



Instruction Manual

Model

845AR

High Impedence
Voltmeter
Null Detector

WARRANTY

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

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

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

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

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

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

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

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

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

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

The JOHN FLUKE MFG. CO., INC. will be happy to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX 43210, MOUNTLAKE TERRACE, WASHINGTON 98043, ATTEN: Sales Dept. For European Customers: Fluke (Nederland) B.V., Zevenhevelenweg 53, Tilburg, The Netherlands.

* For European customers, Air Freight prepaid.

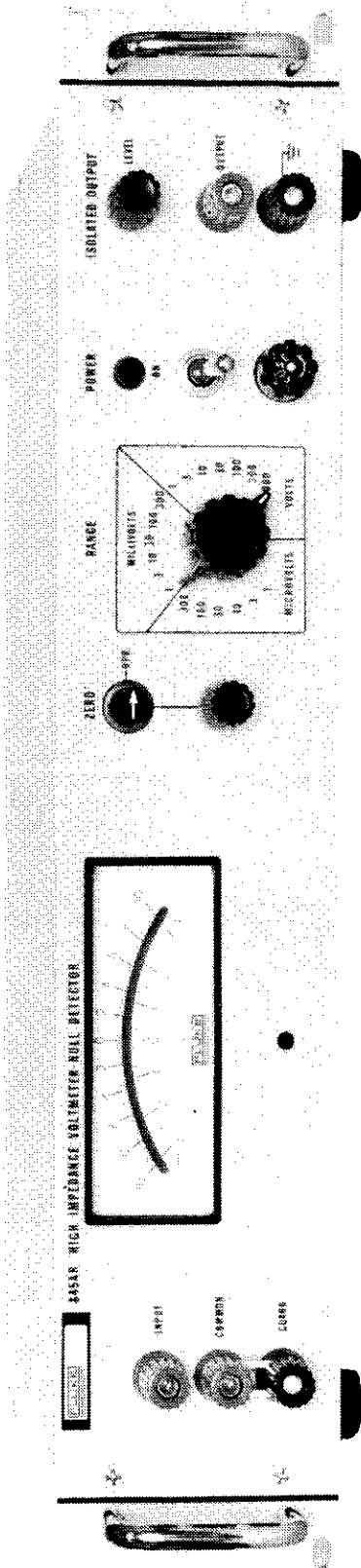
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TABLE OF CONTENTS

Section	Title	Page
I	INTRODUCTION AND SPECIFICATIONS	1-1
	1-1. Introduction	1-1
	1-4. Electrical Specifications	1-1
	1-5. Environmental Specifications	1-1
	1-6. Mechanical Specification	1-2
II	OPERATING INSTRUCTIONS	2-1
	2-1. Receiving Inspection	2-1
	2-3. Controls, Terminals, and Indicator	2-1
	2-5. Preliminary Operation	2-1
	2-7. Mechanical Zeroing	2-2
	2-9. Operation as a High Impedance Voltmeter	2-2
	2-11. Operation as a Null Detector	2-2
	2-13. Measuring Voltages With a Standard Cell	2-3
	2-15. Use of Isolated Output	2-3
	2-20. Operating Notes	2-3
III	THEORY OF OPERATION	3-1
	3-1. Introduction	3-1
	3-3. Block Diagram Analysis	3-1
	3-8. Circuit Description	3-2
IV	MAINTENANCE	4-1
	4-1. General	4-1
	4-3. Test Equipment	4-1
	4-5. 230 Volt Power-Line Conversion	4-1
	4-8. Disassembly Instructions	4-1
	4-10. Corrective Maintenance	4-2
	4-20. Calibration Procedures	4-5
V	LIST OF REPLACEABLE PARTS	5-1
	5-1. Introduction	5-1
	5-3. Columnar Information	5-1
	5-4. How to Obtain Parts	5-1
	5-7. List of Abbreviations	5-2
	5-8. Serial Number Effectivity	5-12
VI	NOT APPLICABLE	
VII	GENERAL INFORMATION	7-1
VIII	SCHEMATIC	8-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
Frontispiece	Model 845AR High Impedance Voltmeter-Null Detector	iii
1-1.	Model 845AR Outline Drawing	1-2
2-1.	Controls, Terminals, and Indicator	2-1
2-2.	Bridge Detector - Floating Supply	2-2
2-3.	Bridge Detector - High Resistance	2-2
2-4.	Bridge Detector - Floating Null Detector	2-3
2-5.	Standard Cell Voltage Measurements	2-3
2-6.	Chassis Ground - Jumper Wire Location	2-4
3-1.	Model 845AR Block Diagram	3-1
4-1.	Test Equipment Requirements	4-1
4-2.	T201 115/230 Volt AC Power Terminals	4-2
4-3.	Troubleshooting Chart (Sheet 1 of 3)	4-2
4-3.	Troubleshooting Chart (Sheet 2 of 3)	4-3
4-3.	Troubleshooting Chart (Sheet 3 of 3)	4-4
4-4.	Waveform at TP10	4-4
4-5.	Waveforms at TP6	4-4
4-6.	Waveform at TP7	4-5
4-7.	Waveform at TP7 - Q104 Removed	4-5
4-8.	Waveform at TP2	4-5
4-9.	Waveform at TP1	4-5
4-10.	Leakage Resistance Test Equipment Equipment Connections	4-6
4-11.	Test and Alignment Points	4-6
4-12.	Calibration Equipment Connections	4-6
5-1.	Final Assembly	5-3
5-2.	Chassis Assembly	5-4
5-3.	Front Panel Assembly	5-5
5-4.	Amplifier P/C Assembly (Sheet 1 of 2)	5-7
5-4.	Amplifier P/C Assembly (Sheet 2 of 2)	5-8
5-5.	Power Supply P/C Assembly	5-10



MODEL 845AR HIGH IMPEDANCE VOLT-METER-NULL DETECTOR

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Fluke Model 845AR High Impedance Voltmeter-Null Detector allows measurement of dc voltages from one microvolt to 1000 volts dc in 19 ranges. When used as a null detector on the 100 millivolt range and below, the input impedance is an excellent 10 megohms. A linear recorder output allows the instrument to be used for production testing, and also as a dc amplifier with a maximum gain of 120 db.

1-3. The instrument may be wired to operate from a line power source of 115 volts ac or 230 volts ac, as desired. The instrument is designed to be mounted directly in a standard EIA 19 inch relay rack. Resilient feet are also provided for bench top use.

1-4. ELECTRICAL SPECIFICATIONS

INPUT VOLTAGE RANGE

1 microvolt to 1000 volts dc end scale in nineteen ranges, using X1 and X3 progression.

INPUT RESISTANCE

100 megohms on 300 millivolt range and above; 10 megohms on 100 millivolt range and below.

ACCURACY

±(3% end scale + 0.1 microvolt).

MAXIMUM NOISE (input shorted)

Range	Noise (peak-peak)
1 microvolt	0.20 microvolt
3 microvolt	0.25 microvolt
10 microvolt - 1000 volt	0.30 microvolt

METER RESPONSE TIME (to 90% of reading)

Range	Time
1 microvolt	5 seconds
3 microvolt	3 seconds
10 microvolt - 1000 volt	1-1/2 seconds

INPUT ISOLATION

Better than 10^{12} ohms at less than 50% relative humidity and 25° C regardless of line, chassis, or recorder

grounding. Better than 10^{10} ohms up to 80% relative humidity and 35° C. With driven guard, isolation improves by at least one order of magnitude up to 10^{13} ohms. Any input terminal may be floated 1100 volts off chassis ground.

DC COMMON MODE REJECTION

Better than 160 db, input short-circuited, 80% relative humidity; better than 140 db, open-circuited, 50% relative humidity; better than 120 db, open-circuited, 80% relative humidity.

AC COMMON MODE REJECTION (below 100 kHz)

100 volts rms or 120 db greater than end scale, whichever is less, will effect reading less than 2% of end scale. Input open-circuited.

AC NORMAL MODE REJECTION (60 Hz and above)

AC voltages 60 db above end scale will effect reading less than 2% of end scale. Maximum voltage not to exceed 750 volts rms.

RECORDER OUTPUT

0-1 volt, one side at chassis ground; linear to 0.5% of end scale. Source impedance, 5k to 7.5k.

STABILITY OF ZERO

Better than 0.15 microvolt/hr, better than 0.3 microvolt/day.

TEMPERATURE COEFFICIENT OF ZERO

Less than 0.1 microvolt/°C from 15° C to 35° C. Less than 0.2 microvolt/°C from 0° C to 50° C.

ZERO CONTROL RANGE

±5 microvolt minimum.

OVERLOAD PROTECTION

Up to 1100 volts dc may be applied on any range. Typical recovery time is 4 seconds.

INPUT POWER

115/230 volts ac ±10%, 50 to 440 Hz, approximately 3 watts.

1-5. ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE RANGE

Within all specifications from 15° C to 35° C.

Within all specifications from 0° to 50° C except:
Derate by a factor of two –
Maximum Noise and Meter Response Time.
DC Common Mode Rejection –
Derate by 20 db.

STORAGE TEMPERATURE RANGE
-40° C to +70° C.

RELATIVE HUMIDITY RANGE
0 to 80%.

SHOCK
Meets hammer blow requirements of MIL-T-945A and
MIL-S-901B.

VIBRATION
Meets 10 Hz to 55 Hz tests of MIL-T-945A.

1-6. MECHANICAL SPECIFICATIONS

MOUNTING
Standard EIA relay rack. Resilient feet provided for
bench use.

WEIGHT
9 pounds.

SIZE
3.47 inches high x 19 inches wide x 8.26 inches deep.

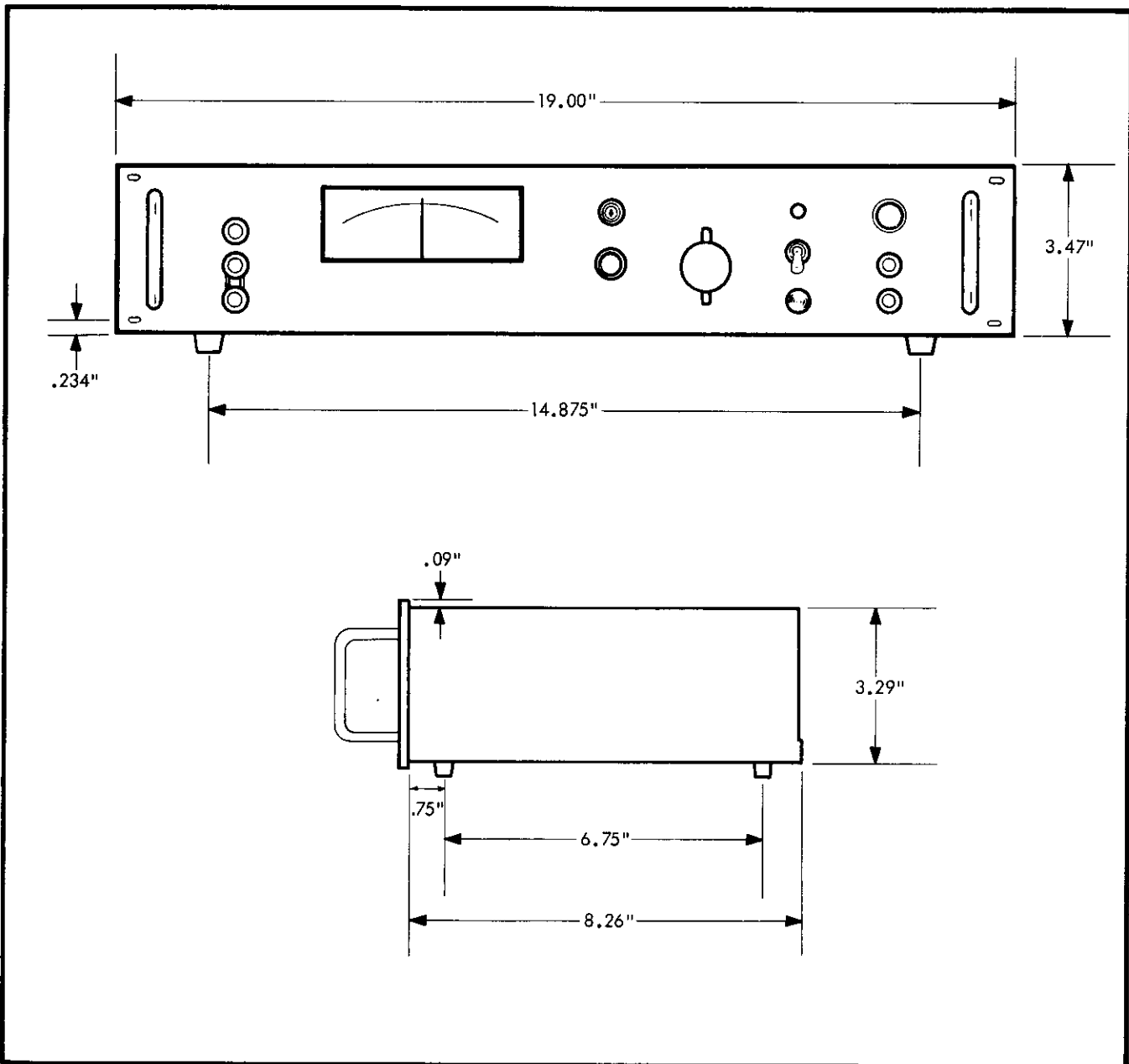


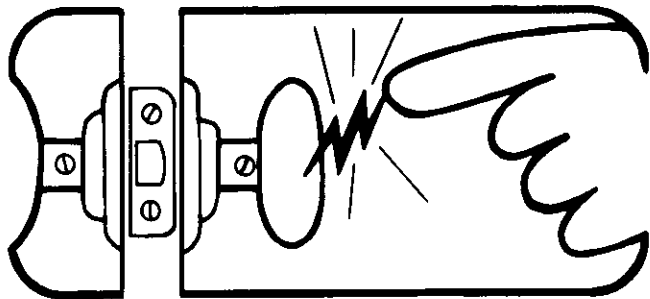
Figure 1-1. MODEL 845AR OUTLINE DRAWING



static awareness



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



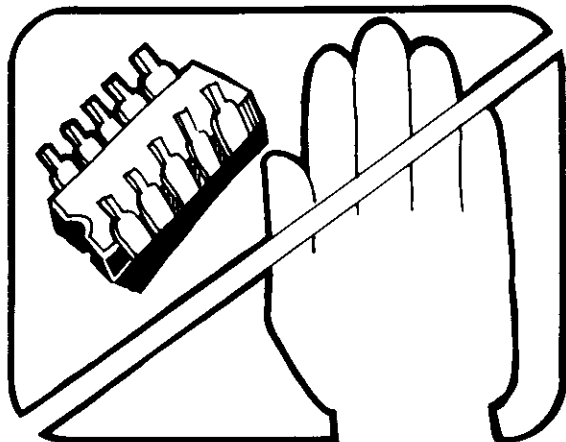
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

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

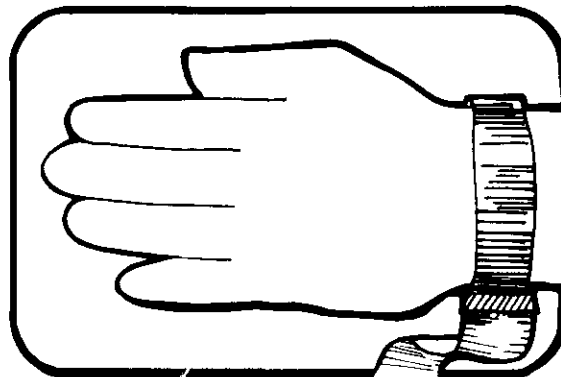
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol



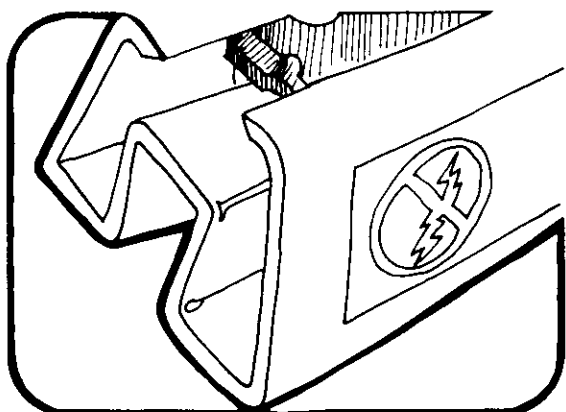
The following practices should be followed to minimize damage to S.S. devices.



