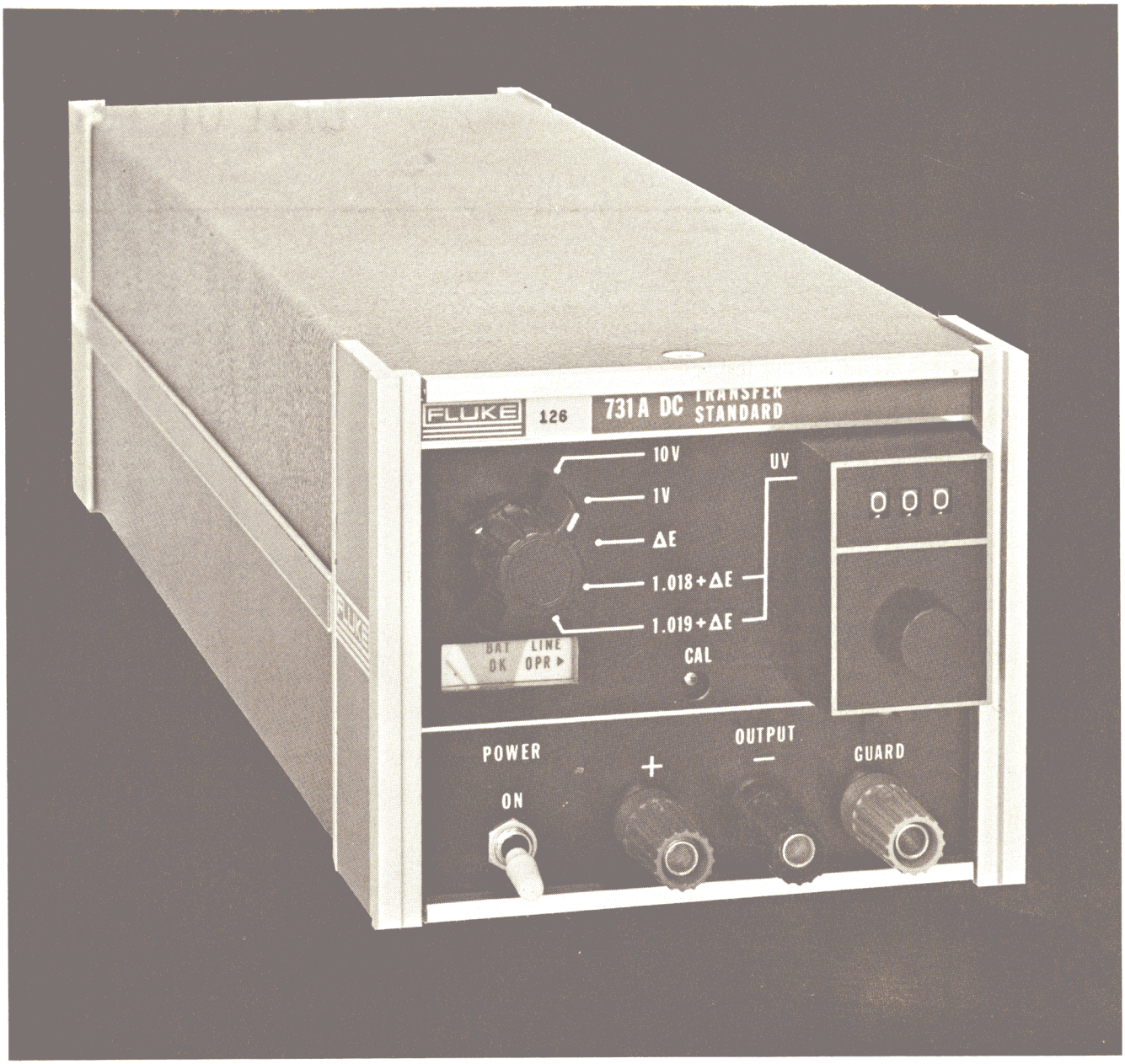


MODEL 731A DC TRANSFER STANDARD

Section 1

Introduction & Specifications

1-1. DESCRIPTION

1-2. The Model 731A DC Transfer Standard is a versatile instrument, providing a variety of precision voltages with standard cell accuracy. It will furnish basic outputs of 1.000 volts, (1.018 + ΔE) volts, (1.019 + ΔE) volts, 10.000 volts, and ΔE (0 to 999 microvolts).

1-3. The ΔE control is a precision 10-turn linear potentiometer which has a 3-digit direct reading dial. The control is equipped with a locking lever which prevents accidental changing of the ΔE setting. Resolution of the control is 1 microvolt, thus allowing 1 microvolt steps (to 999 microvolts) to be added to the 1.018 and 1.019 volt outputs. The ΔE output may be selected independently as well.

1-4. The primary reference element in the 731A is a reference amplifier with precisely known characteristics. The device is a zener diode with active circuitry added to provide a voltage reference having a very low temperature coefficient over a 55°C temperature range. Output voltage stability is better than 10 ppm/month; transfer accuracy is 2 ppm/month between standard cells.

1-5. The 731A is powered by a rechargeable battery pack. State of charge is indicated on a front panel meter.

1-6. The 731A is supplied with non-marring feet for bench or field use. It may also be conveniently mounted in a standard 19" EIA rack using optional mounting kits.

1-7. ELECTRICAL SPECIFICATIONS

OUTPUT VOLTAGE	10.000 volts dc. 1.000 volts dc (1.018 + ΔE) volts dc. (1.019 + ΔE) volts dc. ΔE: +0.0 to 999 uv in 1 uv steps.
TRANSFER ACCURACY	2 ppm between standard cells. 3 ppm between standard cell and 1V output. 5 ppm between standard cell and 10V output.
ΔE RESOLUTION AND ACCURACY	1 uv
REFERENCE STABILITY	Better than 10 ppm per month after 30 minute warmup.
OUTPUT IMPEDANCE	Less than 1.1K for 1V, 1.018V, 1.019V, and 10V positions. Less than 150 for ΔE (0.0 to 999 uv) position.
LINE REGULATION	Less than 1 ppm/±10% line variation.
RIPPLE AND NOISE	Less than 1 ppm p-p from dc to 1 Hz. Less than 20 uv RMS from 1 Hz to 1 mHz.

COMMON MODE REJECTION	120 db at dc. 100 db at 60 Hz. 85 db at 400 Hz.
OUTPUT CURRENT	5 ma (maximum) with output shorted. No instrument damage from shorted output.
ISOLATION	Output may be floated up to 500 vdc between chassis ground and guard.
CALIBRATION ADJUSTMENT	Separate internal adjustments for the five output voltages. Front panel adjustment common to all voltages including the 10.000 volt output. Calibrate at 90-day intervals. Basic reference adjustments accessible from front panel.

1-8. ENVIRONMENTAL SPECIFICATIONS

TEMPERATURE RANGE:	+0°C to +55°C operating. –40°C to +60°C non-operating.
TEMPERATURE COEFFICIENT	Less than .5 ppm/°C, 20°C to 30°C. Less than 1 ppm/°C, 4°C to 40°C. Less than 1.5 ppm/°C, 0°C to 4°C and 40°C to 55°C.
SHOCK AND VIBRATION	Meets requirements of MIL-T-21200H.

1-9. GENERAL SPECIFICATIONS

TERMINALS	Three five-way binding posts for positive, negative and guard. All terminals solid copper with gold flash.
BATTERY OPERATION	Rechargeable nickel-cadmium batteries provide at least 30 hours of continuous operation.
INPUT POWER	115V or 230V ±10 VAC, 50 Hz to 400 Hz single phase or internal battery operation.
SIZE	3.5" high x 4.25" wide x 12" deep (Figure 1-1).
WEIGHT	5 lbs.

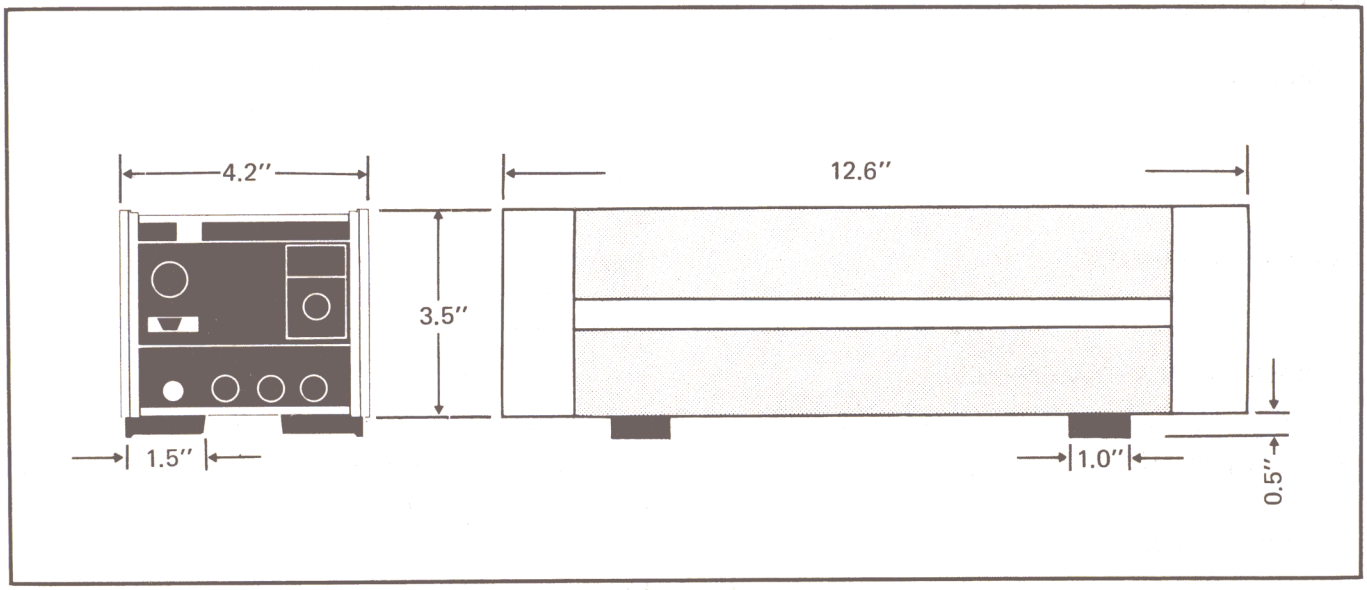


Figure 1-1. 731A OUTLINE DRAWING

1-10. ACCESSORIES

M03-201-601	Rack Mounting Kit, Single 731A, Offset Mounting.
M03-202-603	Rack Mounting Kit, Two 731A's.
M03-206-604	Rack Mounting Kit, Three 731A's.
M03-205-605	Rack Mounting Kit, Four 731A's.
M03-200-611	Rack Mounting Kit, Single 1/2-Rack Instrument plus One 731A.
M03-200-609	Rack Mounting Kit, Single 1/2-Rack Instrument plus Two 731A's.

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section contains operating instructions and applications information for the Model 731A. If any problem is encountered in operating the instrument, contact the nearest John Fluke sales representative or write directly to John Fluke Mfg. Co., Inc. Please include the instrument serial number when writing.

2-3. INSTALLATION

2-4. The 731A is supplied with non-marring feet for bench or field use. Rack mounting kits are available for installation of the instrument in a standard 19-inch rack and are described in Section 6.

2-5. REPACKAGING FOR SHIPMENT

2-6. If reshipment is required, the original container should be used, if available. Upon request, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please include instrument model number when requesting a new container.

2-7. INPUT POWER REQUIREMENTS

2-8. The 731A operates on 115 or 230 volt, 50 Hz to 400 Hz ac power. To convert the instrument from one type of operation to another, place the 115/230 volt switch (located at rear of instrument) in the desired position and select the proper fuse: AGC 1/2 ampere and 115 volt operation and AGC 1/4 ampere for 230 volt operation.

WARNING!

Ensure that the instrument case is connected to a high quality earth ground, either through the polarized line plug or through a separately connected ground wire.

2-9. OPERATING FEATURES AND INSTRUCTIONS

2-10. The function of controls, terminals, and indicators is given in Figure 2-1. Table 2-1 gives instructions for using the 731A.

2-11. APPLICATIONS

2-12. Standard Cell Transfer

2-13. The 731A may be standardized to a standard cell by the procedure given in Table 2-1. The standardized output will be within 2 ppm of the standard cell voltage and will remain so within 10 ppm per month.