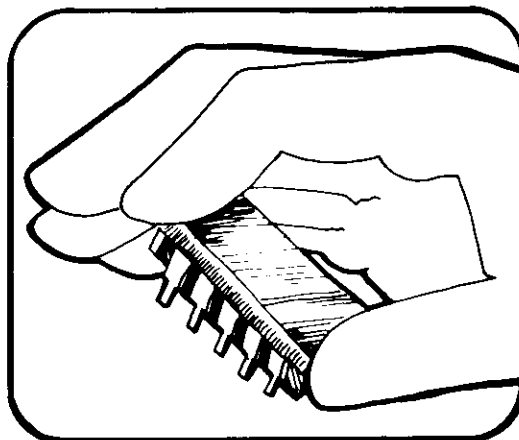
1. MINIMIZE HANDLING



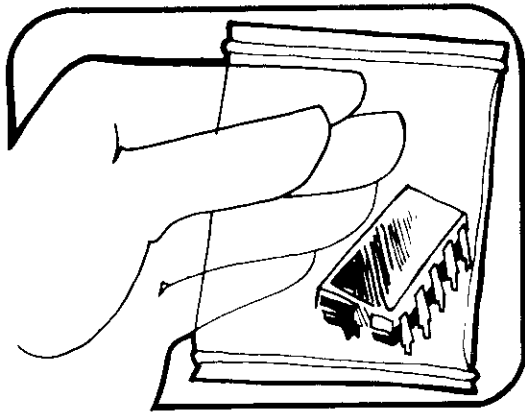
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



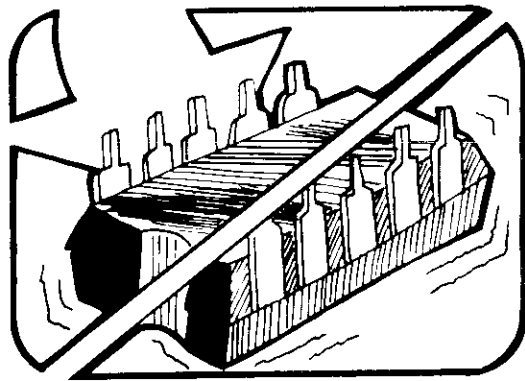
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



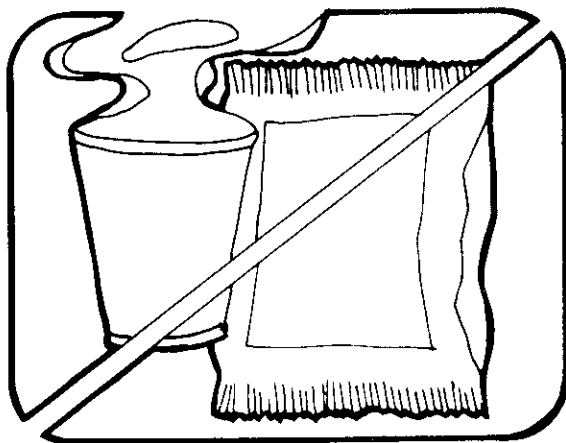
4. HANDLE S.S. DEVICES BY THE BODY



5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT

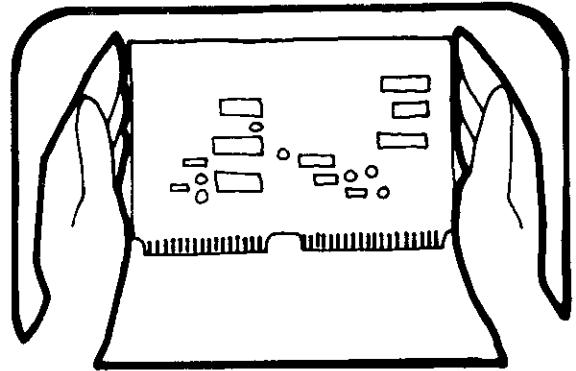


6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE

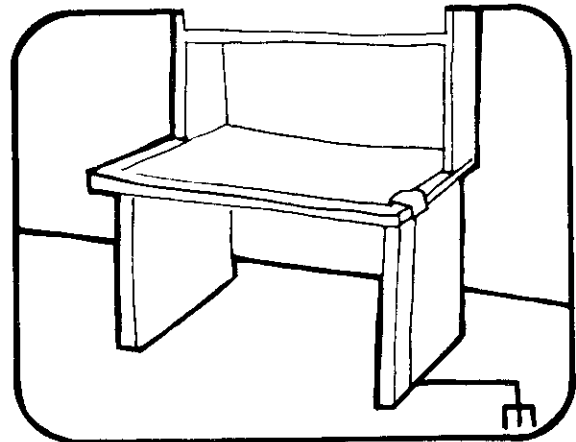


7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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AND GENERAL DYNAMICS, POMONA DIV.



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



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

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
453522	6" X 8" Bag
453530	8" X 12" Bag
453548	16" X 24" Bag
454025	12" X 15" Bag
Pink Poly Sheet	Wrist Strap
30"x60"x60 Mil	P/N TL6-60
P/N RC-AS-1200	\$7.00
\$20.00	

SECTION II

OPERATING INSTRUCTIONS

2-1. RECEIVING INSPECTION

2-2. This instrument has been thoroughly tested and inspected before being shipped from the factory. Immediately upon receiving the instrument, carefully inspect for damage which may have occurred during shipment. If any damage is noted, follow the instructions outlined in the warranty page at the back of this manual.

2-3. CONTROLS, TERMINALS, AND INDICATOR

2-4. The location and function of the front-panel controls are described in Figure 2-1. Detailed operating descriptions are given in the following paragraphs.

2-5. PRELIMINARY OPERATION

2-6. Connect the Model 845AR line plug to a 115 volt ac power outlet or to 230 volts ac if the instrument is so wired.

WARNING!

The round pin on the polarized three-prong plug connects the instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact outlet. For personnel safety, connect the short lead from the adapter to a high-quality earth ground.

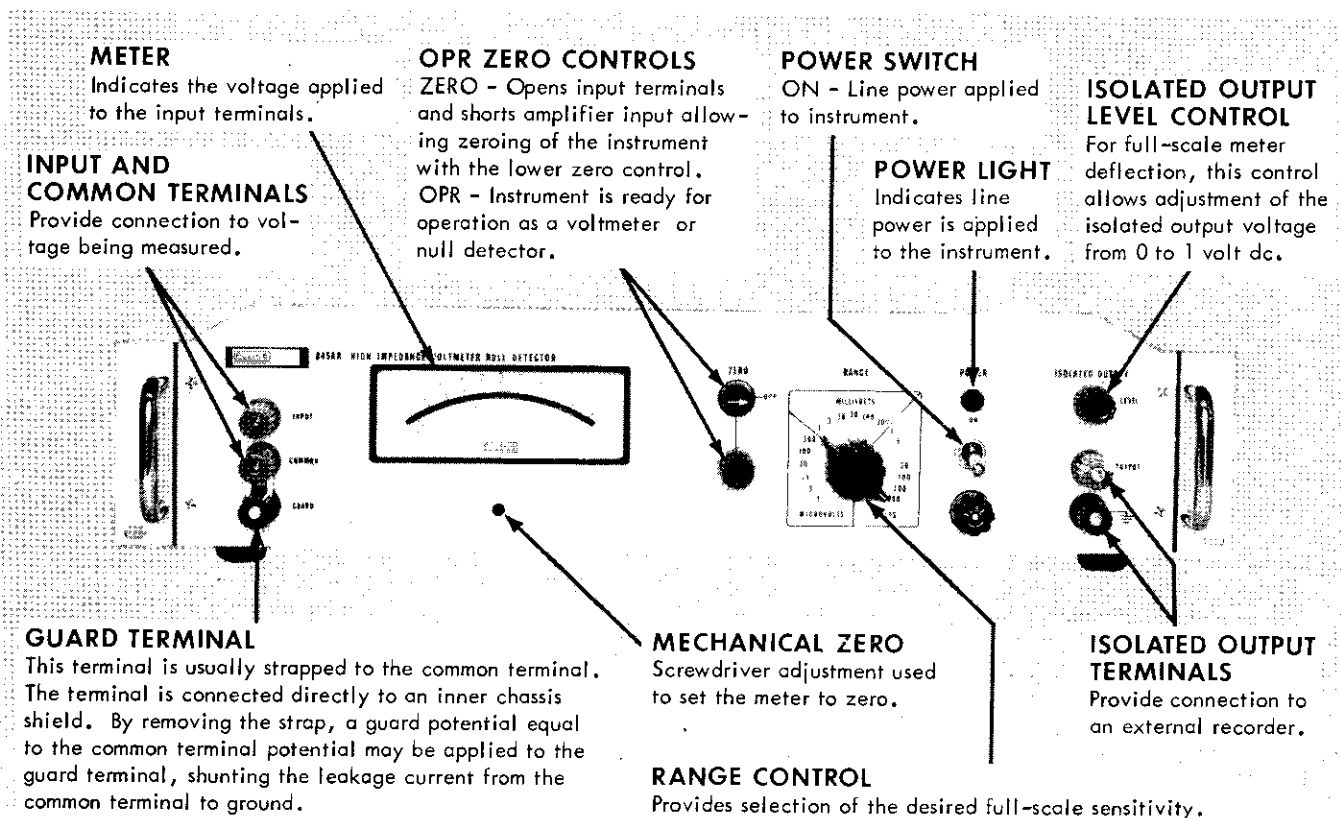


Figure 2-1. CONTROLS, TERMINALS, AND INDICATOR

- a. Place the Model 845AR controls as follows:

POWER	ON
RANGE	10 MICROVOLTS
OPR/ZERO	ZERO

- b. Adjust the zero control for an initial zero meter deflection. Place the RANGE switch to the 1 MICROVOLT RANGE and re-zero with the zero control.

2-7. MECHANICAL ZEROING

2-8. It may become necessary to adjust the mechanical zero control of the Model 845AR at more frequent intervals than complete calibration. To mechanically zero the instrument proceed as follows:

- a. Place the RANGE switch to 1000 VOLTS and the POWER switch to ON.
- b. Adjust the mechanical zero adjustment screw for zero meter deflection.
- c. Place the RANGE switch to 10 MICROVOLTS and electrically zero the instrument as outlined in paragraph 2-5.
- d. Repeat steps a and b.

2-9. OPERATION AS A HIGH IMPEDANCE VOLTMETER

2-10. To operate the Model 845AR as a High Impedance Voltmeter perform the preliminary operations according to paragraph 2-5 and proceed as follows:

- a. Place the controls as follows:

POWER	ON
OPR/ZERO	OPR
RANGE	1000 VOLTS

Note!

When measuring voltages in the microvolt ranges, use copper wire having low thermal EMF's.

- b. Connect the voltage to be measured to the Model 845AR INPUT terminal and connect the common point of the voltage being measured to the COMMON terminal.
- c. Deflection of the meter indicates the polarity and magnitude of the measured voltage. Increase the sensitivity of the Model 845AR for maximum on-scale deflection.

2-11. OPERATION AS A NULL DETECTOR

2-12. The Model 845AR may be used to monitor small voltage differences in bridge circuits, potentiometers, and other measuring apparatus. In most of these applications the circuits are adjusted for zero deflection or a null on the Model 845AR. Equipment connections for

various types of null detector configurations are illustrated by Figure 2-2 through 2-4. To operate the Model 845AR as a Null Detector, perform the preliminary operations according to paragraph 2-5 and proceed as follows:

- a. Select the desired equipment application as illustrated by Figure 2-2 through 2-4 and make the appropriate equipment connections.

- b. Place the Model 845AR controls as follows:

POWER	ON
OPR/ZERO	OPR
RANGE	as desired

- c. Adjust the circuit being measured for zero or a null deflection on the Model 845AR meter.

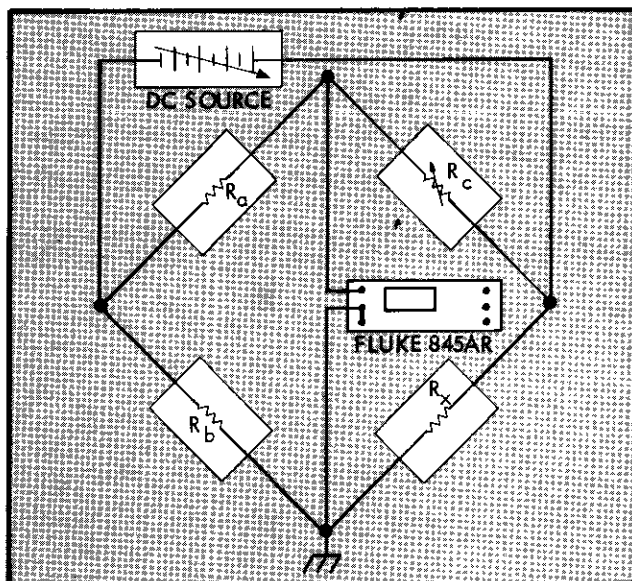


Figure 2-2. BRIDGE DETECTOR - FLOATING SUPPLY

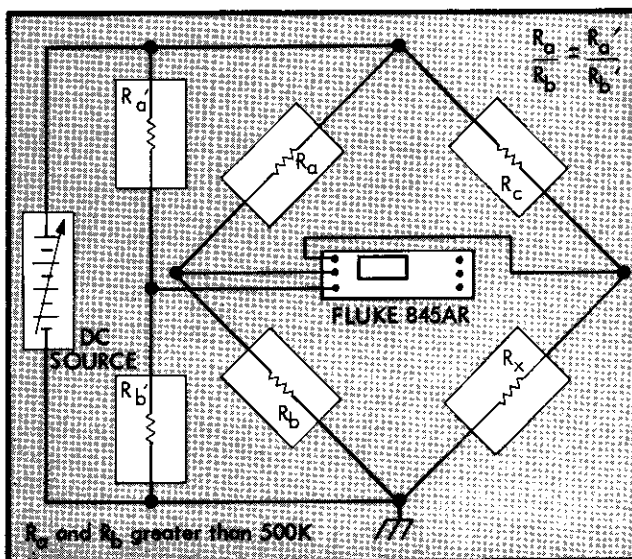


Figure 2-3. BRIDGE DETECTOR - HIGH RESISTANCE

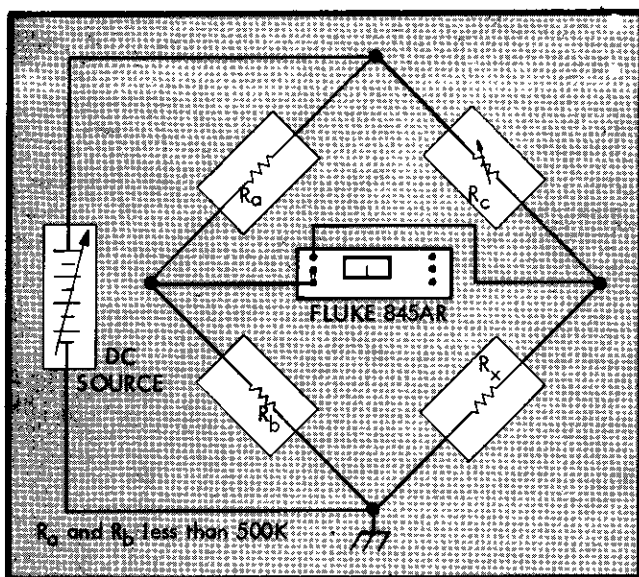


Figure 2-4. BRIDGE DETECTOR - FLOATING NULL DETECTOR

2-13. MEASURING VOLTAGES WITH A STANDARD CELL

2-14. The Model 845AR may be used with a voltage divider and a standard cell to calculate unknown voltages with a high degree of accuracy. Connect the equipment as illustrated in Figure 2-5. Perform the preliminary operation as outlined in paragraph 2-5 and proceed as follows:

- a. Place the Model 845AR controls as follows:

POWER	ON
OPR/ZERO	OPR
RANGE	as desired

- b. Adjust the voltage divider for zero or null deflection on the Model 845AR meter while placing the RANGE switch to successively more sensitive ranges.

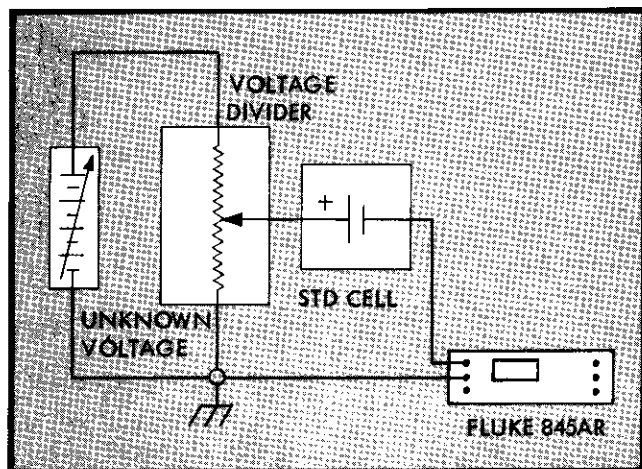


Figure 2-5. STANDARD CELL VOLTAGE MEASUREMENTS

- c. Calculate the unknown voltage by dividing the standard cell voltage by the final division ratio of the divider.

2-15. USE OF ISOLATED OUTPUT

2-16. DC ISOLATION AMPLIFIER

2-17. The Model 845AR may be used as a dc isolation amplifier having a voltage gain of up to 120 db, depending on the settings of the RANGE switch and the OUTPUT LEVEL control. To compute the maximum voltage gain on any range of the Model 845AR, use the following formula:

$$\text{Voltage gain in db} = 20 \log_{10} \frac{1 \text{ volt (maximum isolated output)}}{\text{Range (in volts)}}$$

2-18. RECORDER OUTPUT

2-19. The Model 845AR ISOLATED OUTPUT may be used to provide an output voltage, adjustable from zero to one volt for a full-scale meter deflection for use with a recorder. Since the output is isolated from the input, floating measurements can be made without the use of a floating recorder. To use the adjustable recorder output, proceed as follows:

- a. Connect the recorder to the ISOLATED OUTPUT terminals.

Note!

The lower ISOLATED OUTPUT terminal is connected to chassis ground. If a ground reference is undesirable, remove the jumper wire above R202 on the power supply circuit board. Refer to Figure 2-6 for jumper wire location.

- b. Turn the recorder on.
- c. Proceed as outlined in paragraph 2-9 or 2-11, as desired.
- d. Adjust the ISOLATED OUTPUT LEVEL control for the desired output to the recorder. This control has a log taper so that smooth control is possible at both high and low settings.

Note!

The ISOLATED OUTPUT current capability is 100 microamperes with a 5 kilohm source impedance.

2-20. OPERATING NOTES

2-21. SPURIOUS VOLTAGES AND CURRENTS

2-22. Voltage measurements at the microvolt level involve the persistent problems of thermoelectric effects. These effects may be compensated for by temporarily disconnecting the voltage from the circuit under measurement and noting the meter deflection of the

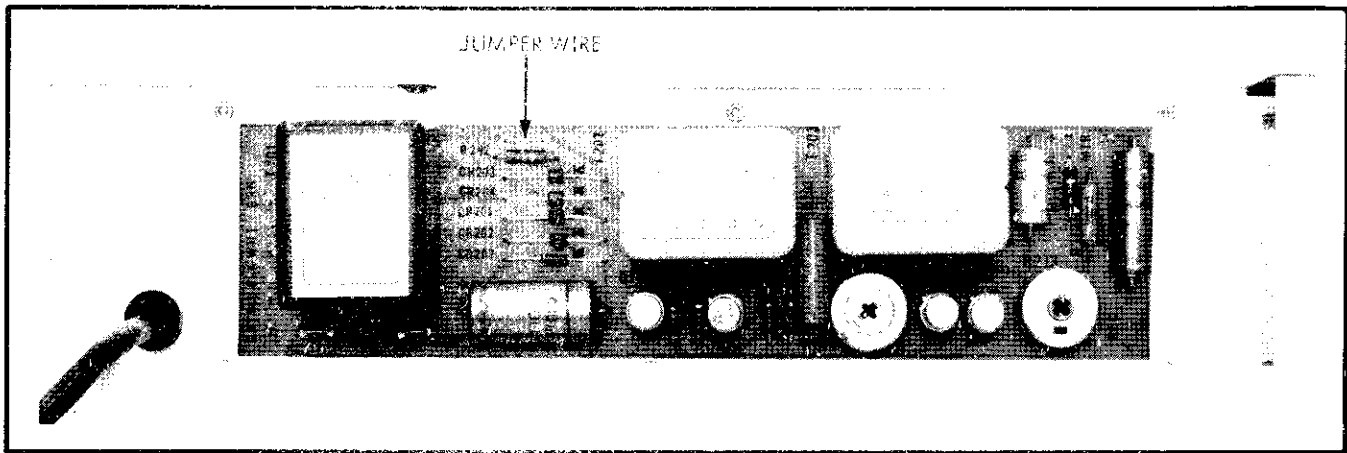


Figure 2-6. CHASSIS GROUND - JUMPER WIRE LOCATION

Model 845AR on the desired range. This reading must then be subtracted from all subsequent voltage measurements. A thorough understanding of these effects can lead to reducing or eliminating them completely.

2-23. THERMOELECTRIC VOLTAGES

2-24. If a circuit is composed of two dissimilar metals, a net voltage will result if the two dissimilar junctions are maintained at different temperatures. These thermoelectric voltages, also known as thermals, thermocouple voltages, or Seebeck voltages, can be reduced by using metals having low thermoelectric potentials, and keeping all junctions at the same temperature. The terminals of the Model 845AR are made of pure copper, gold-flashed to prevent tarnish. For lowest thermal voltages, all connections to the Model 845AR should be made with pure copper wire. Silver plated copper or solder coated copper also produce satisfactory results. Tinned copper is less satisfactory than silver plated or copper coated copper. Nickel and nickel-based alloys are not suitable for connections to the instrument. Excellent results can be obtained using ordinary TV twin lead, or even lamp cord if high insulation resistance is not required. If shielding is necessary, use a length of flat braid over the cable.

2-25. HIGH SOURCE IMPEDANCE

2-26. Due to the very high input resistance and extreme sensitivity of the Model 845AR, it is charge sensitive. Thus, a person's body potential, an electrostatic voltage, can cause charge redistribution at the input to the instrument and result in meter needle deflection as a hand approaches the input terminals. Careful shielding will eliminate this problem. Also, due to charges that may be deposited on the input terminals when the OPR-ZERO switch is set to ZERO, an appreciable transient will result when the switch is set to OPR if nothing is connected to the input terminals. Turning the switch back and forth will dissipate this charge, eliminating the problem. With a high source impedances, the response of the instrument is unavoidably slow due to the low pass filter used to suppress superimposed noise. However, the design of the low pass filter is such that common mode rejection is extremely high while the response time for the normally encountered low source impedances is very fast.

2-27. OVERLOAD VOLTAGES

2-28. The instrument is designed to withstand up to 1100 volts dc or 1100 volts peak ac continuously applied between any two of the three input terminals or between cabinet ground and any of the three input terminals regardless of the setting of the RANGE or OPR-ZERO switch. However, repeated or continuous overloads above 200 volts in the ranges below 3 millivolts will result in dissipation in protective, low-pass-filter resistor R110. This will result in thermal voltages which may take several minutes to subside after the overload is removed.

2-29. GUARDING

2-30. The instrument has an inner chassis connected to the GUARD terminal on the front panel. Ordinarily, this GUARD terminal is strapped to the COMMON terminal. When connected in this way the inner chassis serves as a shield. This greatly improves the leakage resistance to ground and the common mode rejection. However, since the inner chassis is available at the GUARD terminal, it may be driven at the same voltage as the COMMON terminal. This further increases the leakage resistance and common mode rejection by about ten times. The voltage used to drive the GUARD terminal should be obtained from a separate source or by means of a voltage divider connected directly across the source so that the leakage currents do not cause voltage drops across impedances in the circuit under measurement.

2-31. INCREASING INPUT RESISTANCE

2-32. In the 1 microvolt to 1 millivolt ranges, a 10 megohm resistor is connected directly across the input of the instrument. The input resistance may be increased on these ranges by disconnecting the 10 megohm resistor where it attaches to the RANGE switch. However, the input resistance will no longer be well defined. Typical input resistances with the 10 megohm resistor removed are as follows:

Range	Input Resistance
1 uv	300 megohms
3 uv	1,000 megohms
10 uv	3,000 megohms
30 uv to 1 mv	10,000 megohms

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The Model 845AR High Impedance Voltmeter-Null Detector theory of operation is contained in this section of the manual. A block diagram is illustrated in Figure 3-1, and a functional schematic diagram is located at the end of Section V. The block diagram and functional schematic diagram are to be used as an aid in understanding circuit theory, and in troubleshooting.

3-3. BLOCK DIAGRAM ANALYSIS

3-4. The Model 845AR is a photo-chopper stabilized amplifier with the overall gain of the amplifier being

precisely controlled by negative feedback. The instrument's main circuits are an input range divider, a photocell modulator, an ac amplifier, a synchronous demodulator, a dc amplifier, a meter, an isolation converter, a neon drive, an 84 Hz multivibrator, a supply rectifier, and a rectifier filter.

3-5. The input range divider provides a fixed input impedance to signals of less than 1 millivolt while allowing reduction of input signals above 1 millivolt. Photochoppers modulate the input signal to the ac amplifier at 84 Hz. The drive signal for the photo modulator is provided by the neon drive which is composed of neon lamps driven alternately at 84 Hz by the 84 Hz

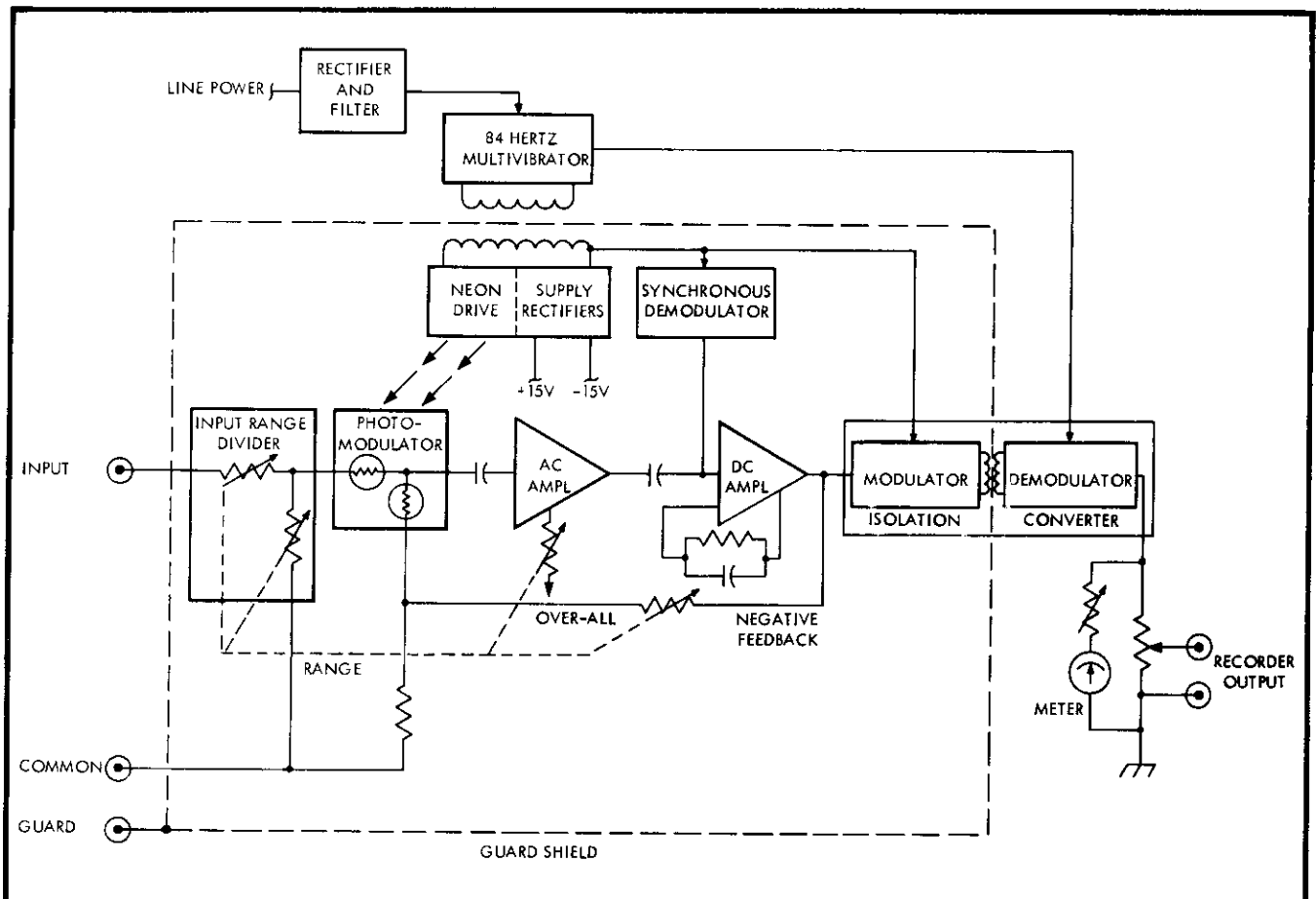


Figure 3-1. MODEL 845AR BLOCK DIAGRAM

multivibrator. Eighty four Hz is used to provide the Model 845 with an operating frequency asynchronous with the power line frequency and its harmonics. The 84 Hz multivibrator also drives the following circuits; (1) the supply rectifiers which provide operating voltages for the amplifiers, (2) the synchronous demodulator which demodulates the amplified dc signal, (3) the isolation converter which produces the meter and isolated recorder output. The entire amplifier and the secondaries of both transformers are surrounded by a guard shield which permits the use of external guard voltages.

3-6. The ac amplifier is a high impedance amplifier whose gain is controlled by the resistance selected by the RANGE control. The amplified dc signal is then detected by the synchronous demodulator.

3-7. The synchronous demodulator is driven by the 84 Hz reference signal and detects the amplified dc signal. The detected dc signal is then amplified by a dc amplifier whose gain is controlled by fixed feedback. The output signal of the dc amplifier is applied to the isolation converter which drives the isolated recorder output, and the meter which indicate the polarity and magnitude of the measured voltage. This same dc signal is also fed back to the input of the ac amplifier to control overall amplifier gain. The feedback ratio is determined by the setting of the RANGE control and allows overall amplifier gain to be precisely controlled.

3-8. CIRCUIT DESCRIPTION

3-9. POWER SUPPLY

3-10. Input power transformer T201 receives 115 volts ac, or 230 volts ac if the instrument is so wired, through the power switch, S1. The primary winding of T201 is constructed in such a manner as to utilize either 115 volts ac input, windings parallel, or 230 volts ac, windings in series. Fuse, F1, protects the Model 845AR circuitry from overloads.

3-11. The secondary voltage of T201 is rectified by bridge rectifier CR201 through CR204. The bridge rectifier output voltage is filtered by C201 and regulated by zener CR207. This regulated output voltage is used as the operating voltage for the 84 Hz multivibrator.

3-12. The 84 Hz multivibrator is used to provide synchronous drive voltages and dc operating voltages for the Model 845AR amplifier circuits free from any power line frequency variations and harmonics. The multivibrator is a transformer-coupled free running multivibrator composed of transistors Q201 and Q202, transformer T202, and frequency determining components C203 and R206 through R208. Variable resistor R206 is used to adjust the frequency of the multivibrator to 84 Hz. The voltage at the secondary of T202 is rectified by CR104 and CR105 to produce the positive and negative 15 volt dc operating voltages for the amplifier circuits. The same winding furnishes the synchronous demodulator and isolation converter drive signals and is tapped at a higher voltage level to drive the neon lamps DS101 and DS102. These neon lamps provide the drive signal for the photocell modulators V101 and V102.

3-2

3-13. INPUT DIVIDER

3-14. The basic full-scale sensitivity of the Model 845AR is limited to a maximum of 1 millivolt. Therefore, input signals above this value must be reduced. The input divider consists of R101 through R109 and RANGE switch S101A. On ranges being a multiple of 1, input voltages above 1 millivolt are divided down to 1 millivolt or less, upon selection of the proper range. On ranges being a multiple of 3, input voltages above 1 millivolt are divided down to 300 microvolts or less, upon selection of the proper range. On ranges of 1 millivolt and below, a 10 megohm resistor, R104, is connected across the input to provide a fixed value of input impedance.

3-15. AC AMPLIFIER

3-16. The input signal from the input divider is filtered by a three stage, low-pass filter composed of R110, C101, R111, C102, R112, and C103. This filter reduces any ac voltage having a frequency above 1 Hz. The filtered dc voltage is then square-wave modulated by photocell modulators V101 and V102, which are driven by DS101 and DS102. The resulting square-wave signal is coupled through C104 and amplified by Q101, Q102, and Q103 which form a three stage amplifier having a high input impedance. The gain of the ac amplifier is controlled by the common emitter resistance selected by the RANGE switch S101B. Maximum gain is used on the 1, 3, 10, and 30 microvolt ranges and is gradually reduced by the selection of R124 through R126 as the range is increased. The output of Q103 is capacitively coupled to a two stage current amplifier composed of Q104 and Q105. The current amplifiers have a constant gain controlled by fixed negative feedback through R130 and C111.

3-18. SYNCHRONOUS DEMODULATOR

3-19. The synchronous demodulator detects the magnitude and phase of the amplified signal. The 84 Hz drive signal is applied to the base of transistor Q106 which references the synchronous demodulator to the same phase as the photocell modulator. The demodulated signal is filtered by R134 and C114 before being applied to the dc amplifier.

3-20. DC AMPLIFIER

3-21. The dc amplifier amplifies the detected dc signal from the synchronous demodulator. Transistors Q107 through Q112 comprise a two-stage differential amplifier with a complementary emitter-follower output. Negative feedback through R149 and C116 is applied to the base of Q108 and controls the dc amplifier gain. The output from the common emitter of Q111 and Q112 is one volt dc for a full range input on any range, which drives the isolation converter. Overall negative feedback through the resistive network of R138 through R142 and R114 is controlled by the position of the RANGE switch S101C. This negative feedback allows precise control of the overall gain of the Model 845AR amplifiers.

3-22. ISOLATION CONVERTER

3-23. The isolation converter drives the recorder output and meter while providing isolation from the Model 845 amplifier circuitry. The output signal from the amplifier is applied to the transistors Q113 and Q114. An 84 Hz reference drive signal is applied to the bases of transistors Q113 and Q114 which causes modulation of the dc input signal to occur. The resulting modulated

signal is coupled to the secondary of T203 where transistors Q203 and Q204 demodulate secondary signals occurring at their 84 Hz base signal rate. Capacitor C204 charges to the peak of the demodulated signal and discharges through the OUTPUT LEVEL control R1, R211 through R213, and the meter M1. The meter M1 indicates the polarity and magnitude of the input voltage. Capacitor C3 and resistor R2 filter the resulting dc output voltage for the recorder output.

SECTION IV

MAINTENANCE

4-1. GENERAL

4-2. The Model 845AR should be checked for calibration annually. Without extreme abuse all that should be required is periodic cleaning and calibration as specified in this section. If a problem arises, the information on corrective maintenance in this section will be extremely useful.

4-3. TEST EQUIPMENT

4-4. Figure 4-1 lists the recommended equipment with their specifications which are required for corrective maintenance and calibration.