2-14. Precision Voltage Reference

2-15. The 731A lends itself to many applications requiring a stable, accurate reference voltage. Once it has been standardized to a standard cell, the 1 volt and 10 volt outputs, with standard cell transfer accuracies of 3 ppm and 5 ppm respectively, may be used directly as reference voltages. For example, standardizing the 731A to a cell having an absolute accuracy of 3 ppm would provide a 10 volt refer-

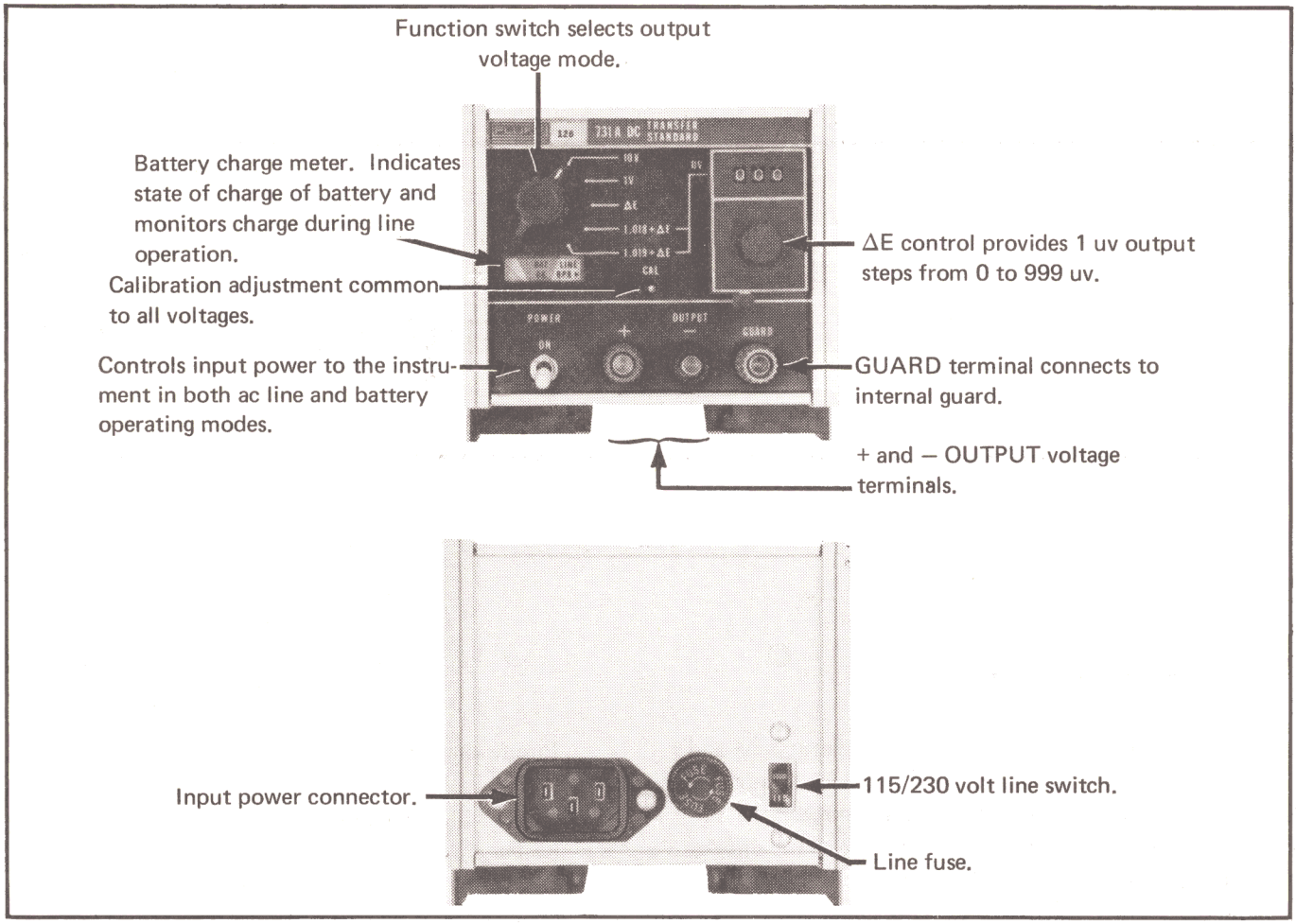


Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS

Table 2-1. 731A OPERATING INSTRUCTIONS

OPERATION	731A		REMARKS/PROCEDURE
	FUNCTION SWITCH POSITION	CONNECTIONS	
Battery Charge	Any	Connect instrument to ac line.	Battery is trickle charged during line operation. With POWER switch OFF, ac line power and battery power are disconnected from the instrument.
Transfer Standard	Set function switch to (1.018 + ΔE) or (1.019 + ΔE) depending on Standard Cell Voltage.	Connect Standard Cell to "+" and "—" OUTPUT terminals through null detector as shown in Figure 2-2.	1. Adjust ΔE control so that function switch setting + ΔE microvolt setting equal the Standard Cell Voltage. 2. Adjust front panel CAL control for null with null detector on most sensitive range. 3. Disconnect standard cell and null detector from 731A. Standardized output is then available at 731A OUTPUT Terminals.
Precision Voltage Source	10V, 1V or ΔE	731A OUTPUT terminals.	Output of 731A will correspond to function switch setting. If 731A is first standardized to a standard cell, specified transfer accuracy of the 731A will apply. See paragraph 2-14.

ence output accurate to 8 ppm (3 ppm standard cell accuracy + 5 ppm 731A transfer accuracy) or 0.0008%.

2-16. OPERATING NOTES

2-17. Guarded Operation

2-18. Complete isolation of 731A circuitry is provided by the guard chassis in the instrument. The guard is brought out to the front panel GUARD terminal. In general, guarded operation will be necessary under the following conditions:

a. When differences of potential exist between equipment power line grounds.

b. When long connecting leads are used and load impedance is high.

c. When the equipment is operated in the presence of high level radiated noise, the most common example of which is stray fields at the power line frequency.

2-19. One of the most common cases requiring guarding is that of differences in power line grounds. When the 731A 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 731A 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 2-3 illustrates correct GUARD terminal connection and the rerouted ground currents.

2-20. Battery Operation

2-21. 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 12 hours of trickle.charging.

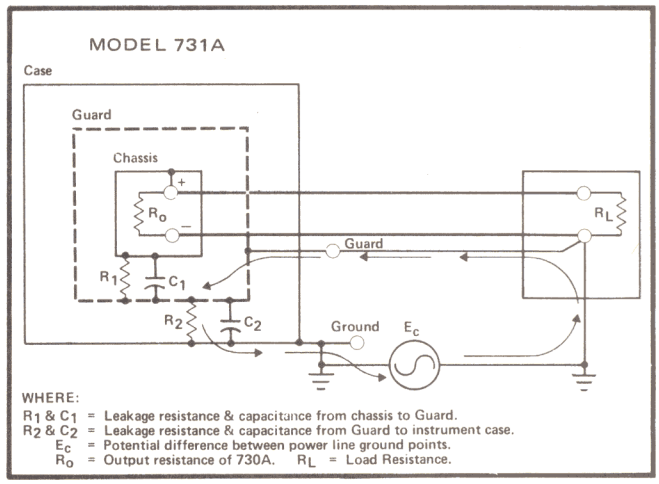


Figure 2-3. PROPER GUARD CONNECTION WHEN POTENTIAL DIFFERENCES EXIST BETWEEN POWER LINE GROUNDS.

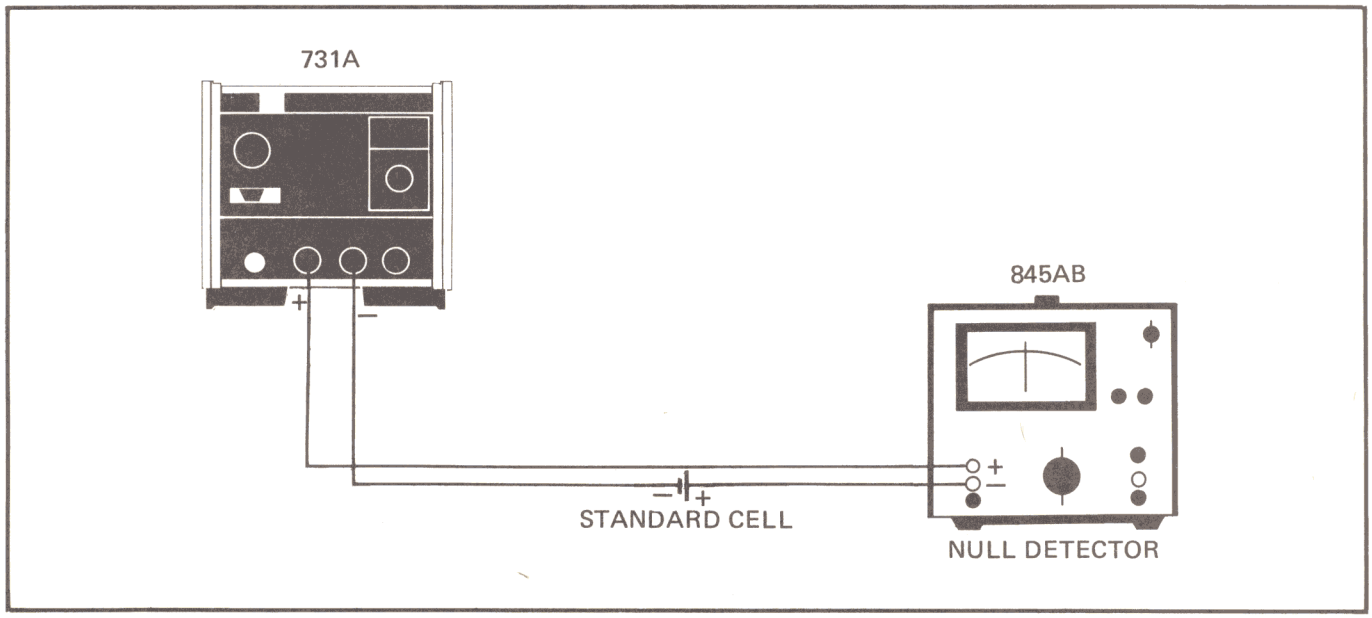


Figure 2-2. STANDARDIZING THE 731A TO A STANDARD CELL

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section contains the theory of operation of the Model 731A. Included is a general discussion of circuit theory and a detailed circuit description which is keyed to the instrument schematic.

3-3. GENERAL

3-4. The 731A consists of a charging circuit, reference supply, resistive output divider, and function and ΔE controls as shown in Figure 3-1.

3-5. CIRCUIT DESCRIPTION

3-6. Charging Circuit

3-7. Input ac from power transofrmer T1 is rectified in a full-wave bridge composed of CR1, CR2, CR3 and CR4. Bridge output is applied through resistor R1 to provide continuous trickle charge for battery BT1. Battery output is connected directly to operational amplifier IC1 in the reference supply. The meter circuit, consisting of meter A1M1, diode CR5, and resistor R2, is calibrated to indicate the state of charge of the battery during battery operation. During line operation, the meter registers full scale (LINE OPR) to indicate that the battery is charging.

3-8. Reference Supply

3-9. Reference amplifier IC2 functions as the primary reference element for the supply. IC2 is a silicon NPN transistor connected in series with a zener diode. Both devices are mounted on a common substrate and enclosed in a single envelope, thereby achieving extremely close thermal coupling. The reference voltage, V_{REF}, (see Figure 3-2) is the sum of the zener voltage, V_Z and the transistor base-to-emitter voltage, V_{eb}. Temperature variations affecting V_Z are compensated for by corresponding changes in V_{eb}. The result is a precision, temperature-compensated dc source.

3-10. Supply output voltage variations are sensed at the base of IC2, amplified, and applied to operational amplifier

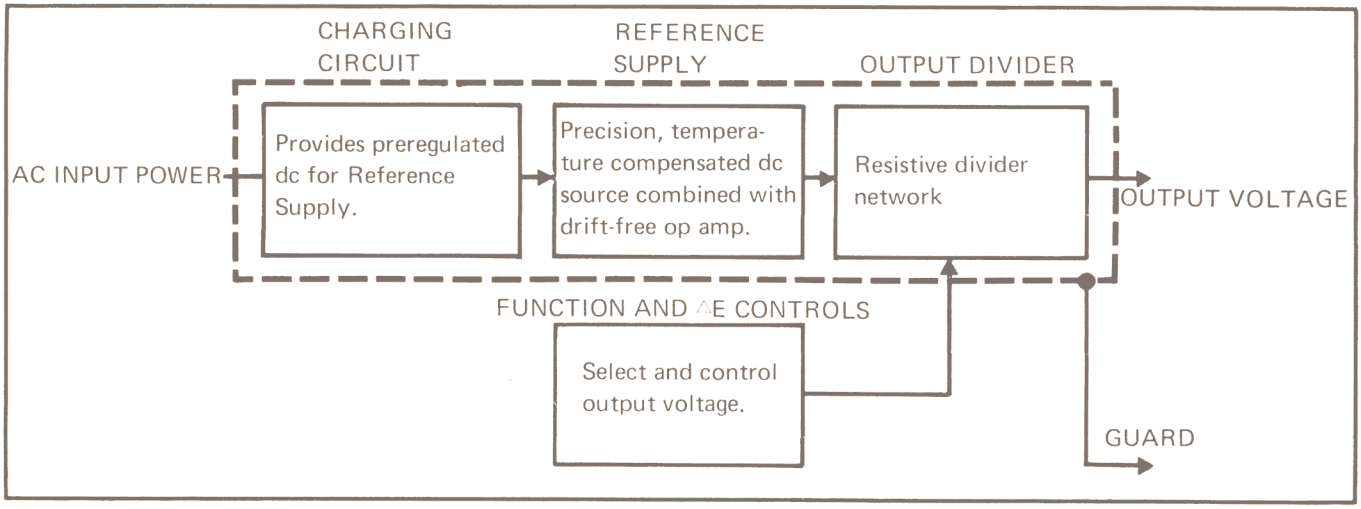


Figure 3-1. 731A BLOCK DIAGRAM

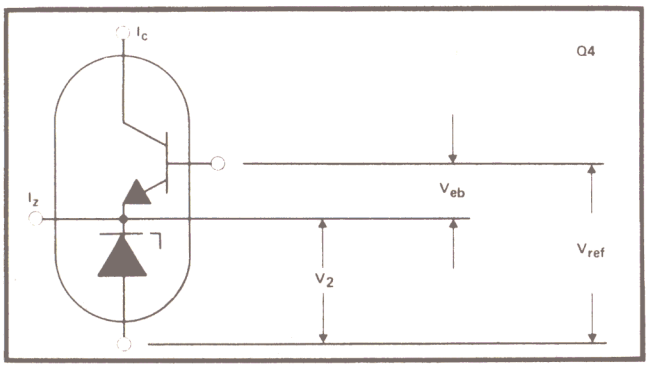


Figure 3-2. REFERENCE AMPLIFIER

IC1. IC1 is connected as a non-inverting operational amplifier, with reference amplifier IC2 supplying the input reference voltage. The circuit is shown in simplified form in Figure 3-3.