4-5. 230 VOLT AC POWER-LINE CONVERSION

4-6. The Model 845AR may be converted for operation on 230 volt ac lines by modifying the power supply P/C board assembly wiring. Factory modified versions will have a decal on the rear panel indicating 230 volts ac input requirements.

4-7. To convert the Model 845AR to 230 volts ac operation, proceed as follows:

- a. Remove the top-back dust cover.
- b. Locate T201 on the power supply P/C board assembly and remove the two jumper wires labeled 115V. Refer to Figure 4-2 for location of jumper wires.
- c. Place the jumpers removed in step b across the 230V labeled terminals, refer to Figure 4-2 for location, and solder the connections.
- d. Replace the top-back dust cover and install a 3AG 1/32 ampere fuse in place of F1. F1 is located on the front panel.

4-8. DISASSEMBLY INSTRUCTIONS

4-9. The following procedure is to be used to gain access to the inside of the Model 845AR:

- a. Remove the top-back cover by removing eight screws, six on top and two on the back. This allows access to the parts on the power supply board, and to capacitors C1 and C2 located on the front panel.
- b. Remove the top cover of the guard chassis by removing six screws, three on the top of the guard and three on the back. This allows access to the dc amplifier and the last two stages of the ac amplifier. The instrument will still operate properly with the top of the guard chassis removed.
- c. Remove the screws that fasten the right side panel to the front panel and other chassis panels, and remove the right side panel from the instrument.
- d. Remove the two remaining screws holding the power supply P/C board. This will allow movement of the board assembly.

EQUIPMENT NOMENCLATURE	SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC POWER SUPPLY	Output voltage of 0 to 1000 volts dc. Accuracy of $\pm 0.25\%$ or 100 microvolts.	Fluke Model 332A.
Oscilloscope	Voltage sensitivity of 200 uv/cm.	Hewlett-Packard Model 130C.
Battery	10 volt.	

Figure 4-1. TEST EQUIPMENT REQUIREMENTS

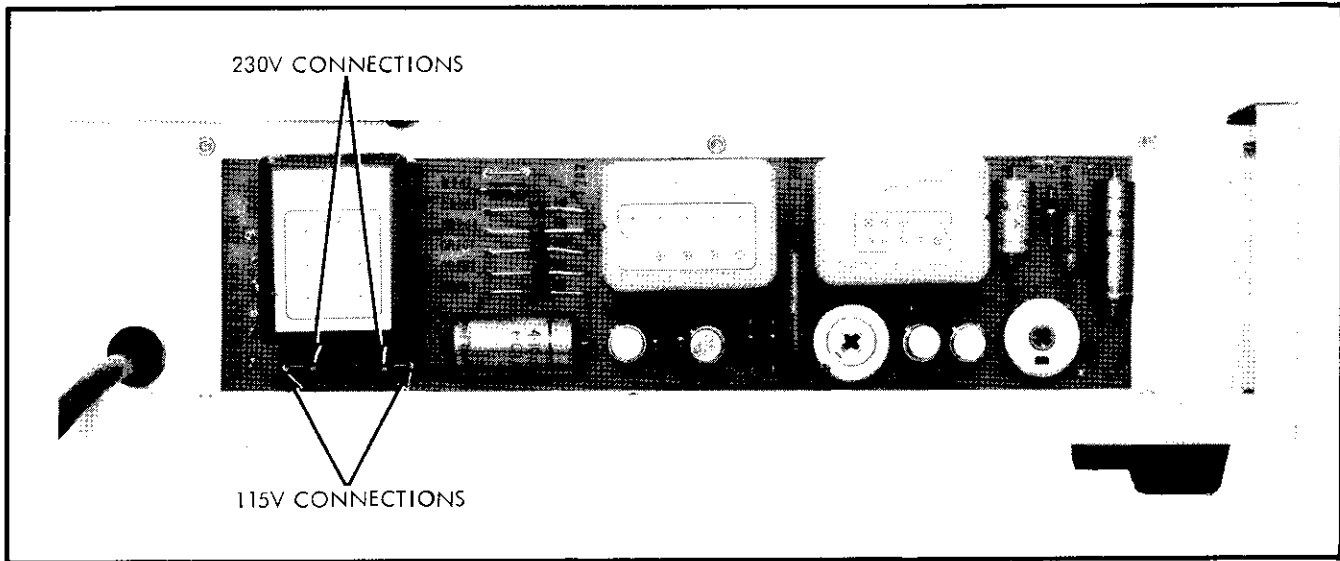


Figure 4-2. T201 115/230 VOLT AC POWER TERMINALS

- e. Remove the bottom-back cover of the guard chassis by removing the three screws on the bottom of the guard chassis. This allows access to the input divider, the plus and minus 15 volts dc filter capacitors, and the isolation convertor modulator.

CAUTION!

Avoid touching the polyethelene grommets. Contamination will cause excessive electrical leakage.

4-10. CORRECTIVE MAINTENANCE

4-11. TROUBLESHOOTING

4-12. The purpose of troubleshooting is to locate and correct as quickly as possible any deficiency in operation. The causes and remedies of the more common troubles that may occur are listed in the troubleshooting chart, Figure 4-3. Waveforms useful for troubleshooting are given in Figures 4-4 through 4-9. A complete understanding of the theory of operation and familiarity with the schematic diagram is the best way to locate and correct the cause of any malfunction.

SYMPTOM	PROBABLE CAUSE	FAULT ISOLATION PROCEDURE
Blows fuses.	Short circuit across secondary of T201.	Test for short circuit between pins 3 and 6.
	Shorted turn in T201.	Unsolder R202 in secondary of T201. A shorted turn will require almost as much current as normal operation.
	Defective CR201 through CR206.	Measure voltage of C201. Should be 10.5 volts. If near zero, replace CR201 through CR206, as necessary.
Photo Modulator inoperative. (Neon lights out)	Defective Q201 or Q202.	If voltage of C201 is less than 7 volts, and batteries are charged, replace Q201 and/or Q202.
	Open winding on T202, or open C203.	Waveform of TP10 should agree with Figure 4-4. If square wave is absent, T202 or C203 is defective.
	No drive to neon lamps DS101 and DS102.	A square wave of over 200 volts peak-peak should be present between pin 9 of T202 and the GUARD terminal. If not, T202 may be defective.

Figure 4-3. TROUBLESHOOTING CHART (Sheet 1 of 3)

SYMPTOM	PROBABLE CAUSE	FAULT ISOLATION PROCEDURE
Meter movement inoperative.	Dead meter. Defective auxiliary supply.	Check meter with an ohmmeter. Panel meter should peg. Measure voltages at TP3 and TP4. If one voltage is near zero, check the associated diode and capacitor. If both voltages are zero, T202 is defective.
Meter pegs or wanders.	Meter mechanically stuck. Defective amplifier	Using an oscilloscope with dc coupling, measure waveforms at TP6. If waveforms agree with Figure 4-5 check Q111, Q112, Q109, Q110, Q107, and Q108 by replacement. If waveforms are not correct, then: (a) Waveform at TP6 looks more like waveform at TP7, Figure 4-6, Q106 is open. (b) No change in waveform at TP6 as ZERO control is rotated. R114 is shorted, base of Q101 is shorted, V101 or V102 is shorted. (c) Waveform at TP6 looks like a square wave. Measure waveform at TP7. If square wave disappears and waveform at TP7 is correct, C112 is shorted. If waveform is not correct, remove Q104 and measure waveform at TP2, Figure 4-7. If square wave persists, short junction of R115, C104, C105, and base of Q101 to common. If square wave disappears, remove short and transfer short to R112, C103, and V101 junction. If square wave returns, a photocell is defective, or C104 is shorted. If square wave does not return, move the short to the end of R110 that connects to RANGE switch. If signal reappears, CR101 or CR102 is defective. If square wave does not reappear, the RANGE switch is defective. (d) No signal at TP6. If there is also no signal at TP7, Q106 is probably shorted. If Q106 is satisfactory, measure waveform at TP2. If there is still no signal, C107, CR103, Q101, Q102, or Q103 is defective.
Erratic or unstable condition when measuring a voltage or zeroing instrument.	S103 Erratic Contact.	Replace or burnish contacts with crocus cloth.
Meter deflects in one direction, only.	Open winding on T203, defective Q113, Q114, Q203, or Q204.	Check and replace as necessary.
Slower response in negative direction.	Leaky C120.	Test and replace if necessary.
Measurements are low on high-sensitivity.	Shorted C116.	Test and replace if necessary.
Poor stability.	Defective CR207.	Replace if necessary.

Figure 4-3. TROUBLESHOOTING CHART (Sheet 2 of 3)

SYMPTOM	PROBABLE CAUSE	FAULT ISOLATION PROCEDURE
Noise on 1, 3, and 10 uv ranges.	Dirty or defective Q101, or defective Q102. Defective chopper	Measure waveform at TP2. Figure 4-9 waveform shown is normal. Additional noise at TP2 is due to dirty Q101 or defective Q102. Remove Q111 and Q112, and apply an input of 1 mv. Observe waveform at TP1. For waveform shown in Figure 4-9: (a) Excessive noise can be caused by poor positioning of neon lamps. (b) Smaller waveform can be caused by slow response of photocells; if so, replace cells.
Unguarded leakage poor.	Dirty grommets. Leakage in T202 or T203.	Clean according to paragraph 4-15. Test and replace if necessary.
Guarded leakage poor	Leakage in T202 or T203, or pins touching circuit board. Contaminated binding posts.	Test and repair as necessary. Clean according to paragraph 4-15.
Poor overload recovery.	Defective C101, C102, C103, C120, CR101, CR102, or R110.	Test and replace as necessary.

Figure 4-3. TROUBLESHOOTING CHART (Sheet 3 of 3)

4-13. VISUAL INSPECTION

4-14. Troubles may sometimes be located by a thorough visual inspection. This may be accomplished by looking for the following symptoms:

- a. Accumulations of dirt, dust, moisture, or grease. Remove contamination as outlined in paragraph 4-15.
- b. Scorched or burned parts. Damage of this type is usually caused by other defective components. Determine the cause of damage before replacing components.

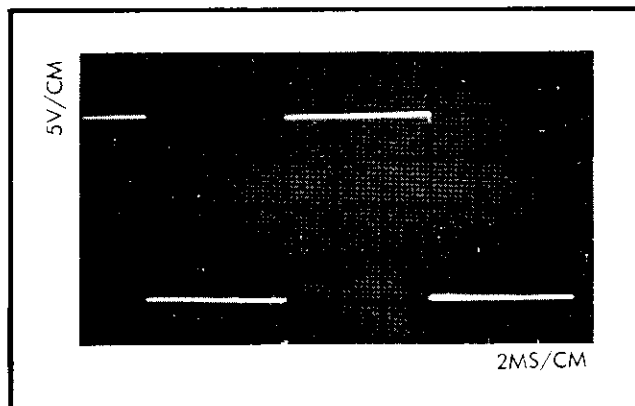


Figure 4-4. WAVEFORM AT TP10

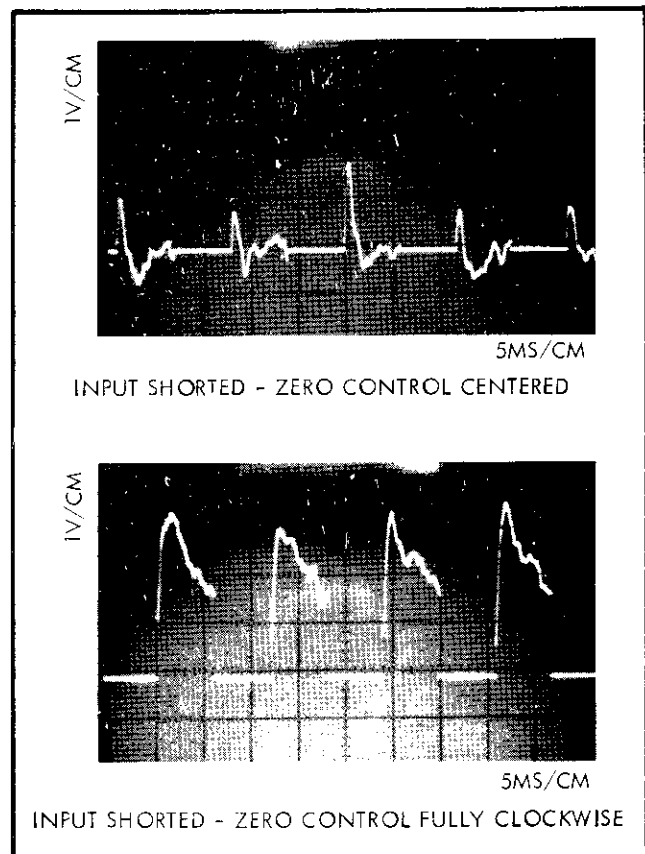


Figure 4-5. WAVEFORMS AT TP6

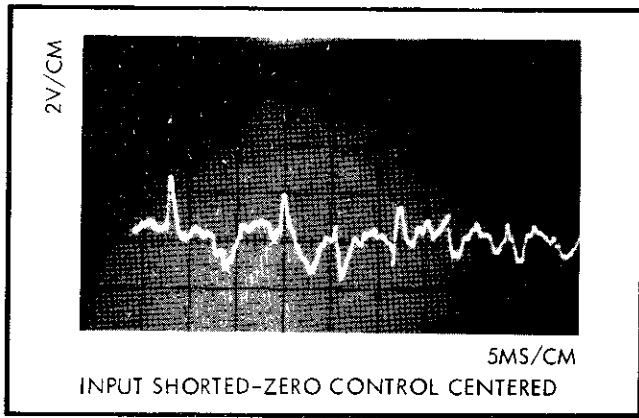


Figure 4-6. WAVEFORM AT TP7

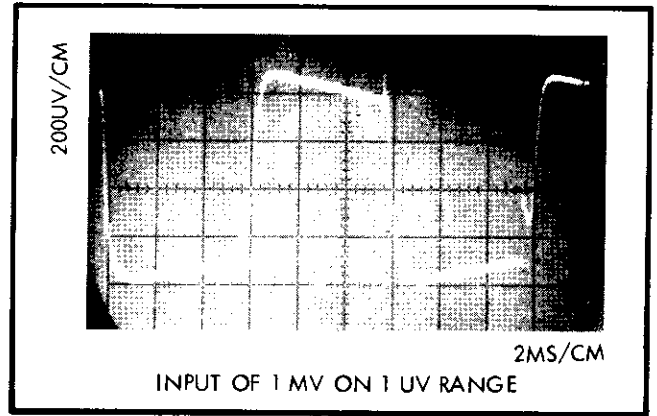


Figure 4-9. WAVEFORM AT TP1

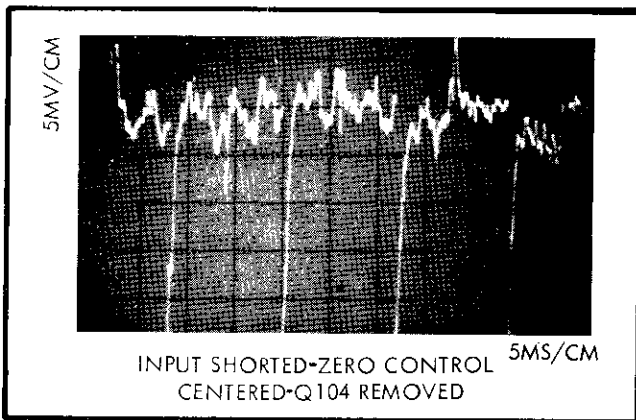


Figure 4-7. WAVEFORM AT TP2 - Q104 REMOVED

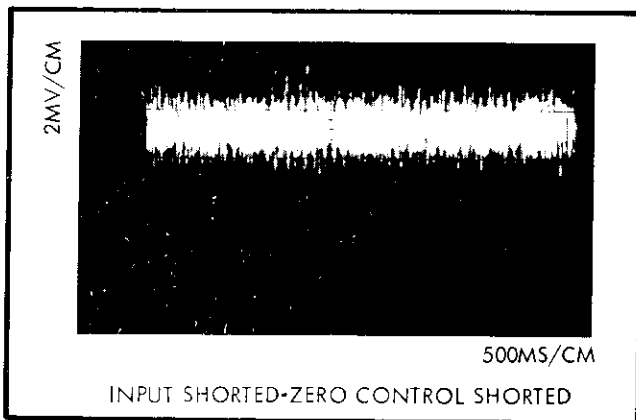


Figure 4-8. WAVEFORM AT TP2

- c. Cracks, cuts, and other damage to the polyethelene grommets or to the circuit boards.

CAUTION!

Do not touch the polyethelene grommets. Contamination will cause excessive electrical leakage.

4-15. PERIODIC MAINTENANCE

4-16. Periodic maintenance consists of occasional cleaning to remove dust, grease, and other contaminations.

4-17. To clean the instrument proceed as follows:

- a. Remove accumulations of dust and other foreign matter with low-pressure, clean dry air.
- b. Clean binding posts and front panel with denatured alcohol, and if necessary, a clean cloth or cotton swab. Do not attempt to clean switches.

4-18. LEAKAGE RESISTANCE TEST

4-19. The following leakage test is to be used to check the leakage resistance of the Model 845. Failure of the instrument to meet the test indicates the need of cleaning or troubleshooting.

- a. Connect the equipment as illustrated in Figure 4-10.
- b. Place the Model 845 controls as follows:

POWER	ON
OPR/ZERO	OPR
RANGE	300 MICROVOLTS

- c. For a leakage resistance of 10^{12} ohms, the panel meter must not indicate more than 100 microvolts. Allow sufficient time for the meter deflection to stabilize.

4-20. CALIBRATION PROCEDURES

4-21. The Model 845 should be calibrated once every year. It is recommended that if component replacement is performed, the Model 845 should be re-calibrated. Test and alignment points are illustrated by Figure 4-11.

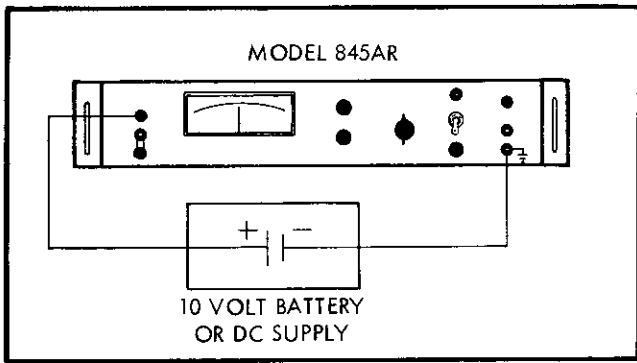


Figure 4-10. LEAKAGE RESISTANCE TEST EQUIPMENT CONNECTIONS

4-22. METER CALIBRATION

4-23. Connect the equipment as illustrated in Figure 4-12 and proceed as follows:

Note!

Allow equipment to warm up for at least 5 minutes.

a. Place the Model 845 controls as follows:

POWER	ON
OPR/ZERO	OPR
RANGE	10 VOLTS

b. Adjust the Model 332 output for 10 volts dc.

c. Adjust R151 for a full-scale deflection (+10) on the Model 845 meter.

4-24. CHOPPER FREQUENCY

4-25. To adjust the 84 Hz multivibrator frequency, proceed as follows:

a. Place the Model 845 POWER switch to ON.

b. Connect an oscilloscope between TP10 and ground.

c. Adjust R206 until the oscilloscope waveform has a time period of 12 milliseconds, as illustrated in Figure 4-5.

Note!

A frequency counter may be used in lieu of the oscilloscope for adjustment of the 84 Hz multivibrator frequency.

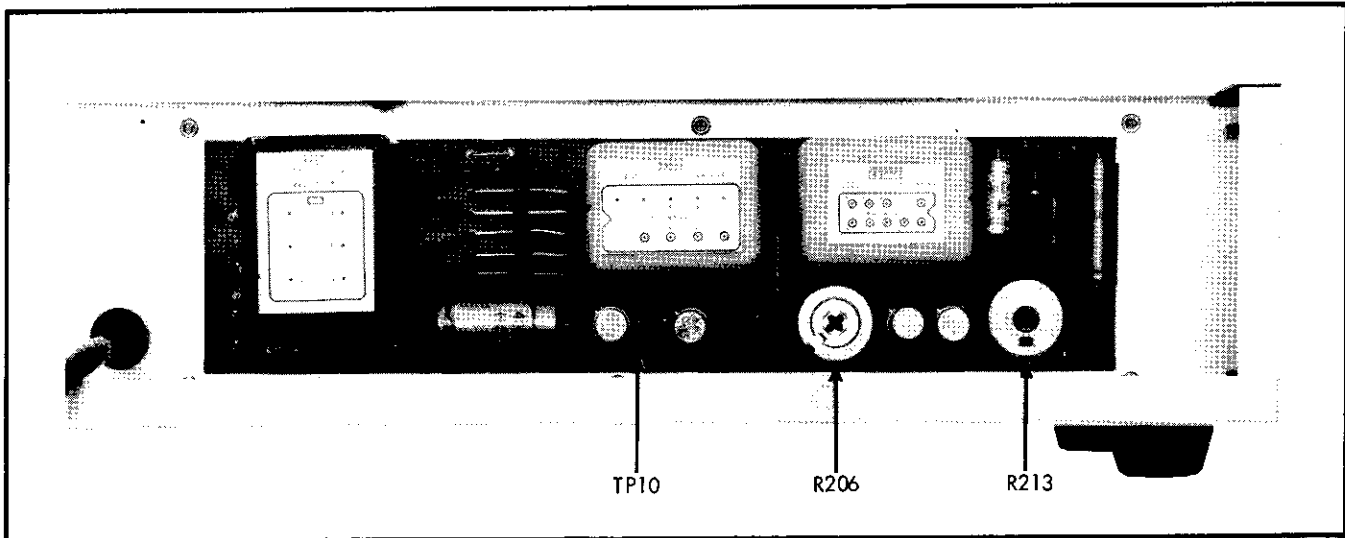


Figure 4-11. TEST AND ALIGNMENT POINTS

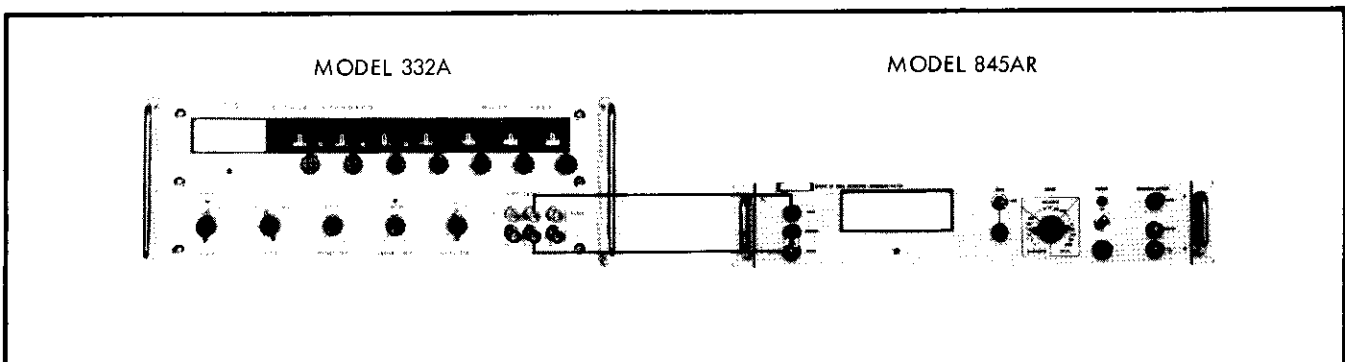


Figure 4-12. CALIBRATION EQUIPMENT CONNECTIONS

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains complete descriptions of those parts one might normally expect to replace during the life of the instrument. The first listing is a breakdown of all of the major assemblies in the instrument. Subsequent listings itemize the components in each assembly. Every listing where possible, is accompanied by an illustration identifying each component in the listing. Assemblies and subassemblies are identified by a reference designation beginning with the letter A, (e.g., A1, A2, A3, etc.). Components are identified by the schematic diagram reference designation (e.g. R1, C107, DS1). Flagnotes are used throughout the parts list and refer to ordering explanations. The flagnote explanations are located at the end of the parts list section in which they appear.

5-3. COLUMNAR INFORMATION

- a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed 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. Indentation of the item 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, see paragraph 5-7.
- c. The ten-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 Federal Supply Code for the item manufacturer is listed in the MFR column. An abbreviated list of Federal Supply Codes is included in the Appendix.
- e. The part number which uniquely identifies the item to the original manufacturer is listed in the MFR PART NO column. If a component must be ordered by description, the type number is listed.
- f. The TOT QTY column lists the total quantity of the item used in the instrument. Second and subsequent listing of the same item are referenced to the first listing with the abbreviation REF. In the case of optional subassemblies, plug ins, etc. that are not

always part of the instrument, the TOT QTY column lists the total quantity of the item in that particular assembly.

- g. 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.
- h. The USE CODE column identifies certain parts which have been added, deleted or modified throughout the life 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 at the end of the parts list. As Use Codes are added to the list, the TOT QTY column listings are changed to reflect the most current information. 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.

5-4. HOW TO OBTAIN PARTS

5-5. 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 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 instructions, if necessary.

5-6. 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: 2 each, 4805-177105, Transistors, 2N3565, Q107-108 for 845AR, s/n 168.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part showing its location to other parts of the instrument is usually most helpful.

5-7. LIST OF ABBREVIATIONS

ac	alternating current	mw	milliwatt
Al	Aluminum	na	nanoampere
amp	ampere	nsec	nanosecond
assy	assembly	nv	nanovolt
cap	capacitor	Ω	ohm
car flm	carbon film	ppm	parts per million
C	centigrade	piv	peak inverse voltage
cer	ceramic	p-p	peak to peak
comp	composition	pf	picofarad
conn	connector	plstc	plastic
db	decibel	p	pole
dc	direct current	pos	position
dpdt	double-pole, double-throw	P/C	printed circuit
dpst	double-pole, single-throw	rf	radio frequency
elect	electrolytic	rfi	radio frequency interference
F	fahrenheit	res	resistor
Ge	germanium	rms	root mean square
gmv	guaranteed minimum value	rtry	rotary
h	henry	sec	second
Hz	hertz	sect	section
hf	high frequency	S/N	serial number
IC	integrated circuit	Si	silicon
if	intermediate frequency	scr	silcon controlled rectifier
k	kilohm	spdt	single-pole, double-throw
kHz	kilohertz	spst	single-pole, single-throw
kv	kilovolt	sw	switch
lf	low frequency	Ta	tantalum
MHz	megahertz	tstr	transistor
M	megohm	tvm	transistor voltmeter
met flm	metal film	uhf	ultrahigh frequency
ua	microampere	vtvm	vacuum tube voltmeter
uf	microfarad	var	variable
uh	microhenry	vhf	very high frequency
usec	microsecond	vlf	very low frequency
uv	microvolt	v	volt
ma	milliampere	va	voltampere
mh	millihenry	vac	volts, alternating current
m	milliohms	vdc	volts, direct current
msec	millisecond	w	watt
mv	millivolt	ww	wire wound

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	FINAL ASSEMBLY - Figure 5-1	845AR					
A1	Chassis Assembly (See Figure 5-2)						
A2	Front Panel Assembly (See Figure 5-3)						
A3	Amplifier P/C Assembly (See Figure 5-4)	1702-198028 (845AR-401)	89536	1702-198028	1		
A4	Power Supply P/C Assembly (See Figure 5-5)	1702-198036 (845AR-402)	89536	1702-198036	1		

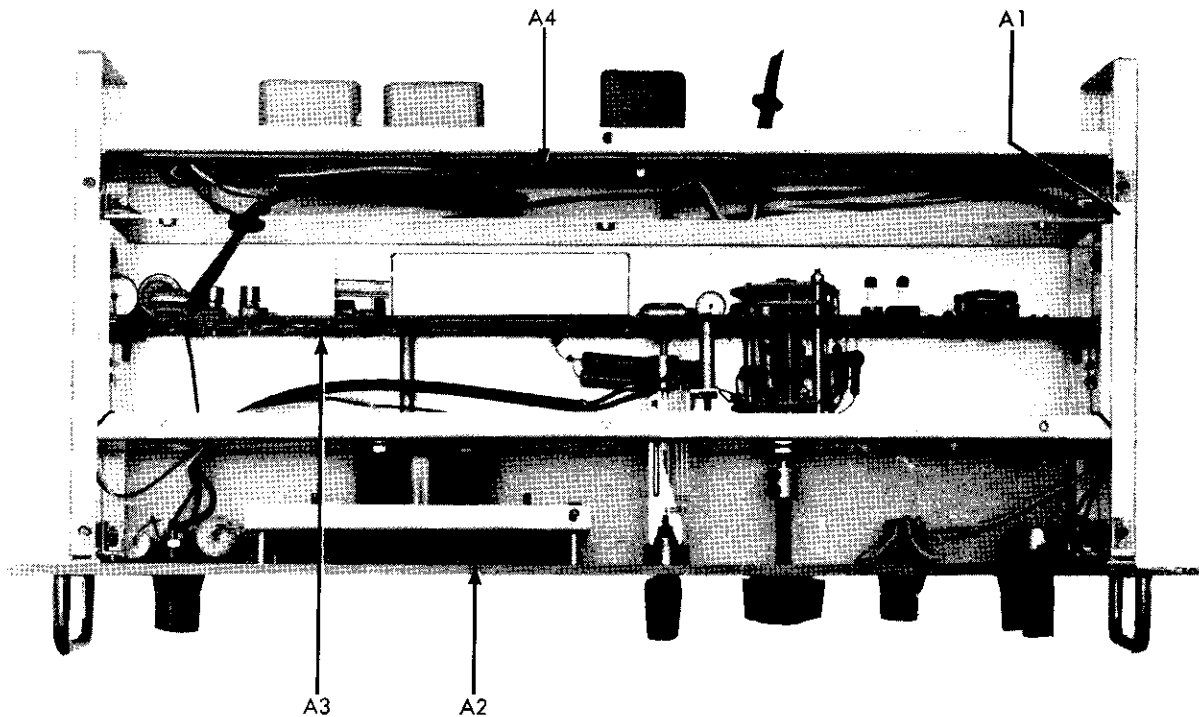


Figure 5-1. FINAL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1	CHASSIS ASSEMBLY - Figure 5-2						
1	Coupler	2402-170506	80583	FC-46-S	1		
2	Coupler, 1/8" to 1/4" (not illustrated)	2402-193557	89536	2402-193557	1		
3	Cover, bottom (not illustrated)	3156-197533	89536	3156-197533	1		
4	Cover, top	3156-197525	89536	3156-197525	1		
5	Foot, rubber	2819-103309	77967	9102-W	4		
6	Line cord with plug	6005-102822	91934	019-3	1		
7	Shaft, range switch	3206-200998	89536	3206-200998	1		
8	Shaft, zero	3200-201012	89536	3200-201012	1		
9	Strain relief, 1/4"	2502-101162	28520	SR-5P-1	1		

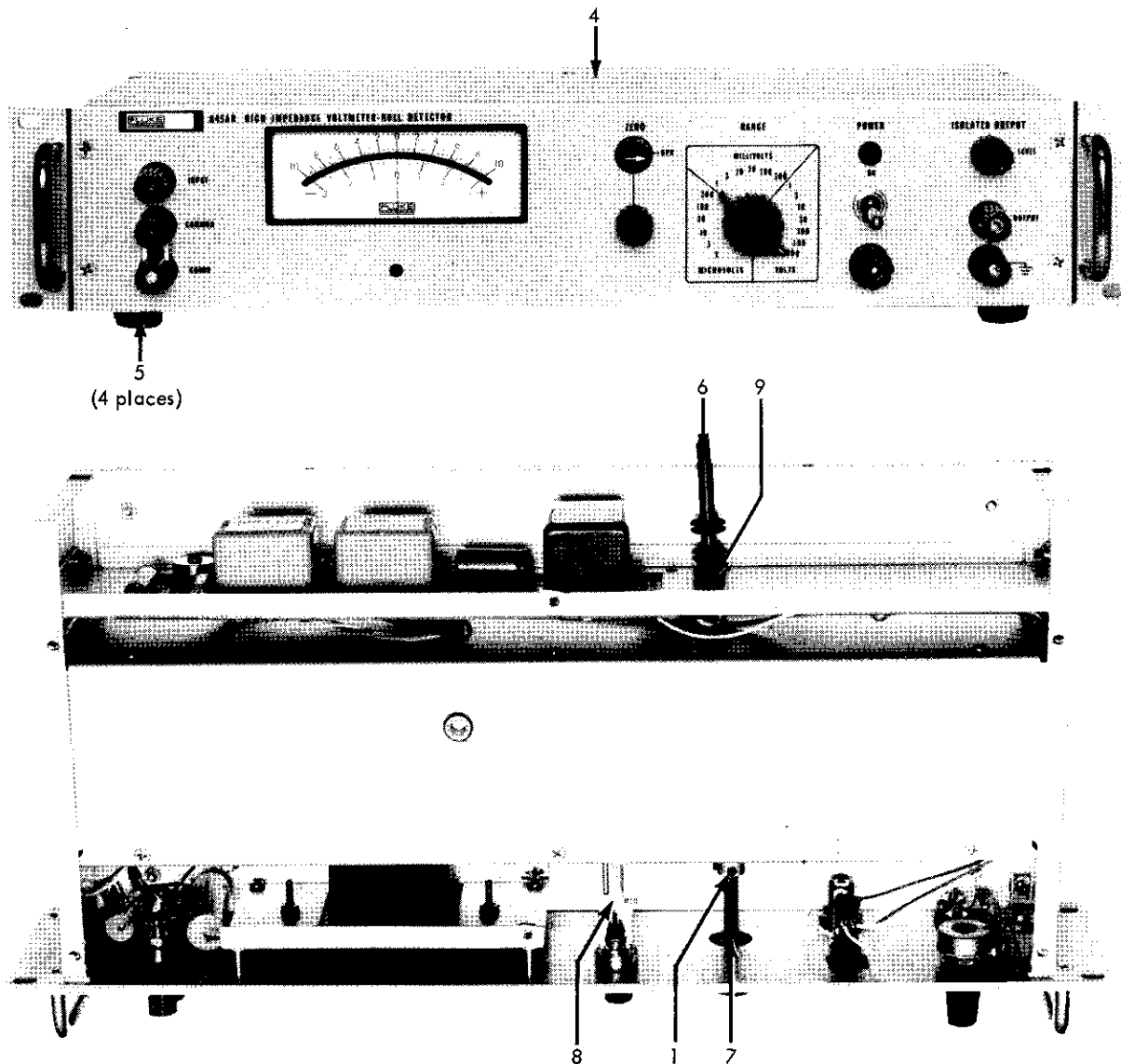


Figure 5-2. CHASSIS ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A2	FRONT PANEL ASSEMBLY-Figure 5-3						
C1,C2	Cap, mylar, 0.047 uf ±20%, 1200v	1507-182683	72928	343-087M	2		
C3	Cap, elect, 10 uf +50/-10%, 25v	1502-170266	73445	C426ARF10	3	1	
DS1	Indicator, Neon 115v	3903-193524	08717	858-R-A/C-68K	1	1	
F1	Fuse, Type MDL, slow-blow, 1/16 amp, 250v (for 115v operation) (not illustrated)	5101-163030	71400	Type MDL	1	5	
F1	Fuse, Type MDL, slow-blow, 1/32 amp, 250v (for 230v operation) (not illustrated)	5101-163022	71400	Type MDL	1	5	
J1, J2	Binding post, red, INPUT & COMMON	2811-149856	58474	BHB-10208-G22	2		
J3	Binding post, black, GUARD	2811-142984	58474	DF31BC	2		
J4	Binding post, red, RECORDER OUTPUT	2811-142976	58474	DF31RC	1		
J5	Binding post, black, RECORDER	2811-142984	58474	DF31BC	REF		
M1	Meter, 100-0-100 ua, 750Ω	2901-192302	55026	524	1		
R1	Res, var, 10k ±30%, 1/3w	4701-192344	71450	WF-45	1		
R2	Res, comp, 4.7k ±10%, 1/2w	4704-108381	01121	EB4721	1		
S1	Switch, toggle, spst, POWER	5106-114850	04009	20994-LH	1		
XF1	Holder, Fuse	2102-160846	75915	342004	1		
10	Handle	2404-100412	05704	825	2		
11	Knob, RANGE	2405-170035	89536	2405-170035	1		
12	Knob, ZERO, LEVEL	2405-158949	89536	2405-158949	2		
13	Panel, front	1406-197475	89536	1406-197475	1		
14	Shorting link	2811-190728	24655	938LG	1		