3-11. Potentiometer R11 (CAL) is the primary calibration adjustment and is set to provide exactly 10 volts at the reference supply output. Subsequent division and control of the output is provided by the output divider circuitry.

3-12. Output Divider

3-13. The divider network incorporates all front panel controls and output calibration adjustments. Critical divider resistors are wound on a single bobbin with the same wire and tension to achieve very low temperature coefficient.

3-14. Primary reference adjustment R11 (CAL) is set to provide exactly 10.000 volts into the divider network. The remaining outputs are derived from this voltage. Each is separately adjustable by internal calibration controls and selected by function switch S2. In (1.018 + ΔE) and (1.019 + ΔE) positions, the 1.018 volt and 1.019 volt dividers are effectively placed in series with the ΔE divider.

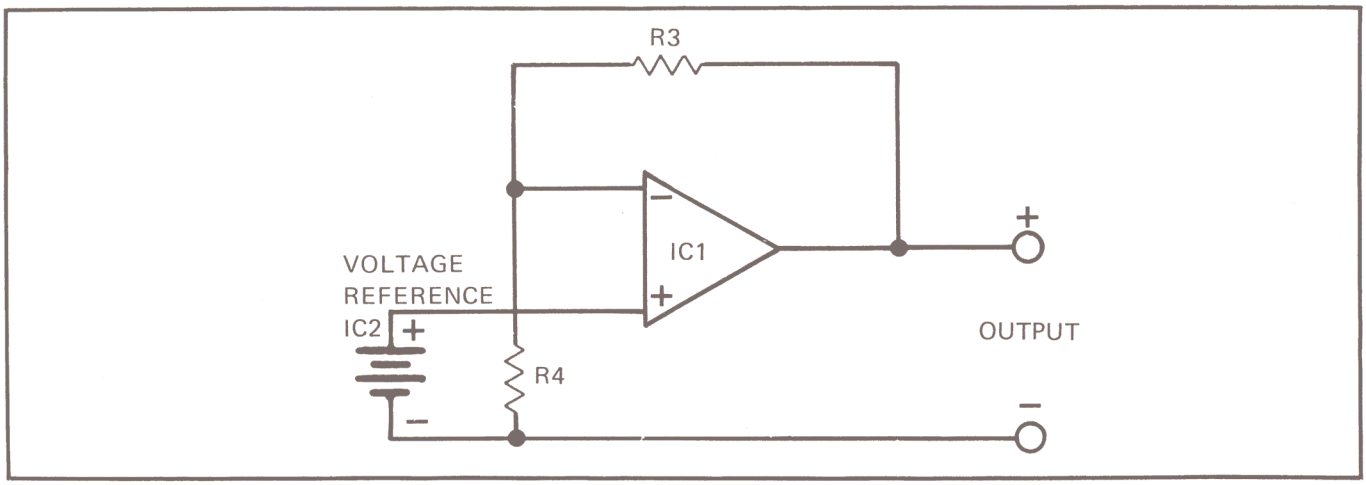


Figure 3-3. BASIC REFERENCE CIRCUIT

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section contains information and instructions concerning preventive and corrective maintenance and calibration for the Model 731A DC Transfer Standard. A calibration interval of 90 days is recommended to ensure instrument operation within the specifications stated in Section 1 of the manual.

4-3. Service Information

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. Complete warranty information is contained in the Warranty page located at the front of the manual. Factory authorized calibration and repair service for all Fluke instruments is available at various world wide locations. A complete list of factory authorized service centers is located at the rear of the manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments which are beyond the warranty period.

4-5. TEST EQUIPMENT

4-6. The equipment recommended for maintenance of the 731A is listed in Table 4-1. If the recommended equipment is not available, other equivalent equipment may be used.

4-7. GENERAL MAINTENANCE

4-8. The following procedure should be used to gain access to the interior of the instrument (see Figure 4-1):

a. Remove top dust cover.

b. Disconnect battery leads from the two pins at the rear of the PCB.

Table 4-1. TEST EQUIPMENT

EQUIPMENT TYPE	RECOMMENDED EQUIPMENT	FUNCTION
Null Detector	Fluke Model 845AB	Performance Testing and Calibration
DC Differential Voltmeter	Fluke Model 895A	Performance Testing and Calibration
True RMS Differential Voltmeter	Fluke Model 931B	Performance Testing
DC Voltage Source	Fluke Model 341A DVM Calibrator	Performance Testing and Calibration
Standard Cell	Guildline Instruments Model 9152/P4	Performance Testing and Calibration
X1000 Amplifier	– – – – – – –	Performance Testing
Resistor (Figure 4-4)	1000 ohms	Performance Testing
Voltage Divider	Fluke Model 720A Kelvin-Varley Voltage Divider	Calibration
Low-Thermal Switch	Leeks & Northrup Type 3702 Tapping Key	Performance Testing and Calibration

c. Remove bottom dust cover. All components in the instrument will then be accessible.

NOTE!

The battery pack is mounted on the inside of the bottom dust cover.

4-9. Fuse Replacement

4-10. The line fuse is mounted in a fuse holder, accessible at the rear of the instrument. The fuse is rated as follows:

115 Volt Operation – AGC 1/2 Ampere

230 Volt Operation – AGC 1/4 Ampere

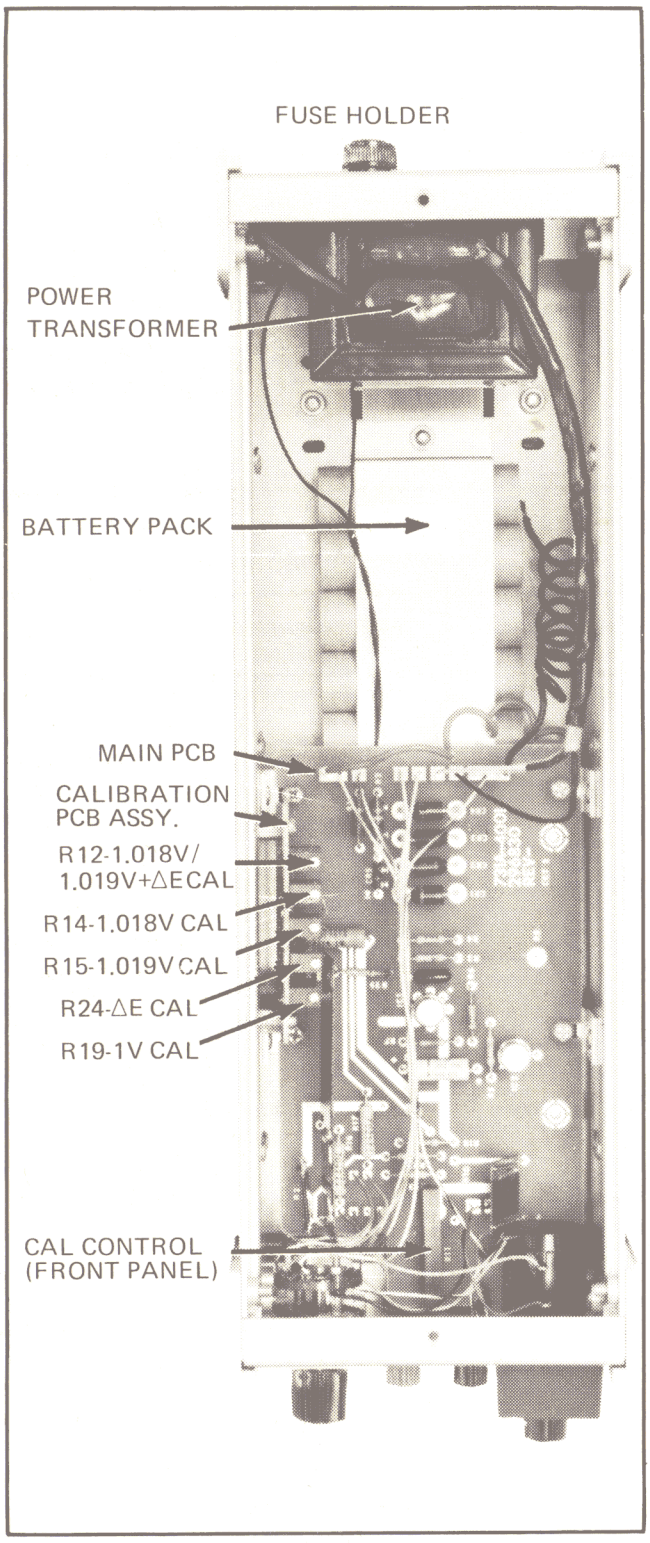


Figure 4-1. INTERNAL LAYOUT

4-11. 115/230 Volt Conversion

4-12. The 731A may be operated from either 115 or 230 volt power, depending upon connection of the power transformer winding. Prepare the 731A for operation at the desired voltage by the following procedure:

a. Disconnect the 731A from the line.

b. Place the 115/230 volt slide switch, located at the rear of the instrument, in the position which corresponds to the desired operating voltage.

c. Ensure that the proper line fuse for the selected voltage is installed (paragraph 4-9) before operating the instrument.

4-13. Cleaning

4-14. The instrument should be cleaned periodically to remove dust, grease, and other contamination. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low-pressure, clean, dry air. Pay particular attention to front panel binding posts and binding post wiring.

b. Clean front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

c. Clean the printed circuit board by spraying with Freon TF Degreaser (MS180 Miller Stephenson Chemical Co., Inc.) followed by application of low pressure, clean, dry air.

4-15. PERFORMANCE TESTS

4-16. The following tests are intended for use in performance testing of the 731A. These tests are especially suited to acceptance testing of new instruments. Tests should be conducted with ambient temperature at 25°C ±5°C and relative humidity less than 70%.

4-17. Line Regulation

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

b. Set line voltage to 115 volts and allow instrument to warm up for approximately 30 minutes.

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

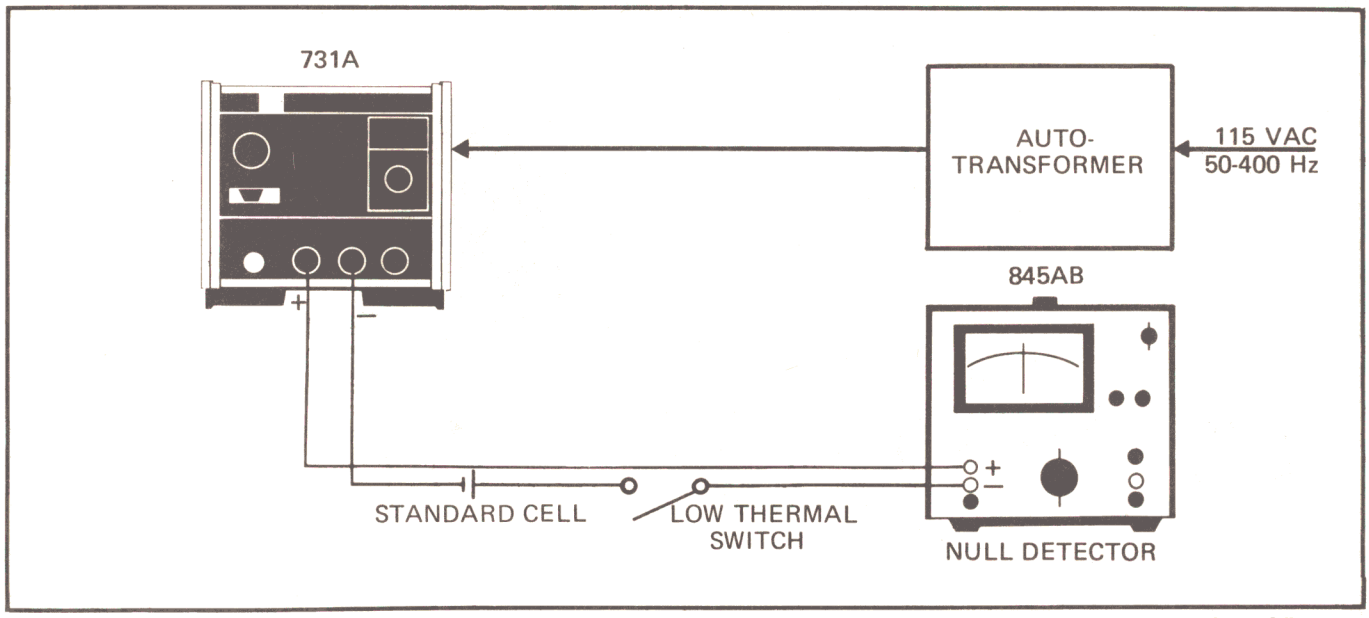


Figure 4-2. EQUIPMENT CONNECTIONS FOR LINE REGULATION, DC TO 1Hz OUTPUT NOISE, AND TRANSFER ACCURACY TESTS.

d. With the test switch open, adjust 731A output to equal the Standard Cell voltage.

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

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

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 731A 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.

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 731A output to 1.018000 volts. The 931B should indicate less than 100 millivolts rms, which represents 100 microvolts output from the 731A.