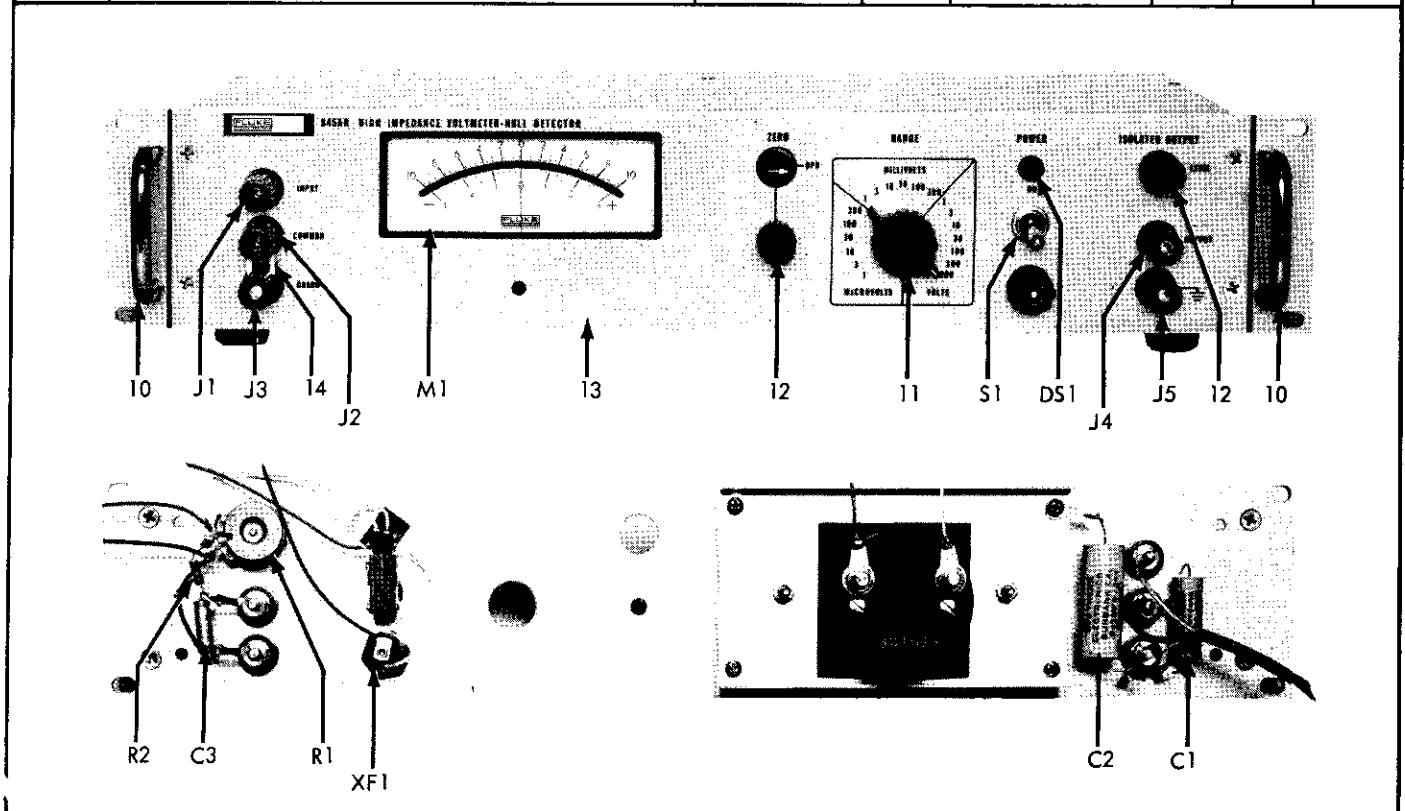





Figure 5-3. FRONT PANEL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A3	AMPLIFIER P/C ASSEMBLY - Figure 5-4	1702-198028 (845AR-401)	89536	1702-198028	REF		
C101 thru C103	Cap, poly, 0.47 uf $\pm 20\%$, 120v	1507-190553	84411	JF-36	3		
C104	Cap, mylar, 0.1 uf $\pm 20\%$, 250v	1507-161992	73445	C280AE/P100K	3		
C105	Cap, cer, 300 pf $\pm 10\%$, 500v	1501-105734	71590	BB60301KW7W	2		
C106	Cap, elect, 1250 uf $+50/-10\%$, 4v	1502-166330	73445	C437ARB1250	1	1	
C107	Cap, elect, 250 uf $+50/-10\%$, 16v	1502-187765	73445	C434ARE250	2	1	
C108	Cap, cer, 300 pf $\pm 10\%$, 500v	1501-105734	71590	BB60301KW7W	REF		
C109	Cap, mylar, 0.1 uf $\pm 20\%$, 250v	1507-161992	73445	C280AE/P100K	REF		
C110	Cap, elect, 10 uf $+50/-10\%$, 25v	1502-170266	73445	C426ARF10	REF	1	
C111	Cap, mylar, 0.0047 uf $\pm 20\%$, 200v	1507-106054	56289	192P47202	1		
C112	Cap, elect, 10 uf $+50/-10\%$, 25v	1502-170266	73445	C426ARF10	REF		
C113	Cap, elect, 400 uf $+50/-10\%$, 4v	1502-187773	73445	C426ARB400	2	1	
C114	Cap, Ta, 10 uf $\pm 10\%$, 20v	1508-160259	05397	K10C20K	1		A
C114	Cap, Ta, 6.8uf $\pm 10\%$, 35v	1508-182782	05397	K6R8C35K	1		B
C115	Cap, mylar, 0.1 uf $\pm 20\%$, 250v	1507-161992	73445	C280AE/P100K	REF		
C116	Cap, Ta, 22 uf $\pm 10\%$, 15v	1508-182816	05397	K22C15K	1		A
C117,	Cap, Ta, 15uf $\pm 10\%$, 20v	1508-153056	05397	K15C20K	1		B
C118	Cap, elect, 400 uf $+50/-10\%$, 25v	1502-168153	73445	C437ARF400	3	1	
C119	Cap, mylar, 0.22 uf $\pm 20\%$, 250v	1507-194803	73445	C280AE/P220K	1		
CR101, CR102	Diode, Cont. Devices Type CD12599	4802-180554	07910	CD12599	2	1	
CR103	Diode, Type 1N961A	4803-113324	07910	Type 1N961A	2	1	
CR104 thru CR107	Diode, Inter. Rect. Type 4D4	4802-180240	81483	Type 4D4	8	2	
DS101, DS102	Light, Neon, NE2U (not illustrated)	3902-162602	89730	NE2U	2	5	
L1	Ferrite bead	2503-219535	02114	56-060-85-3B	1		B
Q101	Tstr, Selected ST-1750T	4805-194456	89536	4805-194456	1	1	
Q102	Tstr, Selected Type S19254	4805-168716	07263	S19254	1	1	
Q103	Tstr, Type 2N3391	4805-168708	09213	2N3391	1	1	
Q104, Q105	Tstr, Type 2N3565	4805-177105	07263	2N3565	4	1	
Q106	Tstr, T.I. Type GA3938	4805-182709	01295	GA3938	2	1	
Q107, Q108	Tstr, Type 2N3565	4805-177105	07263	2N3565	REF		
Q109, Q110	Tstr, Cont. Device Type CS-30011	4805-169375	07910	CS-30011	2	1	
Q111	Tstr, Type 2N1304	4805-117127	01295	2N1304	1	1	
Q112	Tstr, Type 2N1305	4805-190298	01295	2N1305	1	1	
Q113	Tstr, T.I. Type GA3938	4805-182709	01295	GA3938	REF		
Q114	Tstr, T.I. Type GA3937	4805-182691	01295	GA3937	3	1	
R101	Res, car flm, matched set						
R102	Res, car flm, 900k $\pm 1/2\%$, 1/2w	4703-107391	19701	DC1/2A	1		
R103	Res, car flm, matched set						
R104	Res, car flm, 10 meg $\pm 1/2\%$, 1w	4702-107748	19701	DC1	1		
R105 thru R109	Res, car flm, matched set						
R110	Res, car flm, 300k $\pm 1\%$, 2w	4703-107425	12400	Type C30	2		

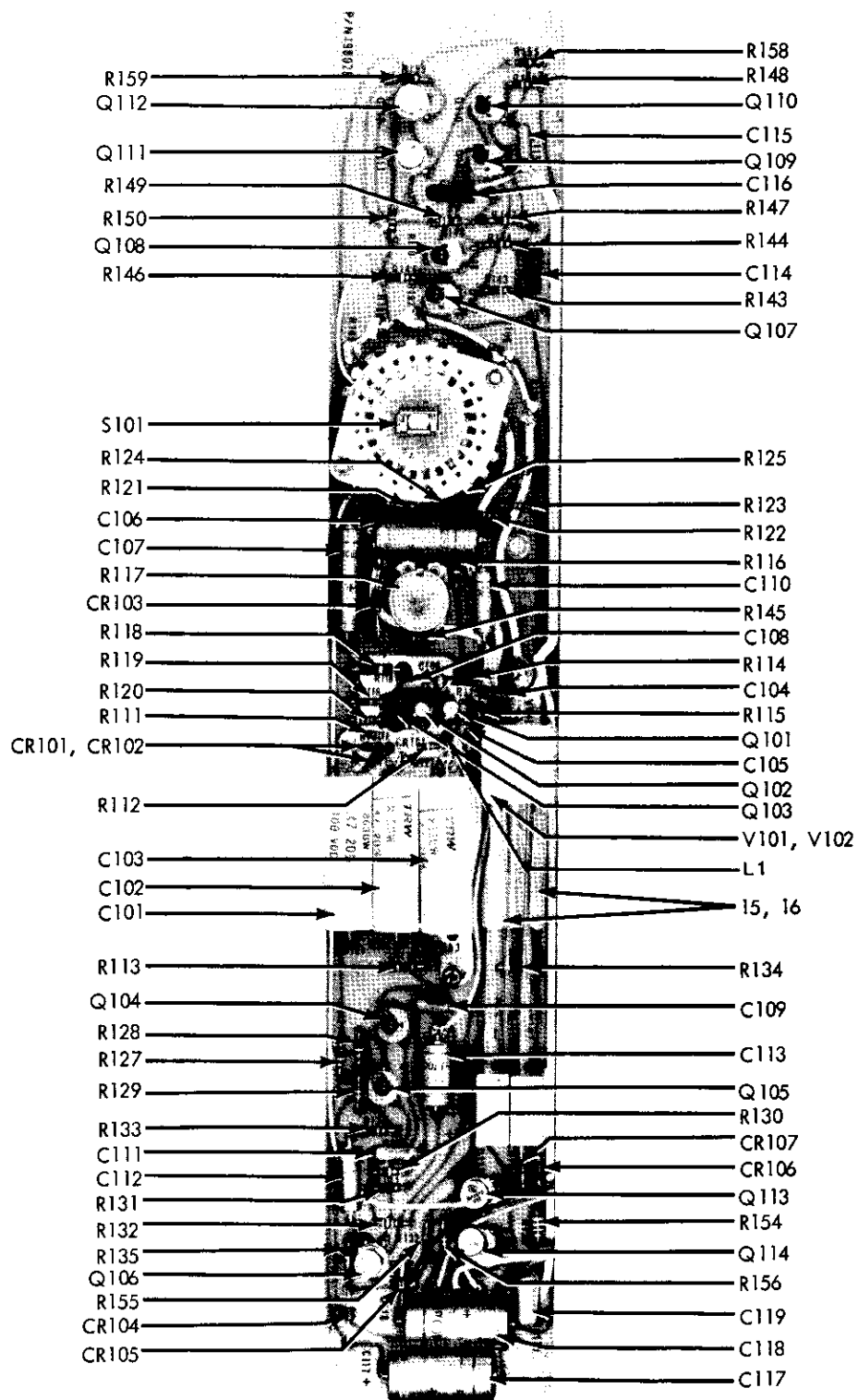
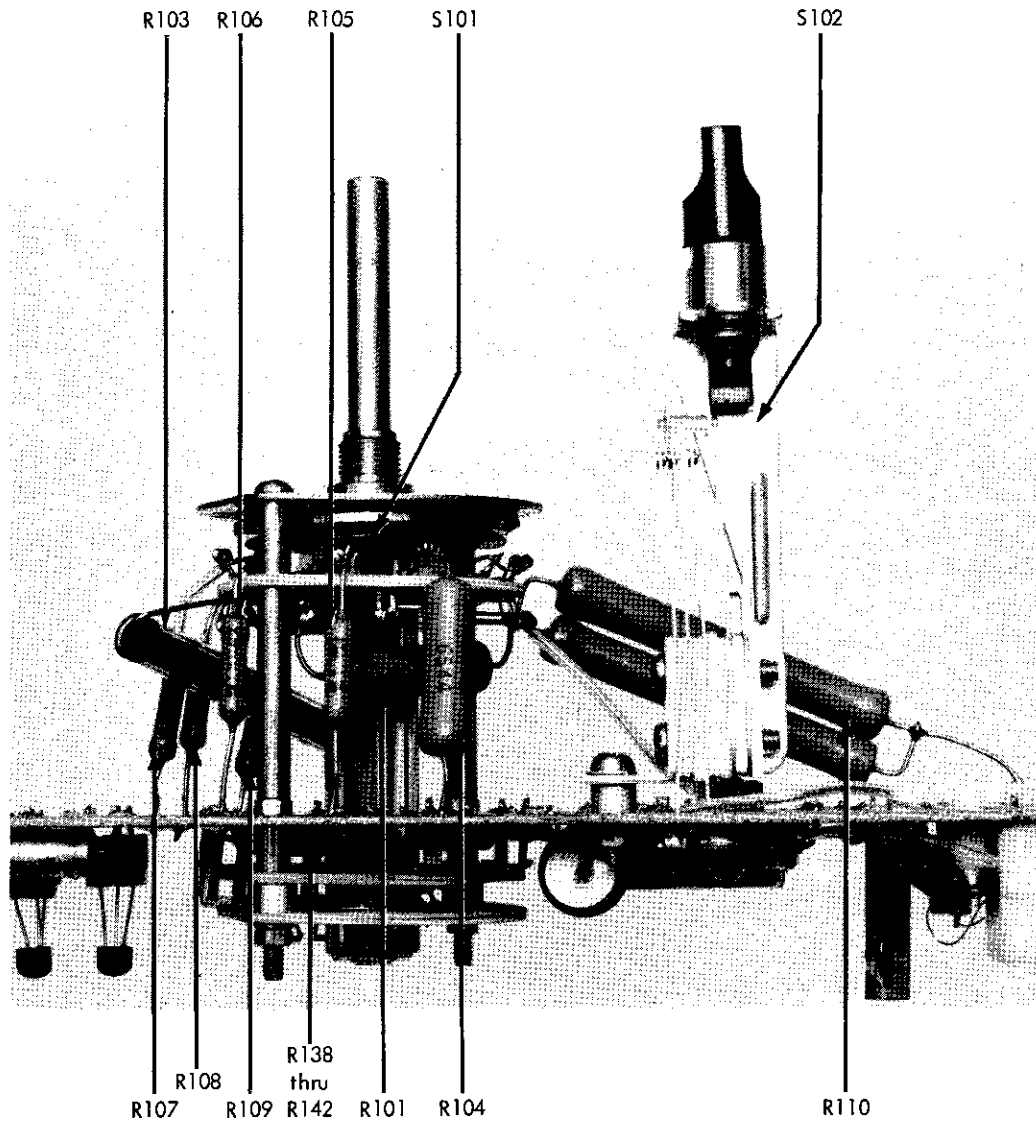