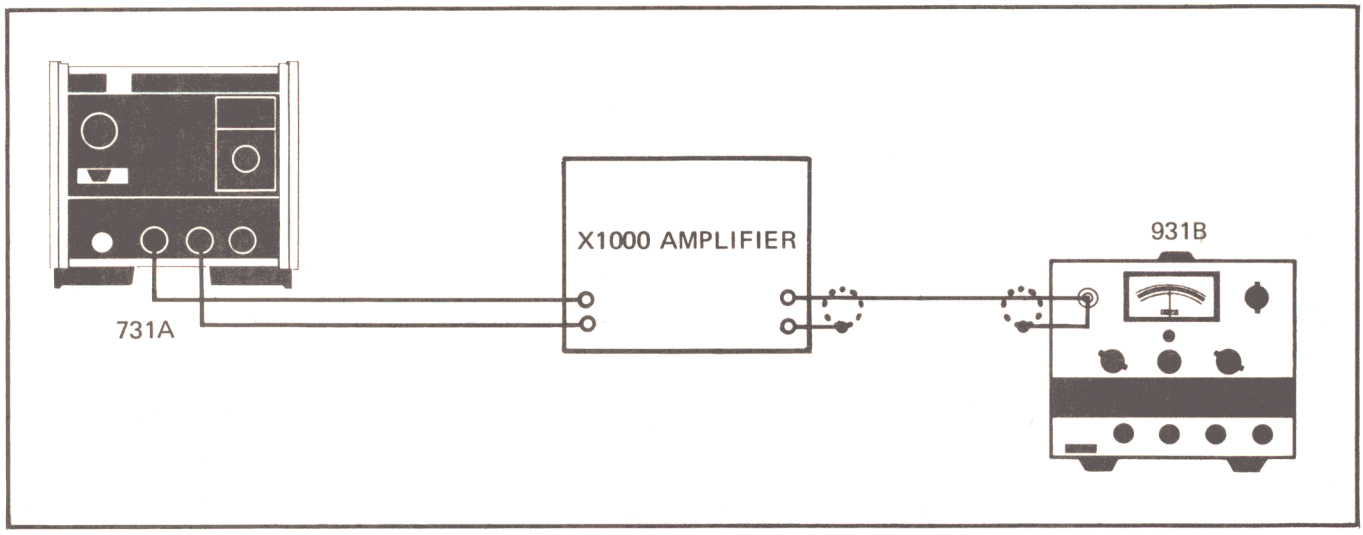


Figure 4-3. EQUIPMENT CONNECTIONS FOR 1 HZ TO 1 MHZ OUTPUT NOISE TEST.

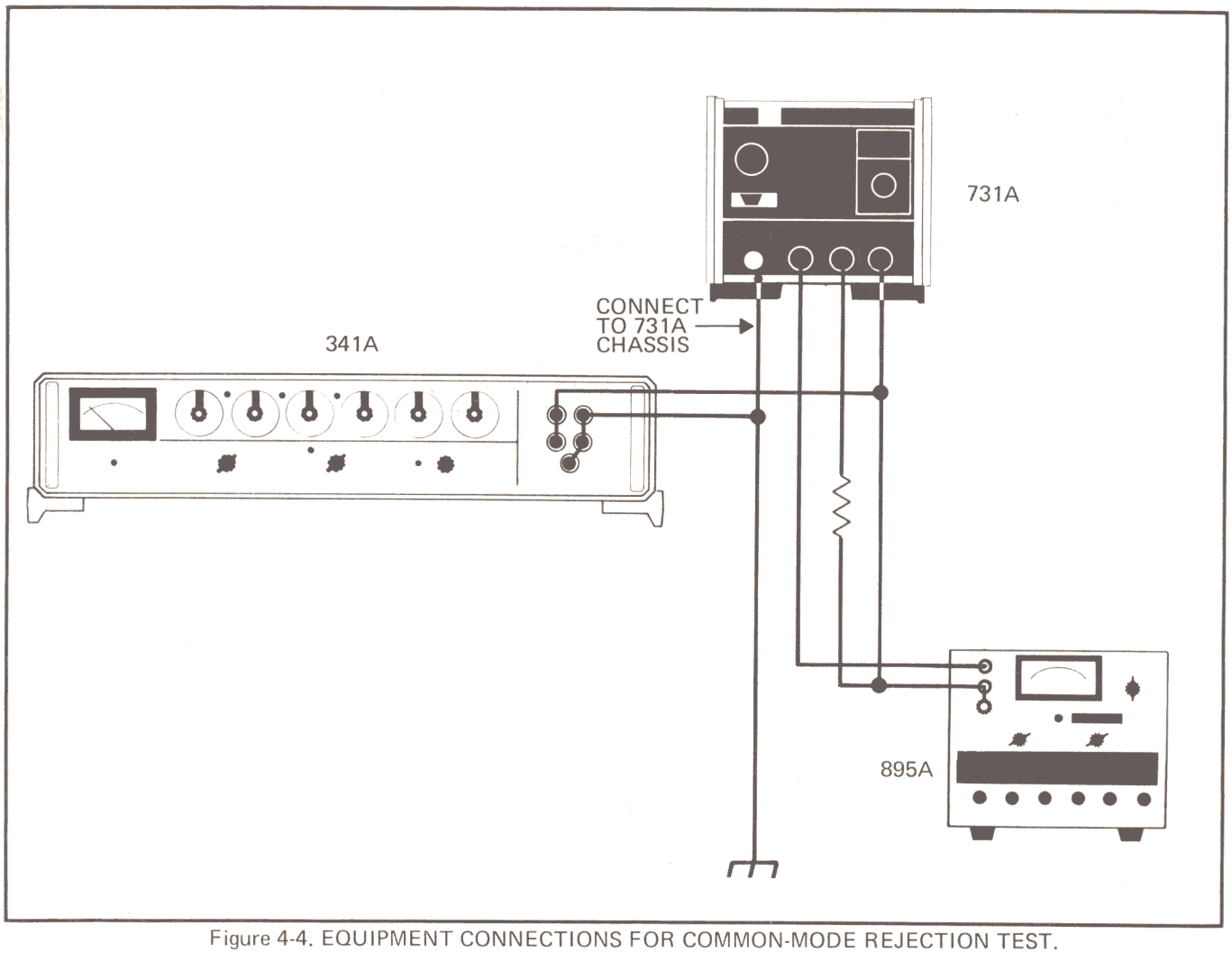


Figure 4-4. EQUIPMENT CONNECTIONS FOR COMMON-MODE REJECTION TEST.

4-20. Common-Mode Rejection

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

b. Set 341A for zero volts output.

c. Set 731A 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.

4-21. Isolation

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

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

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 731A.

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

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 731A output to equal Standard Cell voltage.

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

e. Lock the ΔE control on the 731A.

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

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

4-23. TROUBLESHOOTING

4-24. Before attempting to troubleshoot the 731A, it should be verified that the trouble is actually in the instrument and is not caused by faulty external equipment or connections. As a first step, the 731A should be exercised as described in "Performance Tests" to determine what fault is present.

4-25. 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.

4-26. Battery output voltage should be approximately 14.4 volts, measured at the battery terminals on the PCB. If battery output is correct and the output divider is working properly, it is likely that either IC1 or IC2 in the Reference Supply are defective.

4-27. CALIBRATION

4-28. The calibration procedure for the 731A 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 25°C ±5°C and relative humidity less than 70%. Adjustment locations are shown in Figure 4-1.

Table 4-2. 731A CALIBRATION

STEP	EQUIPMENT CONNECTIONS	731A CONTROL SETTINGS		720A DIAL SETTINGS	845AB 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 (R14) 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		.0010000	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 for zero (±1 uV) on the 845AB.

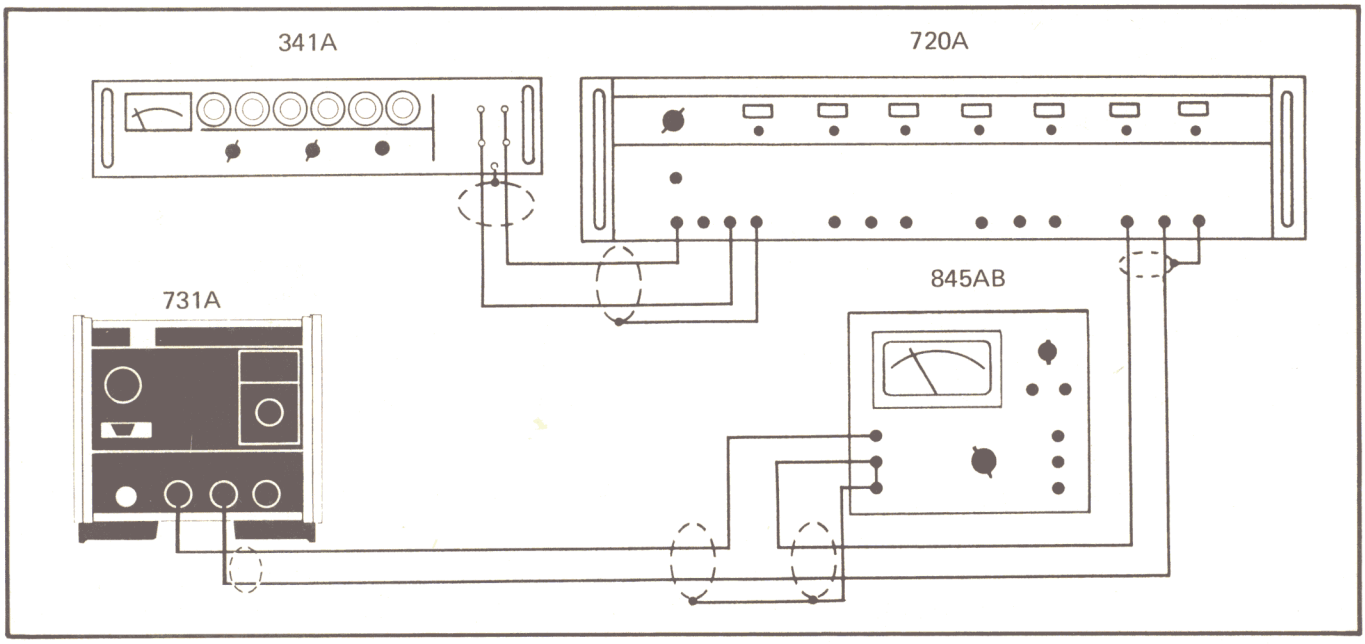


Figure 4-5. DIVIDER ADJUSTMENT - EQUIPMENT CONNECTIONS.

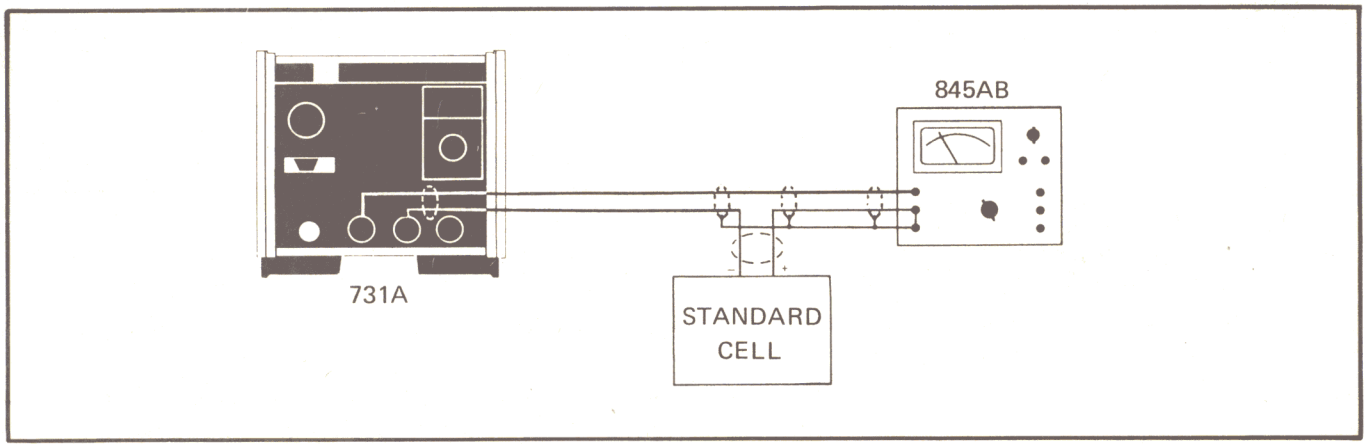


Figure 4-6. ABSOLUTE VOLTAGE ADJUSTMENT – EQUIPMENT CONNECTIONS

Section 5
List of Replaceable Parts

5-1. INTRODUCTION

5-2. This section of the manual is a complete illustrated parts list breakdown itemizing all assemblies and their components for this instrument. Illustrations for each listing aid in locating the assemblies and components. A Cross Reference List of Fluke stock numbers to original manufacturers' part numbers is included at the rear of this section.

5-3. Assemblies and subassemblies are identified by a reference designation beginning with the letter A followed by a number (e.g., A1 etc). Electrical components appearing on the schematic diagram are identified by their schematic diagram reference designation. Components not appearing on the schematic diagram are identified by Fluke stock numbers on the illustrations. Flagnotes are sometimes used and refer to special ordering explanations.

5-4. PARTS LIST COLUMN DESCRIPTIONS

a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.

b. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, refer to Appendix B located at the rear of the manual.

c. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

d. The TOT QTY column lists the quantity of the items used and reflects the latest Use Code. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF. The TOT QTY column lists the total quantity of the item in that particular assembly.

e. Entries in the REC QTY column indicate 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 every part 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 model. The REC QTY column lists the recommended quantity of the item in that particular assembly.

The USE CODE column identifies certain parts which have been added, deleted or modified during the 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 Serial Number Effectivity List, paragraph 5-9. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event

a parenthetical note is added in the DESCRIPTION column.

5-5. MANUFACTURERS' CROSS REFERENCE LIST COLUMN DESCRIPTIONS

a. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., is listed in the FLUKE STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

b. The Federal Supply Code for the item manufacturer is listed in the MFG column. An abbreviated list of Federal Supply Codes is included in the Appendix.

c. The part number which uniquely identifies the item to the original manufacturer is listed in the MFG PART NO. column. If a component must be ordered by description, the type number is listed.

5-6. HOW TO OBTAIN PARTS

5-7. Standard components have been used wherever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co. factory or authorized representative by using the Fluke part 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 instructions, if necessary.

5-8. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co., if you include the following information:

a. Quantity.
b. FLUKE Stock Number.
c. Description
d. Reference Designation
e. Instrument model and serial number

Example: 1 each, 203547, Diode, 1N759A, A2CR5 for 731A, S/N 123.

5-9. SERIAL NUMBER EFFECTIVITY

5-10. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 731A. 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 List below. All parts with no code are used on all instruments with serial numbers above 123.

USE CODE	EFFECTIVITY
NONE	Model 731A serial number 123 and on.

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	DC TRANSFER STANDARD **Figure 5-1**	731A			
A1	Front Panel Assembly (See Figure 5-2)		1		
A2	Main PCB Assembly (See Figure 5-3)	296830	1		
A3	Calibration PCB Assembly (See Figure 5-3)	304295	1		
A4	Rear Panel Assembly (See Figure 5-4)		1		
BT1	Battery pack, rechargeable, Ni-Cad, 14.4V	306134	1	1	
	Cover, bottom	296756	1		
	Cover, top	301523	1		
	Foot	292870	4		
	Line cord & plug	284174	1	1	

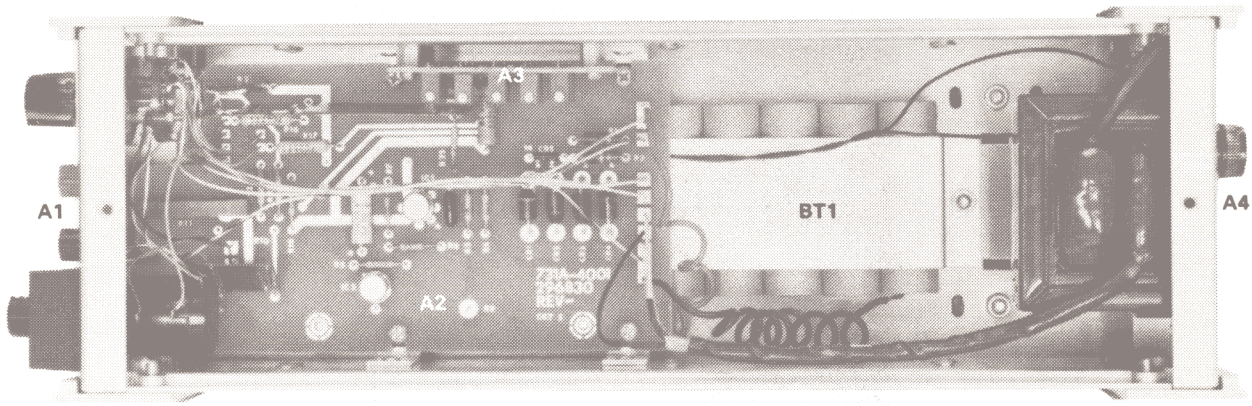


Figure 5-1. DC TRANSFER STANDARD

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A1	**FRONT PANEL ASSEMBLY** **Figure 5-2**		REF		
J1	Binding post, red, +	275552	1		
J2	Binding post, black, –	275560	1		
J3	Binding post, blue, GUARD	275578	1		
M1	Meter, 0-1 ma	266494	1	1	
R1	Res, var, ww, 5K ±5%, 2w	295626	1	1	
S1	Switch, toggle, POWER	115113	1	1	
S2	Switch, rotary, FUNCTION	284414	1	1	
	Dial, counting	295642	1	1	
	Knob, function switch	158956	1		
	Panel, front	296814	1		
	Decal, front panel	284307	1		

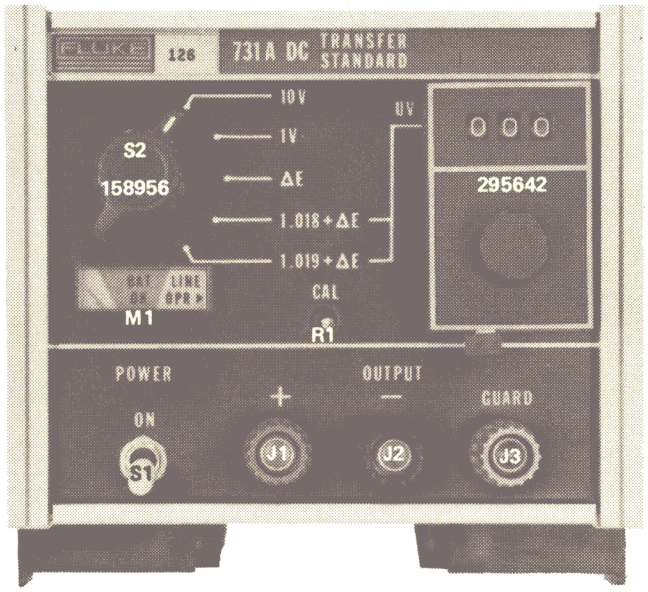


Figure 5-2. FRONT PANEL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2	**MAIN PCB ASSEMBLY** **Figure 5-3**	296830	REF		
C1	Cap, mica, 33 pf ±5%, 500V	160317	1		
C2	Cap, plstc, 0.033 uf ±10%, 200V	106062	1		
CR1 thru CR4	Diode, silicon, 1 amp, 100 piv	116111	4	4	
CR5	Diode, zener, 12V	203547	1	1	
IC1	IC, operational amplifier	271502	1		
IC2, R6, R7, R9, R10	Reference Amplifier Set, Factory selected & matched	297473	1	1	
R1	Res, comp, 510Ω ±5%, 1/2w	108951	1		
R2	Res, met flm, 6.98K ±1%, 1/8w	261685	1		
R3	Res, met flm, 4.22K ±1%, 1/8w	168245	1		
R4	Res, met flm, 12.1K ±1%, 1/8w	234997	1		
R5	Res, met flm, 1.27K ±1%, 1/8w	267369	1		
R8	Res, ww, tapped, 5.9K/11.424K ±0.05%, 1w (mounted on circuit side)	299537	1	1	
R11	Res, var, cermet, 10Ω ±30%, 3/4w	186205	1	1	
R13	Res, met flm, 412K ±1%, 1/2w	291138	1		
R16	Res, met flm, 8.06K ±1%, 1/2w	159467	1		
R17	Res, met flm, 31.6K ±1%, 1/2w	247585	1		
R18	Res, met flm, 1K ±1%, 1/8w	168229	1		
R20	Res, ww, tapped, 856Ω/8.995K ±0.05%, 1w	292771	1	1	
R21	Res, met flm, 732K ±1%, 1/2w	261164	1		
R22	Res, ww, 146Ω ±0.1%, 1/2w	235432	1		
R23	Res, met flm, 715K ±1%, 1/8w	236836	1		
R25	Res, met flm, 107Ω ±1%, 1/8w	309716	1		

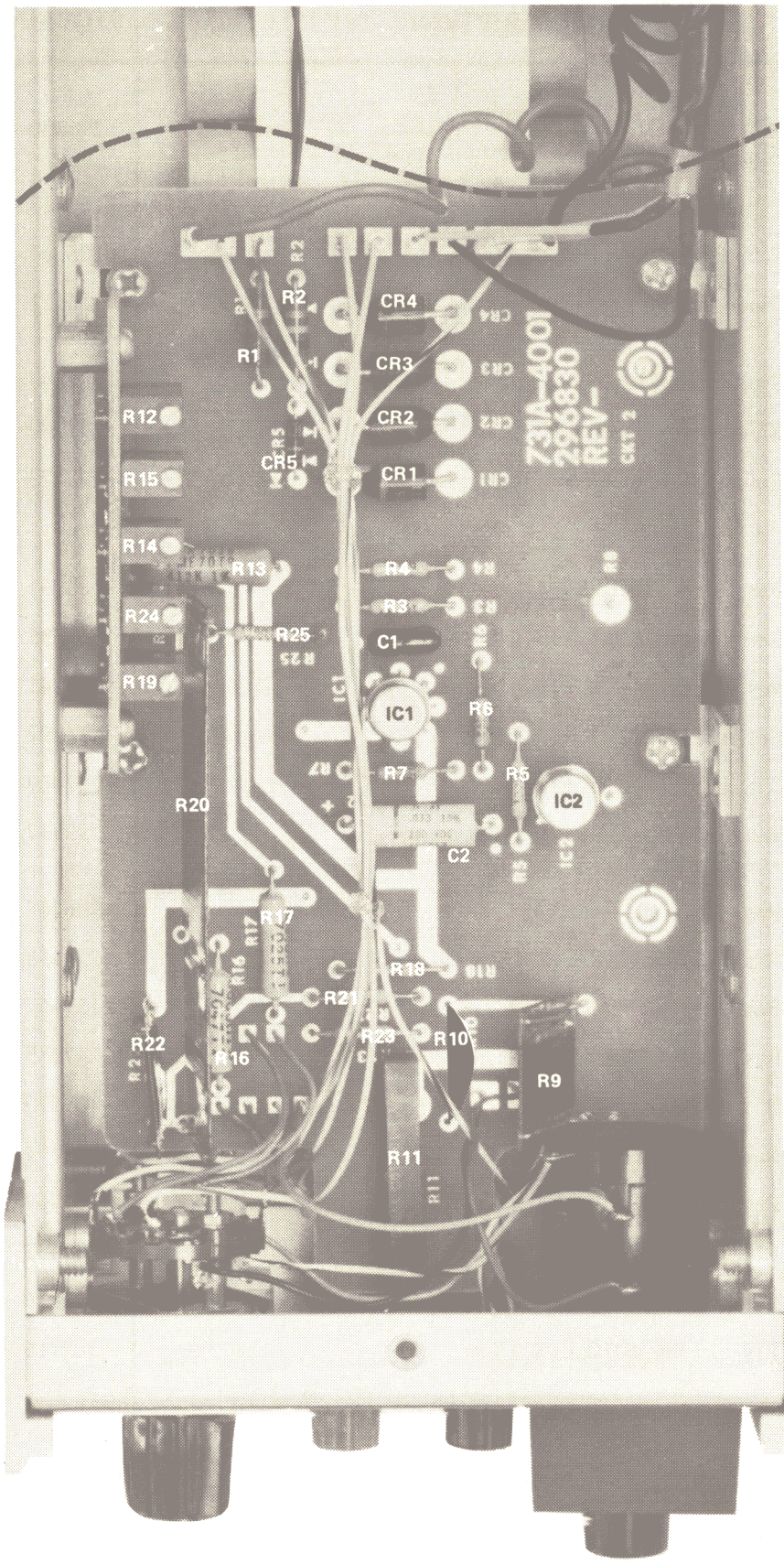


Figure 5-3. CALIBRATION PCB ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A3	**CALIBRATION PCB ASSEMBLY (See Figure 5-3)**	304295	REF		
R12, R14, R15	Res, var, cermet, 10K ±20%, 3/4w	159913	3		
R19	Res, var, cermet, 10Ω ±30%, 3/4w	186205	1		
R24	Res, var, cermet, 20Ω ±30%, 3/4 w	186197	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A4	**REAR PANEL ASSEMBLY** **Figure 5-4**		REF		
F1	Fuse, fast acting, ½ amp, 250v (for 115v operation)	153858	1	3	
F1	Fuse, fast acting, ¼ amp, 250v (for 230v operation)	109314		3	
P1	Connector	284166	1		
S1	Switch, slide, 115/230v	226274	1		
T1	Transformer, power	296871	1		
XF1	Fuse holder	100107	1		
	Panel, rear	296806	1		

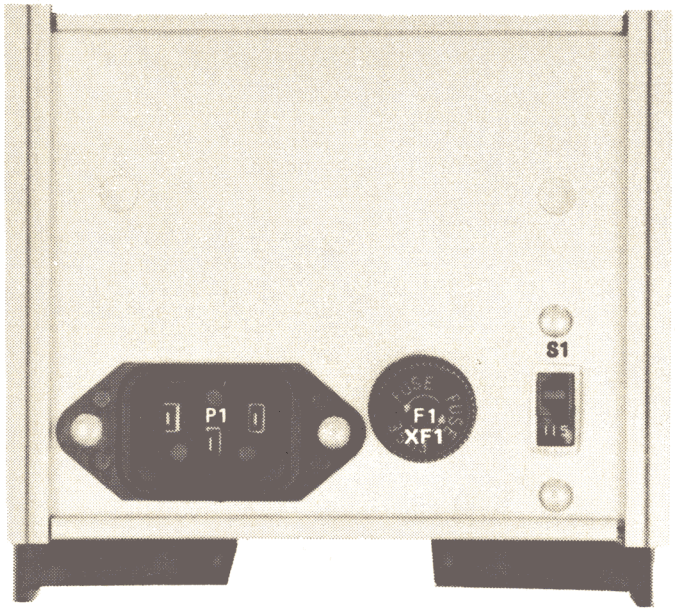


Figure 5-4. REAR PANEL ASSEMBLY

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
100107	71400	HKP
106062	56289	192P33392
108951	01121	EB5115
109314	71400	Type AGC
115113	95146	MST215N
116111	05277	1N4817
153858	71400	Type AGC
158956	89536	158956
159467	91637	Type MFF1/2
159913	73138	78PR10K
160317	14655	CD15E330J
168229	91637	Type MFF1/8
168245	91637	Type MFF1/8
186197	73138	78PR20
186205	73138	78PR10
203547	07910	1N759A
226274	82389	46256-LF
234997	91637	Type MFF1/8
235432	89536	235432
236836	91637	Type MFF1/8
247585	91637	Type MFF1/2
261164	91637	Type MFF1/2
261685	91637	Type MFF1/8
266494	89536	266494
267369	91637	Type MFF1/8
271502	12040	LM301A
275552	Griffith Plastic	820-65
275560	Griffith Plastic	820-45
275578	Griffith Plastic	820-55
284166	82389	EAC301
284174	70903	KHS7041
284307	89536	284307
284414	89536	284414
291138	91637	Type MFF1/2
292771	89536	292771
292870	89536	292870
295626	80294	3509S-9-502
295642	02660	Type 1380
296756	89536	296756
296806	89536	296806
296814	89536	296814
296830	89536	296830
296871	89536	296871
297473	89536	297473
299537	89536	299537
301523	89536	301523
304295	89536	304295
306134	06860	Type 0.450 AH
309716	91637	Type MFF1/8

Section 6

Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the accessories and options available for your instrument.