Figure 5-4. AMPLIFIER P/C ASSEMBLY (Sheet 1 of 2)




SIDE VIEW

Figure 5-4. AMPLIFIER P/C ASSEMBLY (Sheet 2 of 2)

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R111	Res, comp, 47k $\pm 5\%$, 1/4w	4704-148163	01121	CB4735	2		
R112	Res, comp, 100k $\pm 5\%$, 1/4w	4704-148189	01121	CB1045	4		
R113	Res, comp, 470 Ω $\pm 5\%$, 1/4w	4704-147983	01121	CB4715	1		
R114	Res, ww, 10 Ω $\pm 1\%$, 1/2w	4707-193946	89536	4707-193946	1		
R115	Res, comp, 1.2 meg $\pm 10\%$, 1/2w	4704-108407	01121	EB1251	1		
R116	Res, comp, 680k $\pm 5\%$, 1/4w	4704-188433	01121	CB6845	1		
R117	Res, var, 5 meg $\pm 30\%$, 0.2w	4701-193086	71450	U-70	1		
R118	Res, comp, 10 meg $\pm 10\%$, 1/2w	4704-108142	01121	EB1061	1		
R119	Res, comp, 2.2 meg $\pm 5\%$, 1/4w	4704-198390	01121	CB2255	1		
R120	Res, comp, 47k $\pm 5\%$, 1/4w	4704-148163	01121	CB4735	REF		
R121	Res, comp, 10 Ω $\pm 5\%$, 1/4w (not illustrated)	4704-147868	01121	CB1005	1		
R122	Res, comp, 68k $\pm 5\%$, 1/4w	4704-148171	01121	CB6835	2		
R123	Res, comp, 82k $\pm 5\%$, 1/4w	4704-188458	01121	CB8235	1		
R124	Res, comp, 22 Ω $\pm 5\%$, 1/4w	4704-147884	01121	CB2205	1		
R125	Res, comp, 68 Ω $\pm 5\%$, 1/4w	4704-147918	01121	CB6805	1		
R126	Res, comp, 220 Ω $\pm 5\%$, 1/4w	4704-147959	01121	CB2215	1		
R127	Res, comp, 10k $\pm 5\%$, 1/4w	4704-148106	01121	CB1035	2		
R128	Res, comp, 100k $\pm 5\%$, 1/4w	4704-148189	01121	CB1045	REF		
R129	Res, comp, 22k $\pm 5\%$, 1/4w	4704-148130	01121	CB2235	5		
R130	Res, comp, 100k $\pm 5\%$, 1/4w	4704-148189	01121	CB1045	REF		
R131	Res, comp, 100 Ω $\pm 5\%$, 1/4w	4704-147926	01121	CB1015	1		
R132	Res, comp, 39k $\pm 5\%$, 1/4w	4704-188466	01121	CB3935	1		
R133	Res, comp, 10k $\pm 5\%$, 1/4w	4704-148106	01121	CB1035	REF		
R134	Res, comp, 15k $\pm 5\%$, 1/4w	4704-148114	01121	CB1535	2		
R135	Res, comp, 22k $\pm 5\%$, 1/4w	4704-148130	01121	CB2235	REF		
R136	Res, met film, 1.07k $\pm 1\%$, 1/2w (not illustrated)	4705-187930	12400	Type CEC-TO	1		
R137	Res, met film, 3.16k $\pm 1\%$, 1/2w (not illustrated)	4705-187781	12400	Type CEC-TO	1		
R138 thru R142	Res, met film, matched set						
R143 thru R145	Res, comp, 150k $\pm 5\%$, 1/4w	4704-182212	01121	CB1545	3		
R146	Res, comp, 100k $\pm 5\%$, 1/4w	4704-148189	01121	CB1045	REF		
R147	Res, comp, 15k $\pm 5\%$, 1/4w	4704-148114	01121	CB1535	REF		
R148	Res, comp, 22k $\pm 5\%$, 1/4w	4704-148130	01121	CB2235	REF		
R149	Res, comp, 3.9 meg $\pm 5\%$, 1/4w	4704-188417	01121	CB3955	1		
R150	Res, comp, 68k $\pm 5\%$, 1/4w	4704-148171	01121	CB6835	REF		
R154	Res, comp, 33k $\pm 5\%$, 1/2w	4704-108761	01121	EB3331	1		
R155, R156	Res, comp, 22k $\pm 5\%$, 1/4w	4704-148130	01121	CB2235	REF		
R158, R159	Res, comp, 1k $\pm 5\%$, 1/4w	4704-148023	01121	CB1025	2		
S101	Switch, rotary, RANGE	5105-194589	89536	5105-194589	1		
S102	Switch, twist, spdt, ZERO-OPERATE	5105-194936	89536	5105-194936	1		
V101, V102	Photo cell assembly	3700-194449	89536	3700-194449	1		
15,16	Rod, optical	3800-168047	89536	3800-168047	2		

 These resistors are factory matched. If any replacement is required, an entire set, part number 4710-227132, must be replaced.

 These resistors are factory matched. If any replacement is required, an entire set, part number 4710-194423, must be replaced.

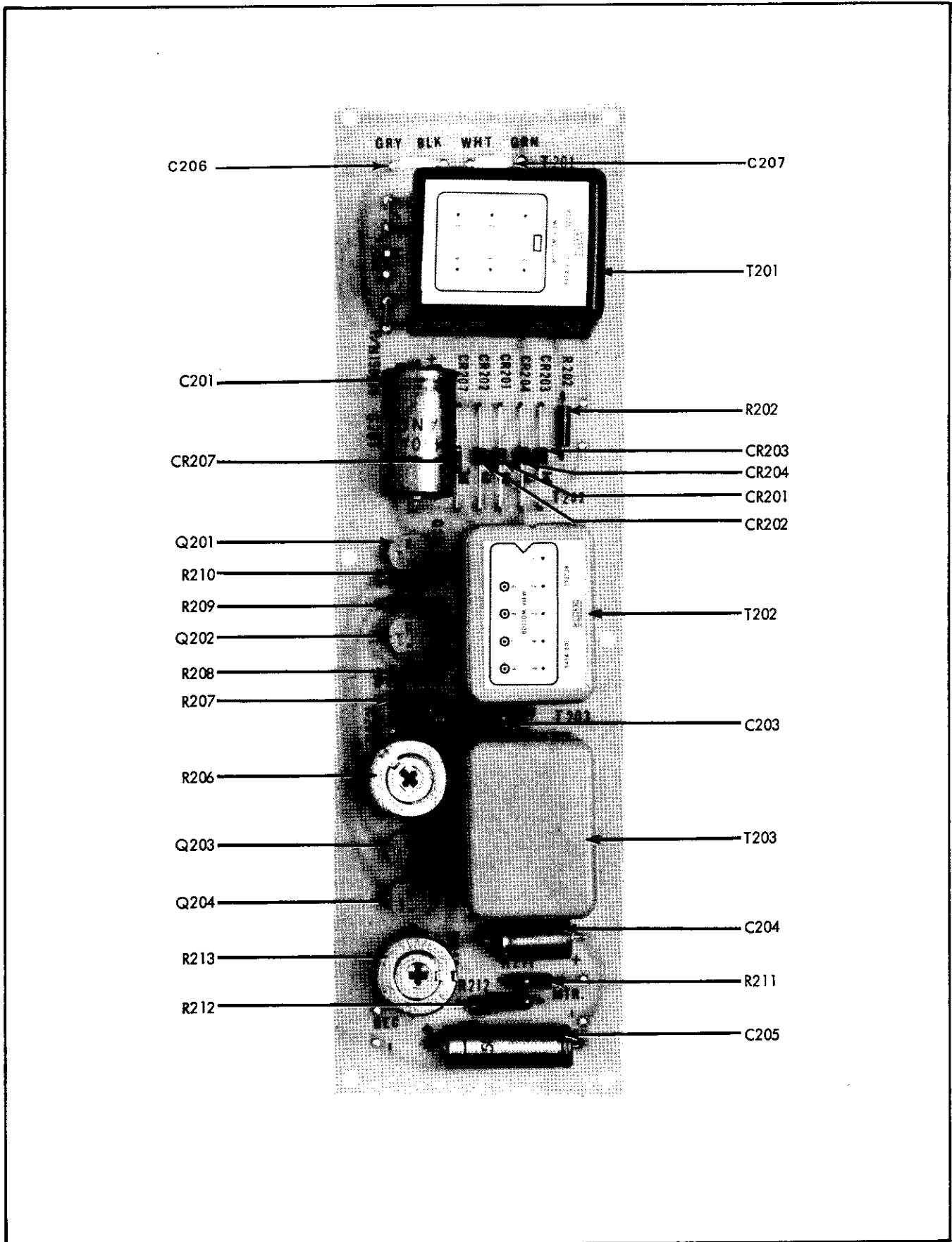


Figure 5-5. POWER SUPPLY P/C ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A4	POWER SUPPLY P/C ASSEMBLY Figure 5-5	1702-198036 (845AR-402)	89536	1702-198036	REF		
C201	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C203	Cap, mylar, 1.0 uf ±20%, 250v	1507-190330	73445	C280AE/P1M	1		
C204	Cap, elect, 400 uf +50/-10%, 4v	1502-187773	73445	C426ARB400	REF		
C205	Cap, elect, 250 uf +50/-10%, 16v	1502-187765	73445	C437ARE250	REF		
C206, C207	Cap, mica, 0.001uf ±5%, 500v	1504-148387	14655	CD19F102J	2		B
CR201 thru CR204	Diode, Inter. Rect. Type 4D4	4802-180240	81483	4D4	REF		
CR207	Diode, Type 1N961A	4803-113324	07910	1N961A	1		
Q201, Q202	Tstr, T. I. Type GA2817	4805-182600	01295	GA2817	2	1	
Q203, Q204	Tstr, T. I. Type GA3937	4805-182691	01295	GA3937	REF		
R202	Res, comp, 150Ω ±5%, 1/2w	4704-186056	01121	EB1515	1		
R206	Res, var, ww, 2k ±5%, 1-1/4w	4702-160705	71450	Type 110	1		
R207, R208	Res, comp, 5.1k ±5%, 1/2w	4704-109108	01121	EB5125	2		
R209, R210	Res, comp, 22k ±10%, 1/2w	4704-108209	01121	EB2231	2		
R211	Res, comp, 1k ±10%, 1/2w	4704-108563	01121	EB1021	1		
R212	Res, met flm, 9.53k ±1%, 1/2w	4705-159442	12400	Type CEC-TO	1		
R213	Res, var, ww, 3k ±20%, 2w	4702-153429	71450	Type 115	1		
T201	Transformer, power	5600-192724	89536	5600-192724	1		
T202	Transformer, drive	5600-192708	89536	5600-192708	1		
T203	Transformer, isolation	5600-197400	89536	5600-197400	1		

5-8. SERIAL NUMBER EFFECTIVITY

5-9. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 845AR. 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. New codes will be added as required by instrument changes.

USE CODE	EFFECTIVITY
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None	Model 845AR serial number 123 and on
A	Model 845AR serial number 123 thru 276 ^{on} .
B	Model 845AR serial number 277 and on.

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. The following information is presented in this section:

List of Abbreviations

Federal Supply Codes for Manufacturers

Fluke Technical Service Centers - U.S. and Canada

Fluke Technical Service Centers - International

Sales Representatives - U.S. and Canada

Sales Representatives - International

List of Abbreviations and Symbols

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

Federal Supply Codes for Manufacturers

00213 Nytronics Comp. Group Inc. Subsidiary of Nytronics Inc. Formerly Sage Electronics Rochester, New York	02660 Bunker Ramo Corp., Conn Div. Formerly Amphenol-Borg Electric Corp. Broadview, Illinois	04946 Standard Wire & Cable Los Angeles, California	06751 Components, Inc. Semcor Div. Phoenix, Arizona
00327 Welwyn International, Inc. Westlake, Ohio	02799 Areo Capacitors, Inc. Chatsworth, California	05082 Replaced by 94988	06860 Gould Automotive Div. City of Industry, California
00656 Aerovox Corp. New Bedford, Massachusetts	03508 General Electric Co. Semiconductor Products Syracuse, New York	05236 Jonathan Mfg. Co. Fullerton, California	06961 Vernitron Corp., Piezo Electric Div. Formerly Clevite Corp., Piezo Electric Div. Bedford, Ohio
00686 Film Capacitors, Inc. Passaic, New Jersey	03614 Replaced by 71400	05245 Components Corp. now Corcom, Inc. Chicago, Illinois	06980 Eimac Div. Varian Associates San Carlos, California
00779 AMP Inc. Harrisburg, Pennsylvania	03651 Replaced by 44655	05277 Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pennsylvania	07047 The Ross Milton Co. South Hampton, Pennsylvania
01121 Allen-Bradley Co. Milwaukee, Wisconsin	03797 Eidema Div. Genisco Technology Corp. Compton, California	05278 Replaced by 43543	07115 Replaced by 14674
01281 TRW Electronic Comp. Semiconductor Operations Lawndale, California	03877 Transistron Electronic Corp. Wakefield, Massachusetts	05279 Southwest Machine & Plastic Co. Glendora, California	07138 Westinghouse Electric Corp., Electronic Tube Div. Horsehead, New York
01295 Texas Instruments, Inc. Semiconductor Group Dallas, Texas	03888 KDI Pyrofilm Corp. Whippany, New Jersey	05397 Union Carbide Corp. Materials Systems Div. New York, New York	07233 TRW Electronic Components Cinch Graphic City of Industry, California
01537 Motorola Communications & Electronics Inc. Franklin Park, Illinois	03911 Clairex Electronics Div. Clairex Corp. Mt. Vernon, New York	05571 Use 56289 Sprague Electric Co. Pacific Div. Los Angeles, California	07256 Silicon Transistor Corp. Div. of BBF Group Inc. Chelmsford, Massachusetts
01686 RCL Electronics Inc. Manchester, New Hampshire	03980 Muirhead Inc. Mountainside, New Jersey	05574 Viking Industries Chatsworth, California	07261 Aumet Corp. Culver City, California
01730 Replaced by 73586	04009 Arrow Hart Inc. Hartford, Connecticut	05704 Replaced by 16258	07263 Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
01884 Use 56289 Sprague Electric Co. Dearborn Electronic Div. Lockwood, Florida	04062 Replaced by 72136	05820 Wakefield Engineering Inc. Wakefield, Massachusetts	07344 Bircher Co., Inc. Rochester, New York
02114 Ferroxcube Corp. Saugerties, New York	04202 Replaced by 81312	06001 General Electric Co. Electronic Capacitor & Battery Products Dept. Columbia, South Carolina	07597 Burndy Corp. Tape/Cable Div. Rochester, New York
02131 General Instrument Corp. Harris ASW Div. Westwood, Maine	04217 Essex International Inc. Wire & Cable Div. Anaheim, California	06136 Replaced by 63743	07792 Lerma Engineering Corp. Northampton, Massachusetts
02395 Rason Mfg. Co. Brooklyn, New York	04221 Aemco, Div. of Midtex Inc. Mankato, Minnesota	06383 Panduit Corp. Tinley Park, Illinois	07910 Teledyne Semiconductor Formerly Continental Device Hawthorne, California
02533 Snelgrove, C.R. Co., Ltd. Don Mills, Ontario, Canada M3B 1M2	04222 AVX Ceramics Div. AVX Corp. Myrtle Beach, Florida	06473 Bunker Ramo Corp. Amphenol SAMS Div. Chatsworth, California	07933 Use 49956 Raytheon Co. Semiconductor Div. HQ Mountain View, California
02606 Fenwal Labs Div. of Travenal Labs. Morton Grove, Illinois	04423 Telonic Industries Laguna Beach, California	06555 Beede Electrical Instrument Co. Penacook, New Hampshire	08225 Industro Transistor Corp. Long Island City, New York
	04645 Replaced by 75376	06739 Electron Corp. Littleton, Colorado	
	04713 Motorola Inc. Semiconductor Products Phoenix, Arizona	06743 Clevite Corp. Cleveland, Ohio	

Federal Supply Codes for Manufacturers (cont)