6-3. ACCESSORY INFORMATION

6-4. The accessory information, if applicable, will contain details concerning accessories that may be used with this particular instrument.

6-5. OPTION INFORMATION

6-6. Each of the options available for this instrument, if any, are described separately under headings containing the option number. The option descriptions contain applicable operating and maintenance instructions and field installation procedures. A complete list of replaceable parts for each option is contained at the end of that option description.

Accessory

Rack Mounting Fixtures

6-1. INTRODUCTION

6-2. The FLUKE quarter-rack instruments can be installed in a 19 inch equipment rack in various combinations and in conjunction with other FLUKE half-rack instruments. Figure 6-1 shows various mounting configurations.

6-3. Instructions for attaching rack mounting brackets are given in Figure 6-2. Figure 6-3 gives instructions for dual, triple, quadruple rack mounting. Instructions for combining quarter-rack with half-rack instruments are given in Figure 6-4.

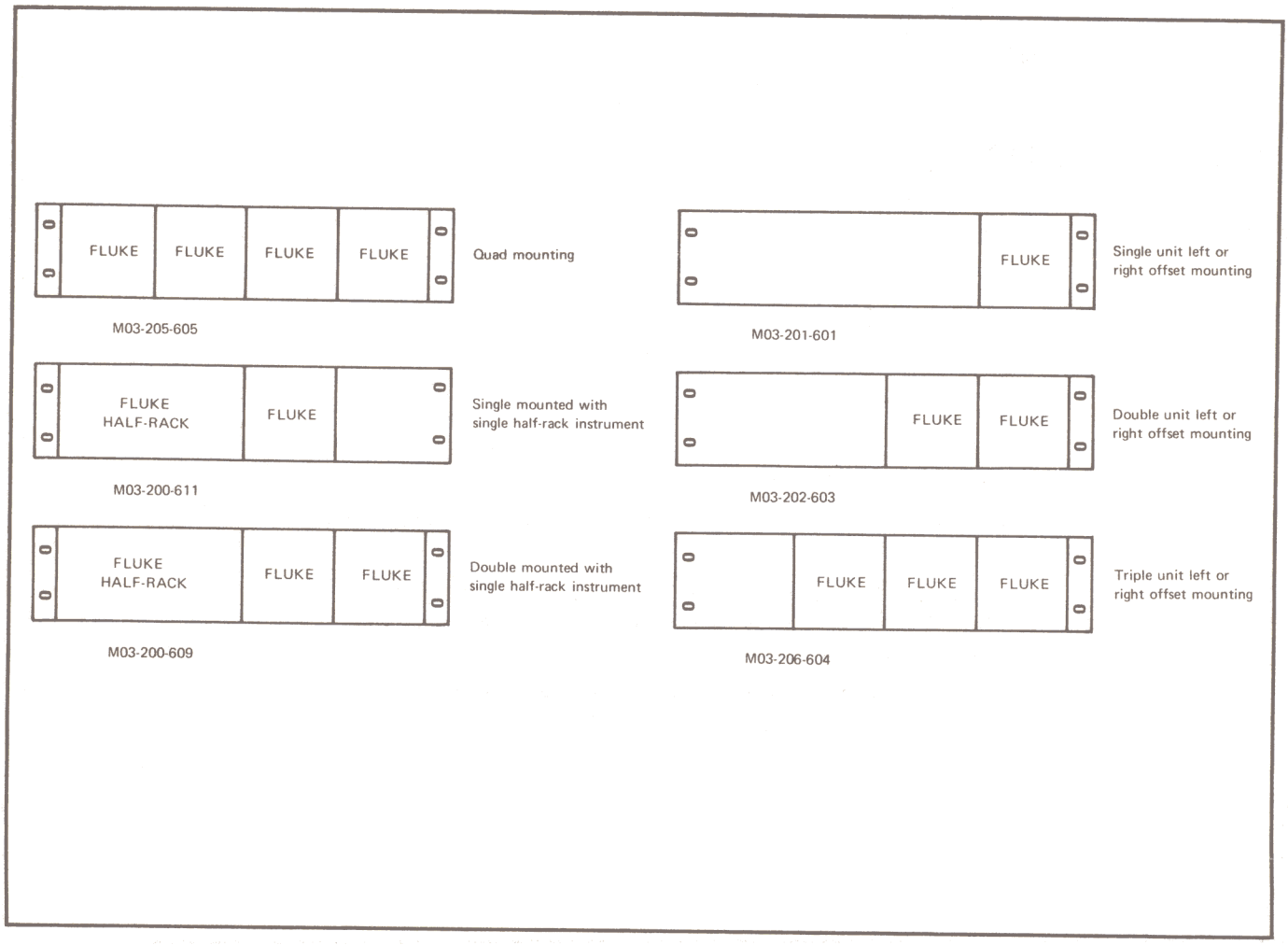
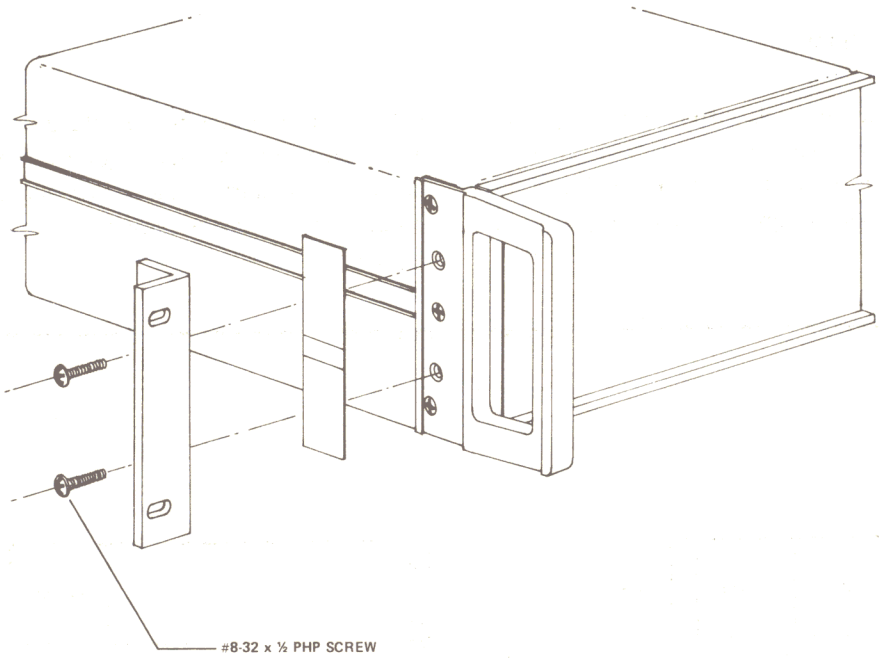


Figure 6-1. RACK MOUNTING CONFIGURATIONS

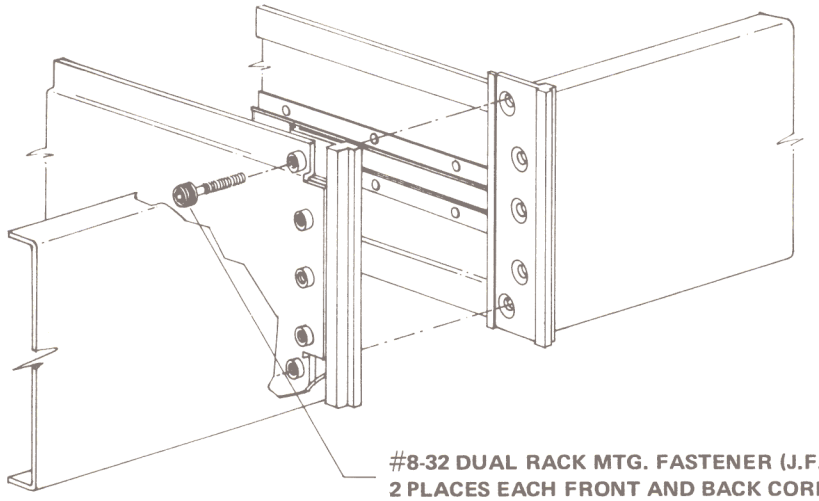
RACK MOUNTING PROCEDURE FOR MODULAR SERIES INSTRUMENTS



1. REMOVE THE FOUR MOLDED FEET AND BAIL FROM BOTTOM COVER.
2. REMOVE THE NAMEPLATE DECALS FROM THE FRONT CORNERS.
3. REMOVE THE SCREWS FROM CORNERS WHICH MATCH HOLE PATTERNS IN RACK MOUNTING EARS.
4. ATTACH RACK MOUNTING EARS WITH PAN HEAD SCREWS (ENCLOSED).

Figure 6-2. RACK EAR INSTALLATION

DUAL, TRIPLE & QUAD MOUNTING FOR MODULAR SERIES INSTRUMENTS



FLUKE PART NO.	DESCRIPTION	QUANTITY		
		DUAL RACK KIT #304816 #304808 #304782 #304360	TRIPLE RACK KIT #308130	QUAD RACK KIT #304980
#309708	DUAL RACK MTG. FASTENER	4	8	12

1. REMOVE TOP & BOTTOM COVERS FROM BOTH INSTRUMENTS.

2. REMOVE NAMEPLATE DECALS FROM CORNERS.

3. REMOVE TOP & BOTTOM SCREWS FROM BOTH FRONT & REAR CORNERS ON THE MATING SIDE OF THE INSTRUMENTS.

4. INSERT NO. 8-32 DUAL MOUNTING FASTENER, THROUGH THE P-NUTS IN BOTH FRONT & REAR CORNERS.

5. REMOVE FEET FROM BOTTOM COVERS AND REPLACE TOP & BOTTOM COVERS .

Figure 6-3. DUAL, TRIPLE AND QUAD MOUNT

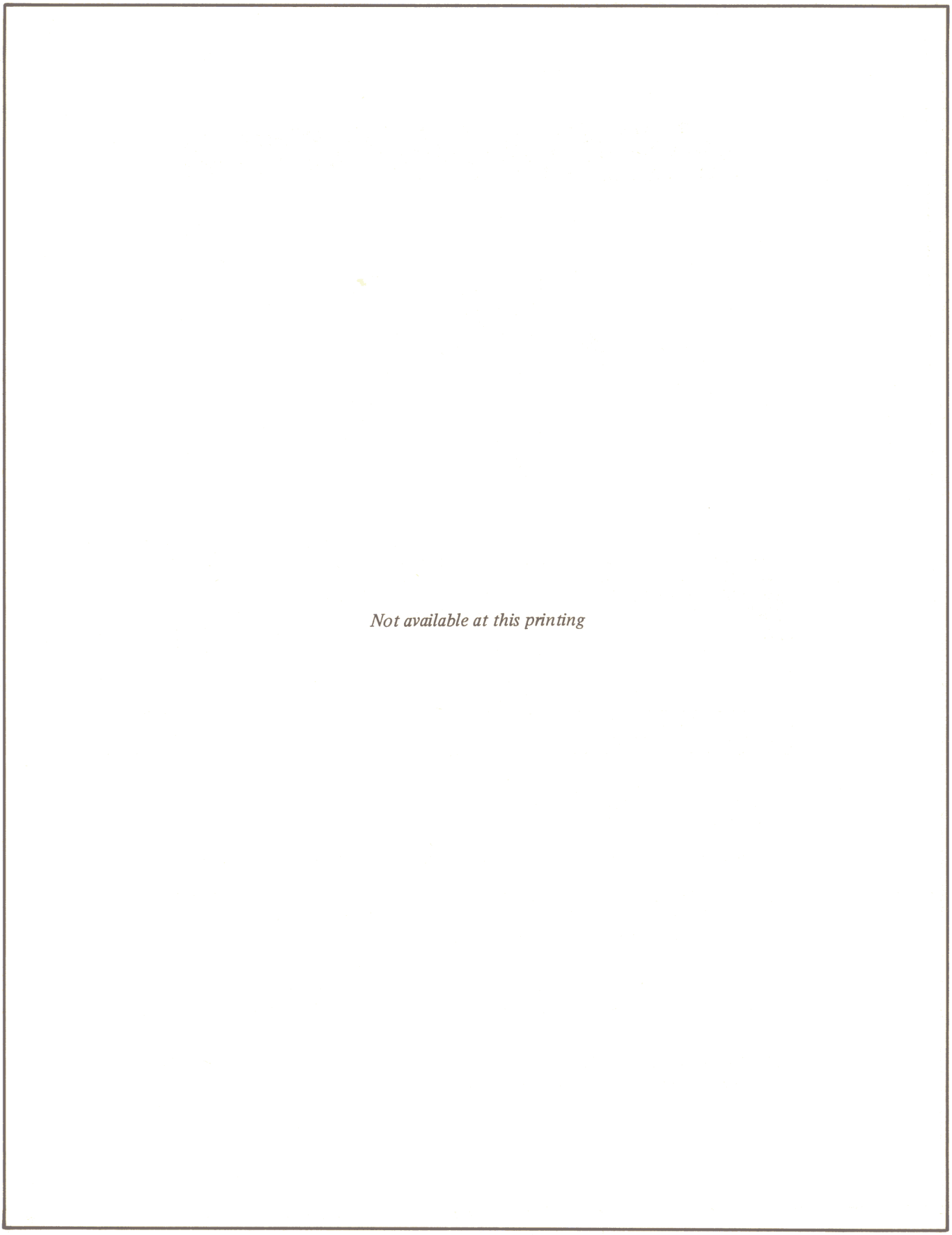


Figure 6-4. COMBINING WITH HALF-RACK INSTRUMENTS

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213 Sage Electronics Corp.
Rochester, New York

00327 Welwyn International, Inc.
Westlake, Ohio

00656 Aerovox Corp.
New Bedford, Massachusetts

00779 AMP Inc.
Harrisberg, Pennsylvania

01121 Allen-Bradley Co.
Milwaukee, Wisconsin

01281 TRW Semiconductors
Lawndale, California

01295 Texas Instruments, Inc.
Semiconductor Components Div.
Dallas, Texas

01686 RCL Electronics Inc.
Manchester, New Hampshire

01730 Deleted

01884 Dearborn Electronics Inc.
Orlando, Florida

02114 Ferroxcube Corp.
Saugerties, New York

02606 Replaced by 15801

02660 Amphenol-Borg Elect. Corp.
Broadview, Illinois

02799 Arco Capacitors, Inc.
Los Angeles, California

03614 Replaced by 71400

03651 Replaced by 44655

03797 Eldema Corp.
Compton, California

03877 Transitron Electronic Corp.
Wakefield, Massachusetts

03888 Pyrofilm Resistor Co., Inc.
Cedar Knolls, New Jersey

03911 Clairex Corp.
New York, New York

03980 Muirhead Instruments, Inc.
Mountainside, New Jersey

04009 Arrow Hart and Hegemen
Electronic Company
Hartford, Connecticut

04062 Replaced by 72136

04202 Replaced by 81312

04217 Essex Wire Corp.
Wire & Cable Div.
Anaheim, California

04221 Aemco
Div. of Midtex Inc.
Mankato, Minnesota

04645 Replaced by 75376

04713 Motorola Semiconductor
Products Inc.
Phoenix, Arizona

05082 Replaced by 94154

05236 Jonathan Mfg. Co.
Fullerton, California

05277 Westinghouse Electric Corp.
Semiconductor Dept.
Youngwood, Pennsylvania

05278 Replaced by 43543

05397 Union Carbide Corp.
Electronics Div.
Cleveland, Ohio

05571 Sprague Electric Co
Pacific Div.
Los Angeles, California

05704 Alac, Inc.
Glendale, California

05820 Wakefield Engineering Ind.
Wakefield, Massachusetts

06001 General Electric Company
Capacitor Department
Irmo, South Carolina

06136 Replaced by 63743

06473 Amphenol Space & Missile Sys.
Chatsworth, California

06555 Beede Electrical Instrument Co.
Penacook, New Hampshire

06739 Electron Corp.
Littletown, Colorado

06743 Clevite Corp.
Cleveland, Ohio

06751 Semcor Div. Components
Phoenix, Arizona

06860 Gould National Batteries Inc.
City of Industry, California

06980 Eitel-McCullough, Inc.
San Carlos, California

07115 Replaced by 14674

07138 Westinghouse Electric Corp.
Electronic Tube Div.
Elmira, New York

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

07344 Bircher Co., Inc.
Rochester, New York

07792 Lerma Engineering Corp.
Northampton, Massachusetts

07910 Continental Device Corp.
Hawthorne, California

08530 Reliance Mica Corp.
Brooklyn, New York

08792 CBS Electronics Semiconductor
Operations-Div. of CBS Inc.
Lowell, Massachusetts

08806 General Electric Co.
Miniature Lamp Dept.
Cleveland, Ohio

08863 Nylomatic Corp.
Norrisville, Pennsylvania

08988 Skottie Electronics Inc.
Archbald, Pennsylvania

09922 Burndy Corp.
Norwalk, Connecticut

11237 Chicago Telephone of Calif. Inc.
South Pasadena, California

11358 CBS Electronics
Div. of CBS Inc.
Newburyport, Massachusetts

11403 Best Products Co.
Chicago, Illinois

11503 Keystone Mfg.
Div. of Avis Industrial Corp.
Warren, Michigan

12014 Chicago Rivet & Machine Co.
Bellwood, Illinois

12040 National Semiconductor Corp.
Danburry, Connecticut

12060 Diodes, Inc.
Chatsworth, California

12136 Philadelphia Handle Co.
Camden, New Jersey

12323 Presin Co., Inc.
Shelton, Connecticut

12327 Freeway Washer & Stamping Co.
Cleveland, Ohio

12400 Replaced by 75042

12617 Hamlin Inc.
Lake Mills, Wisconsin

12697 Clarostat Mfg. Co.
Dover, New Hampshire

12749 James Electronics
Chicago, Illinois

12856 Micrometals
Sierra Madre, California

12954 Dickson Electronics Corp.
Scottsdale, Arizona

13606 Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839 Replaced by 23732

14099 Semtech Corp.
Newbury Park, California

14193 California Resistor Corp.
Santa Monica, California

14298 American Components, Inc.
Conshohocken, Pennsylvania

14655 Cornell-Dubilier Electronics
Newark, New Jersey

14674 Corning Glass Works
Corning, New York

14752 Electro Cube Inc.
San Gabriel, California

14869 Replaced by 96853

15636 Elec-Trol Inc.
Northridge, California

15801 Fenwal Electronics Inc.
Framingham, Massachusetts

15818 Amelco Semiconductor
Div. of Teledyne Inc.
Mountain View, California

15849 Useco, Inc.
Mt. Vernon, New York

15909 Replaced by 17870

16332 Replaced by 28478

16473 Cambridge Scientific Ind. Inc.
Cambridge, Maryland

16742 Paramount Plastics
Downey, California

16758 Delco Radio
Div. of General Motors
Kokomo, Indiana

17069 Circuit Structures Lab.
Upland, California

17856 Siliconix, Inc.
Sunnyvale, California

17870 Daven-Div. of Thomas A. Edison
Ind. --McGraw-Edison Co.
Manchester, New Hampshire

18083 Deleted

18178 Vactec Inc.
Maryland Heights, Missouri

18736 Voltronics Corp.
Hanover, New Jersey

19429 Montronics, Inc.
Seattle, Washington

19451 Perine Machinery & Supply Co.
Seattle, Washington

19701 Electra Mfg. Co.
Independence, Kansas

20584 Enochs Mfg. Co.
Indianapolis, Indiana

22767 ITT Semiconductors
Div. of ITT
Palo Alto, California

23732 Tracor
Rockville, Maryland

24248 Southco
Div. of South Chester Corp.
Lester, Pennsylvania

24655 General Radio Co.
West Concord, Massachusetts

25403 Amperex Electronic Corp
Semiconductor & Receiving
Tube Division
Slatersville, Rhode Island

28478 Deltrol Controls Corp.
Milwaukee, Wisconsin

28520 Heyman Mfg. Co.
Kenilworth, New Jersey

30323 Illinois Tool Works Inc.
Chicago, Illinois

33173 General Electric Co.
Tube Dept.
Owensboro, Kentucky

37942 Mallory, P. R., & Co., Inc.
Indianapolis, Indiana

38315 Honeywell Inc.
Precision Meter Div.
Manchester, New Hampshire

42498 National Company
Melrose, Massachusetts

43543 Nytronics Inc.
Transformer Co. Div.
Alpha, New Jersey

44655 Ohmite Mfg. Co.
Skokie, Illinois

49671 Radio Corp. of America
New York, New York

49956 Raytheon Company
Lexington, Maine

53021 Sangamo Electric Co.
Springfield, Illinois

55026 Simpson Electric Company
Chicago, Illinois

56289 Sprague Electric Co.
North Adams, Massachusetts

58474 Superior Electric Co.
Bristol, Connecticut

60399 Torrington Mfg. Co.
Torrington, Connecticut

62460 Deleted

63743 Ward Leonard Electric Co.
Mount Vernon, New York

64834 West Mfg. Co.
San Francisco, California

65092 Weston Instruments Inc.
Newark, New Jersey

66150 Winslow Tele-Tronics Inc.
Asbury Park, New Jersey

70563 Amperite Company
Union City, New Jersey

70903 Belden Mfg. Co.
Chicago, Illinois

71002 Birnbach Radio Co., Inc.
New York, New York

71400 Bussmann Mfg.
Div. of McGraw-Edison Co.
St. Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71468 ITT Cannon Electric Inc.
Los Angeles, California

71482 Clare, C. P. & Co.
Chicago, Illinois

71590 Centralab
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707 Coto Coil Co., Inc.
Providence, Rhode Island

71744 Chicago Miniature Lamp Works
Chicago, Illinois

71785 Cinch Mfg. Co. & Howard
B. Jones Div.
Chicago, Illinois

72005 Driver, Wilber B., Co.
Newark, New Jersey

72092 Replaced by 06980

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72259 Nytronics Inc.
Berkeley Heights, New Jersey

72354 Deleted

72619 Dialight Corp.
Brooklyn, New York

72653 G. C. Electronics
Rockford, Illinois

72665 Replaced by 90303

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

72928 Gudeman Co.
Chicago, Illinois

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293 Hughes Aircraft Co.
Electron Dynamics Div.
Newport Beach, California

73445 Amperex Electronic Corp.
Hicksville, New York

73559 Carling Electric Inc.
Hartford, Connecticut

73586 Circle F Industries
Trenton, New Jersey

73734 Federal Screw Products, Inc.
Chicago, Illinois

73743 Fischer Special Mfg. Co.
Cincinnati, Ohio

73899 JFD Electronics Co.
Brooklyn, New York

73949 Guardian Electric Mfg. Co.
Chicago, Illinois

74199 Quam Nichols Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74276 Signalite Inc.
Neptune, New Jersey

74306 Piezo Crystal Co.
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 IRC Inc.
Philadelphia, Pennsylvania

75376 Kurz-Kasch, Inc.
Dayton, Ohio

75382 Kulka Electric Corp.
Mt. Vernon, New York

75915 Littlefuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 Potter & Brumfield
Div. of Amer. Machine & Foundry
Princeton, Indiana

77969 Rubbercraft Corp. of Calif. LTD.
Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
St. Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Deleted

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components &
Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88419 Use 14655

88690 Replaced by 04217

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

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

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

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg. Co., Inc.
Wakefield, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

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

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co., Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div
Mamaroneck, New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

Revised August 1, 1968
Using H4-1 and H4-2
Dated June, 1968

Appendix B

List of Abbreviations

A,amp	ampere
ampl	amplifier
ac	alternating current
assy	assembly
BCD	binary coded decimal
cap	capacitor
car	carbon
cm	centimeter
C	centigrade
cer	ceramic
cw	clockwise
CMRR	common mode rejection ratio
comp	composition
CCW	counterclockwise
conn	connector
CRT	cathode ray tube
cps	cycles per second
db	decibel
dvm	digital voltmeter
dc	direct current
dpdt	double-pole, double-throw
dpst	double-pole, single-throw
elect	electrolytic
ext	external
f	fahrenheit
F	farad
FET	field effect transistor
flm	film
Ge	germanium
g	giga or 10^9
gnd	ground
gmv	guaranteed minimum value
grd	guard
h	henry
Hz	hertz
hf	high frequency
IC	integrated circuit
if	intermediate frequency
int	internal
kc	kilocycle
k	kilo (10^3)
lf	low frequency
mc	megacycle
M	meg or mega (10^6)
met	metal
MOS	metal oxide silicon
μ	micro or 10^{-6}
m	milli or 10^{-3}
mm	millimeter
n	nano or 10^{-9}
neg	negative
Ω	ohm
osc	oscilloscope
ppm	parts per million
piv	peak inverse voltage
p-p	peak to peak
p	pico or 10^{-12}
plstc	plastic
$\pm$	plus or minus
pos	positive
pps	pulses per second
PCB	printed circuit board
QTY	quantity
rf	radio frequency
rfi	radio frequency interference
REC	recommended
REF	reference
RH	relative humidity
res	resistor
rms	root mean square
rtry	rotary
sec	second
sect	section
S/N	serial number
Si	silicon
scr	silicon controlled rectifier
spdt	single-pole, double-throw
spst	single-pole, single-throw
sw	switch
Ta	tantalum
TC	temperature coefficient
t	tera or 10^{12}
xfmr	transformer
tstr	transistor
tvm	transistor voltmeter
uhf	ultra high frequency
vtvm	vacuum tube voltmeter
var	variable
vhf	very high frequency
vlf	very low frequency
V	volt
VCO	voltage controlled oscillator
w	watt
ww	wire wound