08261 Spectra Strip Corp. Garden Grove, California	11726 Qualidyne Corp. Santa Clara, California	13606 Use 56289 Sprague Electric Co. Transistor Div. Concord, New Hampshire	16299 Corning Glass Electronic Components Div. Raleigh, North Carolina
08530 Reliance Mica Corp. Brooklyn, New York	12014 Chicago Rivet & Machine Co. Bellwood, Illinois	13839 Replaced by 23732	16332 Replaced by 28478
08806 Generic Electric Co. Miniature Lamp Products Dept Cleveland, Ohio	12040 National Semiconductor Corp. Danbury, Connecticut	14099 Semtech Corp. Newbury Park, California	16473 Cambridge Scientific Ind. Div. of Chemed Corporation Cambridge, Maryland
08863 Nylomatic Corp. Norrisville, Pennsylvania	12060 Diodes, Inc. Chatsworth, California	14140 Edison Electronic Div. Mc Gray-Edison Co. Manchester, New Hampshire	16742 Paramount Plastics Fabricators, Inc. Downey, California
08988 Use 53085 Skottie Electronics Inc. Archbald, Pennsylvania	12136 Philadelphia Handle Co. Camden, New Jersey	14193 Cal-R-Inc. formerly California Resistor, Corp. Santa Monica, California	16758 Delco Electronics Div. of General Motors Corp. Kokomo, Indiana
09214 G.E. Co. Semi-Conductor Products Dept. Power Semi-Conductor Products OPN Sec. Auburn, New York	12300 Potter-Brumfield Div. AMF Canada LTD. Guelph, Ontario, Canada	14298 American Components, Inc. an Insilco Co. Conshohocken, Pennsylvania	17001 Replaced by 71468
09353 C and K Components Watertown, Massachusetts	12323 Presin Co., Inc. Shelton, Connecticut	14655 Cornell-Dublier Electronics Division of Federal Pacific Electric Co. Govt. Control Dept. Newark, New Jersey	17069 Circuit Structures Lab. Burbank, California
09423 Scientific Components, Inc. Santa Barbara, California	12327 Freeway Corp. formerly Freeway Washer & Stamping Co. Cleveland, Ohio	14752 Electro Cube Inc. San Gabriel, California	17338 High Pressure Eng. Co., Inc. Oklahoma City, Oklahoma
09922 Burdny Corp. Norwalk, Connecticut	12443 The Budd Co. Polychem Products Plastic Products Div. Bridgeport, Pennsylvania	14869 Replaced by 96853	17545 Atlantic Semiconductors, Inc. Asbury Park, New Jersey
09969 Dale Electronics Inc. Yankton, S. Dakota	12615 U.S. Terminals Inc. Cincinnati, Ohio	14936 General Instrument Corp. Semi Conductor Products Group Hicksville, New York	17856 Siliconix, Inc. Santa Clara, California
10059 Barker Engineering Corp. Formerly Amerace, Amerace ESNA Corp. Kenilworth, New Jersey	12617 Hamlin Inc. Lake Mills, Wisconsin	15636 Elec-Troi Inc. Saugus, California	17870 Replaced by 14140
11236 CTS of Berne Berne, Indiana	12697 Clarostat Mfg. Co. Dover, New Hampshire	15801 Fenwal Electronics Inc. Div. of Kidde Walter and Co., Inc. Framingham, Massachusetts	18178 Vactec Inc. Maryland Heights, Missouri
11237 CTS Keene Inc. Paso Robles, California	12749 James Electronics Chicago, Illinois	15818 Teledyne Semiconductors, formerly Amelco Semiconductor Mountain View, California	18324 Signetics Corp. Sunnyvale, California
11358 CBS Electronic Div. Columbia Broadcasting System Newburyport, Minnesota	12856 Micrometals Sierra Madre, California	15849 Litton Systems Inc. Useco Div. formerly Useco Inc. Van Nuys, California	18612 Vishay Resistor Products Div. Vishay Intertechnology Inc. Malvern, Pennsylvania
11403 Best Products Co. Chicago, Illinois	12954 Dickson Electronics Corp. Scottsdale, Arizona	15898 International Business Machines Corp. Essex Junction, Vermont	18736 Voltronics Corp. Hanover, New Jersey
11503 Keystone Columbia Inc. Warren, Michigan	12969 Unitrode Corp. Watertown, Massachusetts	15909 Replaced by 14140	18927 GTE Sylvania Inc. Precision Material Group Parts Division Titusville, Pennsylvania
11532 Teledyne Relays Hawthorne, California	13103 Thermalloy Co., Inc. Dallas, Texas	16258 Space-Lok Inc. Burbank, California	19451 Perine Machinery & Supply Co. Seattle, Washington
11711 General Instrument Corp. Rectifier Division Hicksville, New York	13327 Solitron Devices Inc. Tappan, New York		19701 Electro-Midland Corp. Mepco-Electra Inc. Mineral Wells, Texas
	13511 Amphenol Cadre Div. Bunker-Ramo Corp. Los Gatos, California		20584 Enochs Mfg. Inc. Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891 Self-Organizing Systems, Inc. Dallas, Texas	28480 Hewlett Packard Co. Corporate HQ Palo Alto, California	43543 Nytronics Inc. Transformer Co. Div. Geneva, New York	70903 Beiden Corp. Geneva, Illinois
21604 Bucheys Stamping Co. Columbus, Ohio	28520 Heyman Mfg. Co. Kenilworth, New Jersey	44655 Ohmite Mfg. Co. Skokie, Illinois	71002 Birnback Radio Co., Inc. Freeport, New York
21845 Solitron Devices Inc. Transistor Division Riviera Beach, Florida	29083 Monsanto, Co., Inc. Santa Clara, California	49671 RCA Corp. New York, New York	71400 Bussmann Mfg. Div. of McGraw-Edison Co. Saint Louis, Missouri
22767 ITT Semiconductors Palo Alto, California	29604 Stackpole Components Co. Raleigh, North Carolina	49956 Raytheon Company Lexington, Massachusetts	71450 CTS Corp. Elkhart, Indiana
23050 Product Comp. Corp. Mount Vernon, New York	30148 AB Enterprise Inc. Ahoskie, North Carolina	50088 Mostek Corp. Carrollton, Texas	71468 ITT Cannon Electric Inc. Santa Ana, California
23732 Tracor Inc. Rockville, Maryland	30323 Illinois Tool Works, Inc. Chicago, Illinois	50579 Litronix Inc. Cupertino, California	71482 Clare, C.P. & Co. Chicago, Illinois
23880 Stanford Applied Engrng. Santa Clara, California	31091 Optimax Inc. Colmar, Pennsylvania	51605 Scientific Components Inc. Linden, New Jersey	71590 Centrelab Electronics Div. of Globe Union Inc. Milwaukee, Wisconsin
23936 Pamotor Div., Wm. J. Purdy Co. Burlingame, California	32539 Mura Corp. Great Neck, New York	53021 Sangamo Electric Co. Springfield, Illinois	71707 Coto Coil Co., Inc. Providence, Rhode Island
24248 Replaced by 94222	32767 Griffith Plastic Corp. Burlingame, California	54294 Cutler-Hammer Inc. formerly Shallcross, A Cutter-Hammer Co. Selma, North Carolina	71744 Chicago Miniature Lamp Works Chicago, Illinois
24355 Analog Devices Inc. Norwood, Massachusetts	32879 Advanced Mechanical Components Northridge, California	55026 Simpson Electric Co. Div. of Am. Gage and Mach. Co. Elgin, Illinois	71785 TRW Electronics Components Cinch Connector Operations Div. Elk Grove Village Chicago, Illinois
24655 General Radio Concord, Massachusetts	32897 Erie Technological Products, Inc. Frequency Control Div. Carlisle, Pennsylvania	56289 Sprague Electric Co. North Adams, Massachusetts	72005 Wilber B. Driver Co. Newark, New Jersey
24759 Lenox-Fugle Electronics Inc. South Plainfield, New Jersey	32997 Bourns Inc. Trimpot Products Division Riverside, California	58474 Superior Electric Co. Bristol, Connecticut	72092 Replaced by 06980
25088 Siemen Corp. Isilen, New Jersey	33173 General Electric Co. Products Dept. Owensboro, Kentucky	60399 Torin Corp. formerly Torrington Mfg. Co. Torrington, Connecticut	72136 Electro Motive Mfg. Co. Williamantic, Connecticut
25403 Amperex Electronic Corp. Semiconductor & Micro-Circuits Div. Slatersville, Rhode Island	34333 Silicon General Westminister, California	63743 Ward Leonard Electric Co., Inc. Mount Vernon, New York	72259 Nytronics Inc. Pelham Manor, New Jersey
27014 National Semiconductor Corp. Santa Clara, California	34335 Advanced Micro Devices Sunnyvale, California	64834 West Mfg. Co. San Francisco, California	72619 Dialight Div. Amperex Electronic Corp. Brooklyn, New York
27264 Molex Products Downers Grove, Illinois	34802 Electromotive Inc. Kenilworth, New Jersey	65092 Weston Instruments Inc. Newark, New Jersey	72653 G.C. Electronics Div. of Hydrometals, Inc. Brooklyn, New York
28213 Minnesota Mining & Mfg. Co. Consumer Products Div. St. Paul, Minnesota	37942 P.R. Mallory & Co., Inc. Indianapolis, Indiana	66150 Winslow Tele-Tronics Inc. Eaton Town, New Jersey	72665 Replaced by 90303
28425 Serv-/Link formerly Bohannon Industries Fort Worth, Texas	42498 National Radio Melrose, Massachusetts	70485 Atlantic India Rubber Works Chicago, Illinois	72794 Dzus Fastener Co., Inc. West Islip, New York
28478 Detroit Controls Div. Detroit Corporation Milwaukee, Wisconsin		70563 Amperite Company Union City, New Jersey	72928 Gulton Ind. Inc. Gudeman Div. Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982 Erie Tech. Products Inc. Erie, Pennsylvania	75382 Kulka Electric Corp. Mount Vernon, New York	80583 Hammarlund Mfg. Co., Inc. Red Bank, New Jersey	83594 Burrhoughs Corp. Electronic Components Div. Plainfield, New Jersey
73138 Bechman Instrument Inc. Helipot Division Fullerton, California	75915 Littlefuse Inc. Des Plaines, Illinois	80640 Arnold Stevens, Inc. South Boston, Massachusetts	83740 Union Carbide Corp. Battery Products Div. formerly Consumer Products Div. New York, New York
73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, California	76854 Oak Industries Inc. Switch Div. Crystal Lake, Illinois	81073 Grayhill, Inc. La Grange, Illinois	84171 Arco Electronics Great Neck, New York
73445 Amperex Electronic Corp. Hicksville, New York	77342 AMF Inc. Potter & Brumfield Div. Princeton, Indiana	81312 Winchester Electronics Div. of Litton Industries Inc. Oakville, Connecticut	84411 TRW Electronic Components TRW Capacitors Ogallala, Nebraska
73559 Carling Electric Inc. West Hartford, Connecticut	77638 General Instrument Corp. Rectifier Division Brooklyn, New York	81483 Therm-O-Disc Inc. Mansfield, Ohio	84613 Fuse Indicator Corp. Rockville, Maryland
73586 Circle F Industries Trenton, New Jersey	77969 Rubbercraft Corp. of CA. LTD. Torrance, California	81483 International Rectifier Corp. Los Angeles, California	84682 Essex International Inc. Industrial Wire Div. Peabody, Massachusetts
73734 Federal Screw Products, Inc. Chicago, Illinois	78189 Shakeproof Div. of Illinois Tool Works Inc. Elgin, Illinois	81590 Korry Mfg. Co. Seattle, Washington	86577 Precision Metal Products of Malden Inc. Stoneham, Massachusetts
73743 Fischer Special Mfg. Co. Cincinnati, Ohio	78277 Sigma Instruments, Inc. South Braintree, Massachusetts	81741 Chicago Lock Co. Chicago, Illinois	86684 Radio Corp. of America Electronic Components Div. Harrison, New Jersey
73899 JFD Electronics Co. Components Corp. Brooklyn, New York	78488 Stackpole Carbon Co. Saint Marys, Pennsylvania	82305 Palmer Electronics Corp. South Gate, California	86928 Seastrom Mfg. Co., Inc. Glendale, California
73949 Guardian Electric Mfg. Co. Chicago, Illinois	78553 Eaton Corp. Engineered Fastener Div. Tinnerman Plant Cleveland, Ohio	82389 Switchcraft Inc. Chicago, Illinois	87034 Illuminated Products Inc. Subsidiary of Oak Industries Inc. Anahiem, California
74199 Quan Nichols Co. Chicago, Illinois	79136 Waldes Kohinoor Inc. Long Island City, New York	82415 North American Phillips Controls Corp. Frederick, Maryland	88219 Gould Inc. Industrial Div. Trenton, New Jersey
74217 Radio Switch Corp. Marlboro, New Jersey	79497 Western Rubber Company Goshen, Indiana	82872 Roanwell Corp. New York, New York	88245 Litton Systems Inc. Useco Div. Van Nuys, California
74276 Signalite Div. General Instrument Corp. Neptune, New Jersey	79963 Zierick Mfg. Corp. Mt. Kisko, New York	82877 Rotron Inc. Woodstock, New York	88419 Cornell-Dubilier Electronic Div. Federal Pacific Co. Fuquay-Varian, North Carolina
74306 Piezo Crystal Co. Carlisle, Pennsylvania	80031 Electro-Midland Corp. Mepco Div. A North American Phillips Co. Norristown, New Jersey	82879 ITT Royal Electric Div. Pawtucket, Rhode Island	88486 Plastic Wire & Cable Jewitt City, Connecticut
74542 Hoyt Elect. Instr. Works Penacook, New Hampshire	80145 LFE Corp., Process Control Div. formerly API Instrument Co. Chesterland, Ohio	83003 Varo Inc. Garland, Texas	88690 Replaced by 04217
74970 Johnson E.F., Co. Waseca, Minnesota	80183 Use 56289 Sprague Products North Adams, Massachusetts	83058 The Carr Co., United Can Div. of TRW Cambridge, Massachusetts	89536 John Fluke Mfg. Co., Inc. Seattle, Washington
75042 TRW Electronics Components IRC Fixed Resistors Philadelphia, Pennsylvania	80294 Bourns Inc., Instrument Div. Riverside, California	83298 Bendix Corp. Electric Power Div. Eatontown, New Jersey	89730 G.E. Co., Newark Lamp Works Newark, New Jersey
75376 Kurz-Kasch Inc. Dayton, Ohio		83330 Herman H. Smith, Inc. Brooklyn, New York	
75378 CTS Knights Inc. Sandwich, Illinois		83478 Rubbercraft Corp. of America, Inc. West Haven, Connecticut	

Federal Supply Codes for Manufacturers (cont)

90201 Mallory Capacitor Co. Div. of P.R. Mallory Co., Inc. Indianapolis, Indiana	91836 King's Electronics Co., Inc. Tuckahoe, New York	95354 Methode Mfg. Corp. Rolling Meadows, Illinois	98291 Sealectro Corp. Mamaroneck, New York
90211 Use 56365 Square D Co. Chicago, Illinois	91929 Honeywell Inc. Micro Switch Div. Freeport, Illinois	95712 Bendix Corp. Electrical Components Div. Microwave Devices Plant Franklin, Indiana	98388 Royal Industries Products Div. San Diego, California
90215 Best Stamp & Mfg. Co. Kansas City, Missouri	91934 Miller Electric Co., Inc. Div. of Aunet Woonsocket, Rhode Island	95987 Weckesser Co. Inc. Chicago, Illinois	98743 Replaced by 12749
90303 Mallory Battery Co. Div. of Mallory Co., Inc. Tarrytown, New York	92194 Alpha Wire Corp. Elizabeth, New Jersey	96733 San Fernando Electric Mfg. Co. San Fernando, California	98925 Replaced by 14433
91094 Essex International Inc. Suglex/IWP Div. Newmarket, New Hampshire	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts	96853 Gulton Industries Inc. Measurement and Controls Div. formerly Rustrak Instruments Co. Manchester, New Hampshire	99120 Plastic Capacitors, Inc. Chicago, Illinois
91293 Johanson Mfg. Co. Boonton, New Jersey	94145 Replaced by 49956	96881 Thomson Industries, Inc. Manhasset, New York	99217 Bell Industries Elect. Comp. Div. formerly Southern Elect. Div. Burbank, California
91407 Replaced by 58474	94154 Use 94988 Wagner Electric Corp. Tung-Sol Div. Newark, New Jersey	97540 Master Mobile Mounts, Div. of Whitehall Electronics Corp. Ft. Meyers, Florida	99392 STM Oakland, California
91502 Associated Machine Santa Clara, California	94222 Southco Inc. formerly South Chester Corp. Lester, Pennsylvania	97913 Industrial Electronic Hardware Corp. New York, New York	99515 ITT Jennings Monrovia Plant Div. of ITT Jennings formerly Marshall Industries Capacitor Div. Monrovia, California
91506 Augat Inc. Attleboro, Massachusetts	95146 Alco Electronic Products Inc. Lawrence, Massachusetts	97945 Penwalt Corp. SS White Industrial Products Div. Piscataway, New Jersey	99779 Use 29587 Bunker-Ramo Corp. Barnes Div. Landsdowne, Pennsylvania
91637 Dale Electronics Inc. Columbus, Nebraska	95263 Leecraft Mfg. Co. Long Island City, New York	97966 Replaced by 11358	99800 American Precision Industries Inc. Delevan Division East Aurora, New York
91662 Elco Corp. Willow Grove, Pennsylvania	95264 Replaced by 98278	98094 Replaced by 49956	99942 Centrelab Semiconductor Centrelab Electronics Div. of Globe-Union Inc. El Monte, California
91737 Use 71468 Gremar Mfg. Co., Inc. ITT Cannon/Gremar Santa Ana, California	95275 Vitramon Inc. Bridgeport, Connecticut	98159 Rubber-Teck, Inc. Gardena, California	Toyo Electronics (R-Ohm Corp.) Irvine, California
91802 Industrial Devices, Inc. Edgewater, New Jersey	95303 RCA Corp. Receiving Tube Div. Cincinnati, Ohio	98278 Malco A Microdot Co., Inc. Connector & Cable Div. Pasadena, California	National Connector Minneapolis, Minnesota
91833 Keystone Electronics Corp. New York, New York	95348 Gordo's Corp. Bloomfield, New Jersey		

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