Appendix C

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Port O'Call Executive Ctr.
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8031 Zurich
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Suriwong
Bangkok, Thailand

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Garnet Close
Watford, WD2 4TT
England

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Cerrito 617 - 4º Piso
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Coasin C.A.
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Sabana Grande No. 1
Caracas, Venezuela

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Fey Elektronische Messgeraete
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Horemansstrasse 28
West Germany

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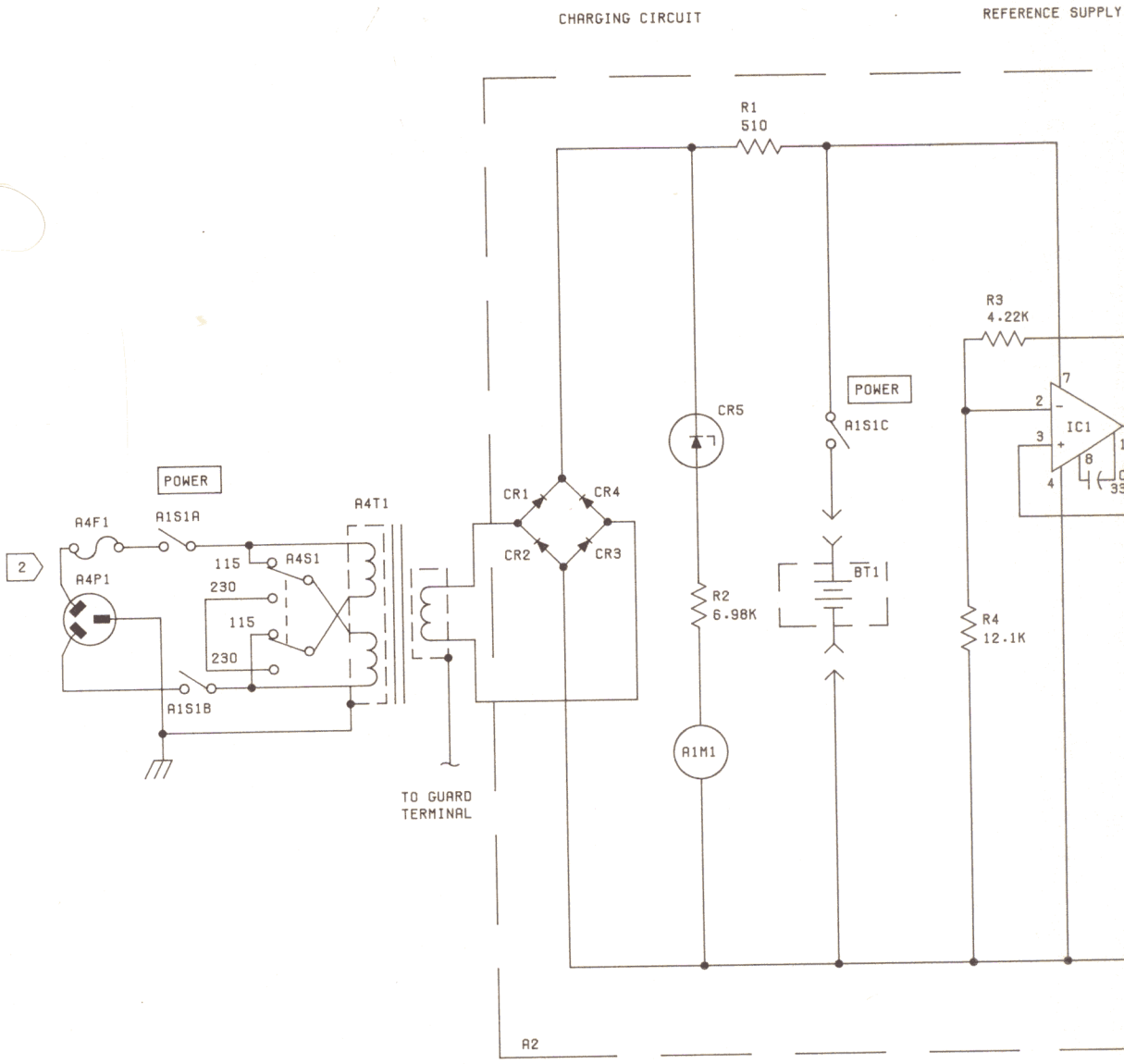
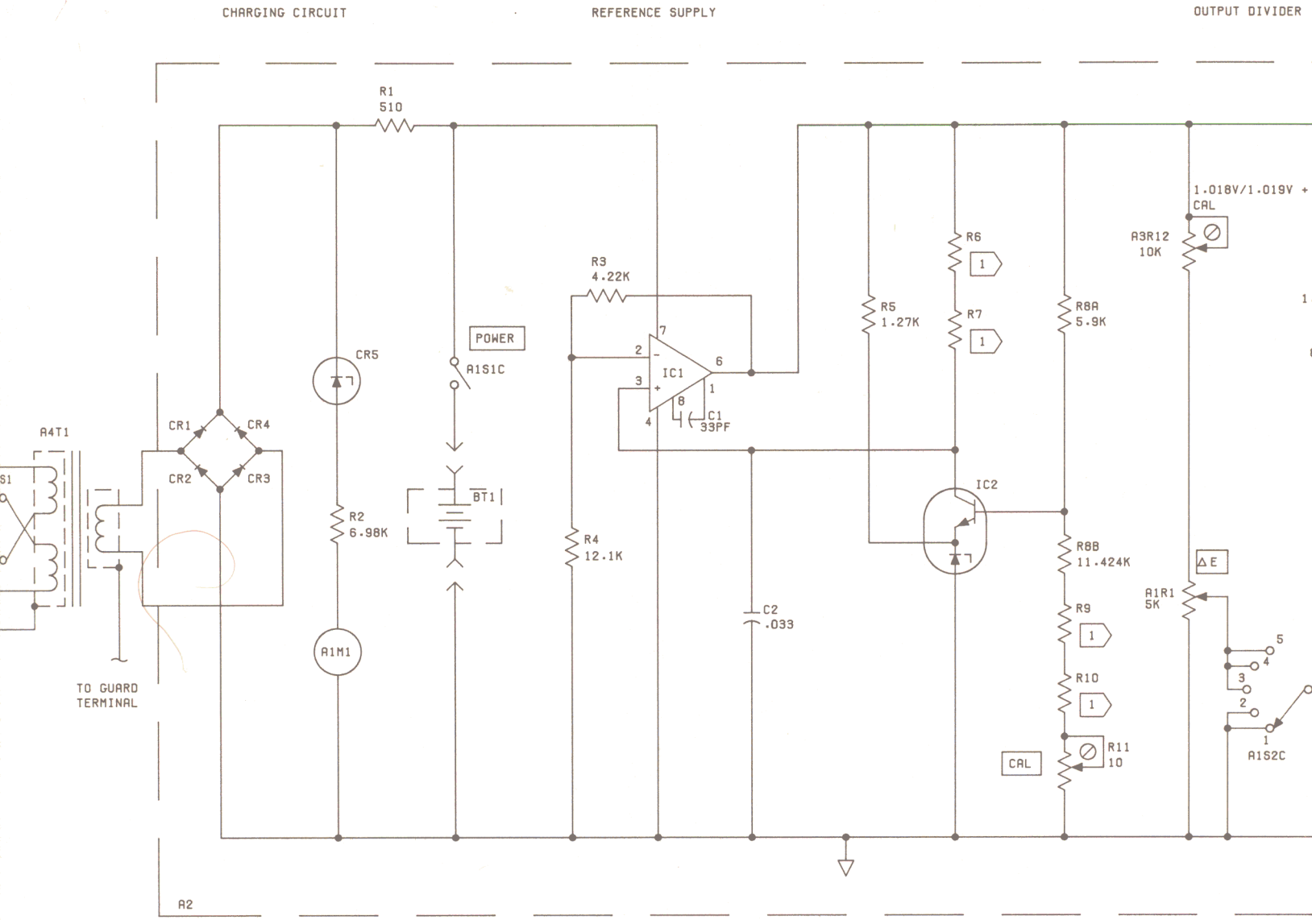


REF DESIG PREFIX	ASSEMBLY NAME	NEXT HIGHER ASSEMBLY
NONE	CHASSIS	NONE
A1	FRONT PANEL	CHASSIS
A2	MAIN PCB	CHASSIS
A3	CALIBRATION PCB	A2
A4	REAR PANEL	CHASSIS

SWITCH A1S2 POSITION	FUNCTION
1	10V
2	1V
3	ΔE
4	1.018 + ΔE
5	1.019 + ΔE



REF DESIG PREFIX	ASSEMBLY NAME	NEXT HIGHER ASSEMBLY
NONE	CHASSIS	NONE
A1	FRONT PCB	CHASSIS
A2	MAIN PCB	CHASSIS
A3	CALIBRATION PCB	A2
A4	REAR PANEL	CHASSIS

SWITCH A1S2 POSITION	FUNCTION
1	10V
2	1V
3	ΔE
4	1.018 + ΔE
5	1.019 + ΔE

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ALL RESISTANCES IN OHMS AND
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UNLESS OTHERWISE SPECIFIED.

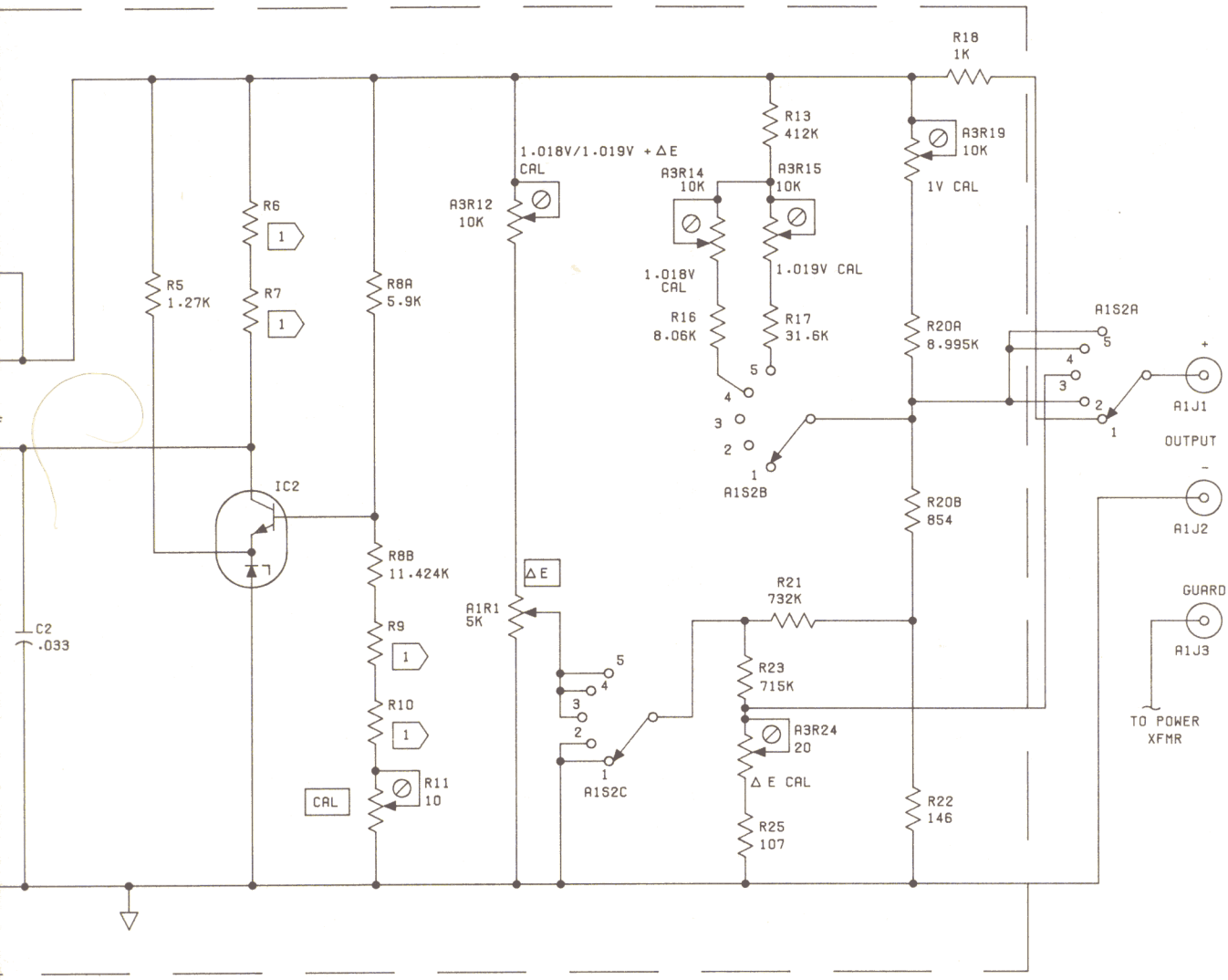
⊘ DENOTES SCREWDRIVER ADJUSTMENT.

□ DENOTES FRONT PANEL LOCATION.

⟨1⟩ DENOTES SELECTED COMPONENT.

⟨2⟩ FUSE RATING 115V - AGC 1/2 AMPERE
230V - AGC 1/4 AMPERE

OUTPUT DIVIDER



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LL RESISTANCES IN OHMS AND
LL CAPACITANCES IN MICROFARADS
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DENOTES FRONT PANEL LOCATION.

1 DENOTES SELECTED COMPONENT.

2 FUSE RATING 115V - AGC 1/2 AMPERE
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