FLUKE®

Instruction Manual

Model

887A & 887AB

AC/DC Differential Voltmeters

P/N 294256

FEBRUARY 1967

REV. 2 8/73

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., Zevenheuvelenweg 53, Tilburg, The Netherlands.

* For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., • P.O. Box 43210 • Mountlake Terrace, Washington 98043

Rev. 9/78

CHANGE/ERRATA INFORMATION

Issue No: 8   September 28, 1979

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

1. The revision letter given with each change is equal to or higher than that which is stamped on the indicated pcb assembly.
2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title:	887A & 887AB AC/DC DIFFERENTIAL VOLTMETERS
Print Date:	FEBUARY 1, 1967
Rev and Date:	2, 8/73

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	5/78
2	12/78
3	9/79

ERRATA #1

On page 5-16:

Change the description of switch S7 FROM: 2 pol,2 pos,2 section TO: 2 pol,10 pos,2 section.

ERRATA #2

On page 1-3, under INPUT POWER:

FROM: (minimum 30 hours operation on full charge)
TO: (minimum 15 hours operation on full charge)

On page 2-3, para. 2-9, step b:

Change last two words of first sentence FROM: 30 hours TO: 15 hours.

ERRATA #3

On page 5-4, change the mfg no:

FROM: 56289 TO: 14752

CHANGE #1 - 7301

On page 5-9:

FROM: R107-Res,comp 1.8M ± 1%,1/2W-4704-108720-01121-EB1851-1
TO: R107-Res,comp 10K ± 1%,1/2W-4704-109165-01121-EB1031-1

CHANGE #2 - 9293

On page 5-6

FROM: 10-Knob, Null and Range-2405-158956-89536-2405-158956-2
TO: 10-Knob, Null and Range-2405-341404-89536-2405-341404-2

FROM: 11-Knob, POWER-2405-162347-89536-2405-162347-1
TO: 11-Knob, POWER-2405-426189-89536-2405-426189-1

FROM: 12-Knob voltage-2405-158949-89536-2405-158949-6
TO: 12-Knob voltage-2405-341396-89536-2405-341396-6

ERRATA #4

On page 4-6, para.4-24, step b:

FROM: -10 ± 0.5 volts dc
TO: -8.5 ± 0.5 volts dc

CHANGE #3 - 11468

On page 5-4, delete the existing BT1 and BT4 entries and add:

BT1,BT3-Battery Pack, Ni-cad(887AB only)-460998-89536-460998-1

CHANGE #4 - 11476

On page 5-7:

ADD: CR103-Diode,zener,6.8V-4803-260695-07910-1N754A-1

On the schematic:

ADD: 6.8V zener diode in parallel with C101(cathode to +6V, anode to common)

CHANGE #5 - 11771

On page 5-13:

FROM: R226,R227-Res,comp,47K ± 10%,2W-4704-110015-01121-HB4731-2
TO: R226,R227-Res,comp,33K ± 5%,1/4W-4704-148155-01121-CB3335-2

On the functional schematic change the value of R226 and R227 FROM: 47K TO: 33K

ERRATA #6

Place the following warning directly following para 4-47:

WARNING

THE CONDUCTIVE DUST COVER USED ON THE FOLLOWING TRIM CAPACITORS;C401,C403 AND C502 WILL BE AT INPUT POTENTIAL. TO AVOID SHOCK HAZARD, ALWAYS REMOVE INPUT VOLTAGE BEFORE REMOVING DUST COVER.

CHANGE #6 - 11883,11996

Rev.-E, A100 Reference Supply Assembly

On page 5-7:

FROM: C101-Cap,elect,500 uF -10/+50%-1502-160101-56289-34D507G015FJ2-1-1

TO: C101-Cap,elect,500 uF -10/+50%-1502-160101-56289-34D507G015FJ2-1-1

FROM: Q106,Q107-Tstr,type 2N1307-4805-148643-01295-2N1307-2-1
TO: Q106,Q107-Tstr,type 2N3906-4818-195974-04713-2N3906-2-1

Change TOT QTY of Q104 FROM: 1 TO: 2

FROM: Q102-Tstr,type 2N1303-4805-148619-01295-2N1303-1-1
TO: Q102-Tstr,selected-4818-288761-89536-288761-1-1

FROM: Q105-Tstr,type 2N404-4805-163188-01295-2N404-1-1
TO: Q105-Tstr,T.I. type SM6419-4805-190389-01295-SM6419-1-1

On page 5-9:

FROM: R130,R131-Res,comp,1k ± 10%,1/2W-4704-108563-01121-EB1021-5
TO: R130,R131-Res,comp,2k ± 5%,1/2W-4704-169854-01121-EB2025-5

FROM: Q108,Q109-Tstr,type 2N1304-4805-117127-01295-2N1304-2-1
TO: Q108,Q109-Tstr,type 2N3905-4819-218396-04713-2N3904-2-1

On the Functional Schematic Diagram, Model 887A & AB Differential Voltmeter:

FROM:	C101, 500	FROM:	R130,R131, 1k
TO:	C101, 1,000	TO:	R130,R131, 2k

Rev.-C, A200 Null Detector Assembly

On page 5-12:

FROM: Q206-Tstr,type 2N1372-4805-116129-01295-2N1372-1
TO: Q206-Tstr,selected-4818-321398-89536-321298-1

CHANGE #7 - 12434

Rev.-F, A100 Reference Supply Assy (887A-401)

On page 5-7:

DELETE: Q106,Q107-Tstr,type 2N3906-4818- 195974-04713-2N3906-2-1
FROM: Q102-Tstr,type selected-4818-288761-89536-288761-1-1
TO: Q102,Q106,Q107-Tstr,type slct-4818-288761-89536-288761-3-1

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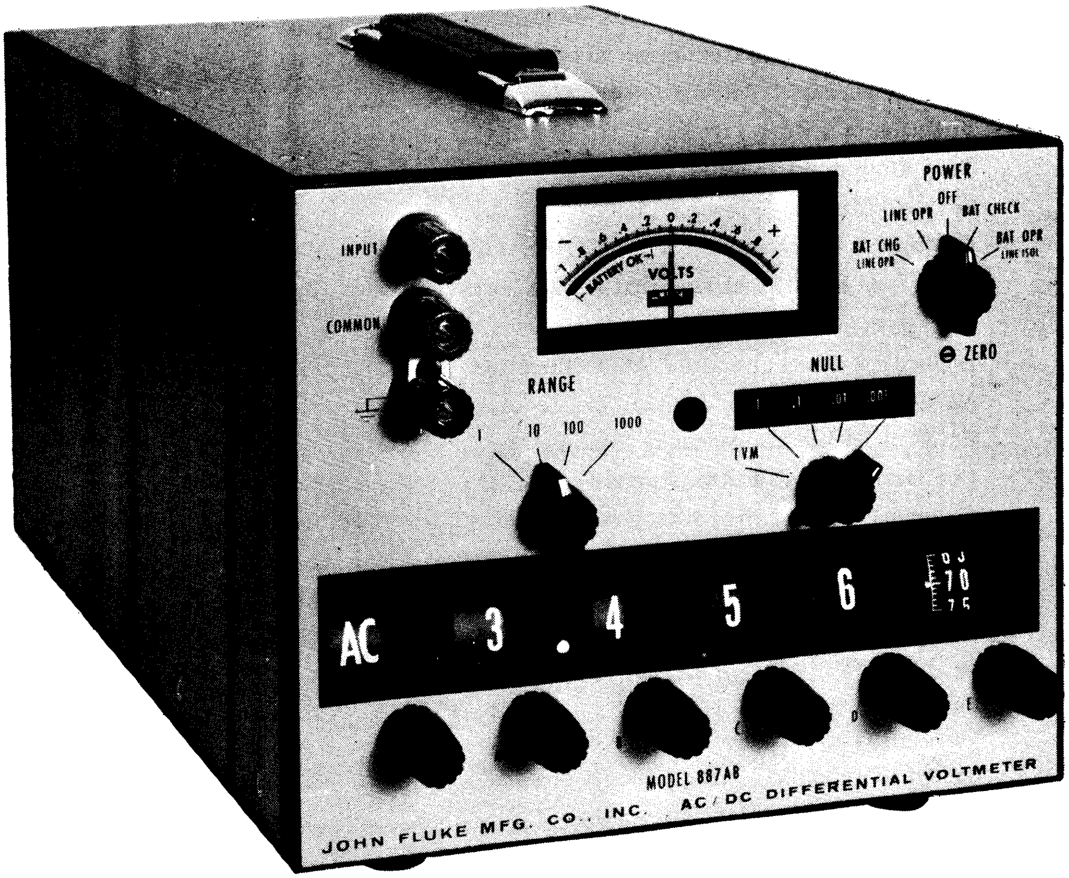
LIST OF ILLUSTRATIONS



MODEL 887AB AC/DC DIFFERENTIAL VOLTMETER

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. This instruction manual is for use with the 887A series Differential AC/DC voltmeters. These are available as either a line-powered instrument (Model 887A) or as a combination line-powered or battery-powered instrument (Model 887AB). Both instruments are half rack size and are equipped with resilient feet and tilt-up bail for field or bench use. A single instrument may be mounted in a standard 19 inch rack by means of metal handle rack adapter kit 881A-102. Two instruments may be mounted side-by-side by means of metal handle rack adapter kit 881A-103.

1-3. The 887A/AB series instruments are capable of being used as conventional voltmeters for rapid determination of voltages from 0 to 1100 volts dc and from 0.001 to 1100 volts ac to within ±3% of range setting; as differential voltmeters for precise measurement of dc voltages from 0 to ±1100 volts to within ±(0.0025% of input + 0.0001% of range + 5µv); as accurate ac voltmeters for measurement of ac voltages from 0.001 to 500 volts to within ±(0.05%of input + 0.0025% of range) from 30 Hz to 5 kHz, with reduced accuracy to 5 Hz and 100 kHz; and as megohmmeters for measurement of resistance from 10 megohms to 11,000 megohms with a typical accuracy of 5%. They can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source at null up to 11 volts dc. Thus the determination of the unknown potential is independent of its source resistance. Above 11 volts dc, the input resistance is an excellent 10 megohms. To minimize errors due to common mode voltages, the 887A series is provided with extremely high leakage resistance to ground - - typically several hundred thousand megohms. Also, where ground loops errors are a problem, the battery operated mode of the 887AB eliminates these errors due to complete isolation from the power line. As additional features, the 887A series contains a polarity switch for equal convenience in measuring positive or negative dc voltages and an adjustable recorder output which makes the instrument particularly useful for monitoring the stability of almost any ac or dc voltage. Furthermore, thorough shock, vibration, humidity, and temperature testing assure years of hard use under severe environmental conditions.

1-4. When used as a dc differential voltmeter, the 887A operates on the potentiometric principal. An unknown voltage is measured by comparing it to a known adjustable voltage with the aid of a null detector. An accurate standard for measurement is obtained from 11 volt dc reference supply derived from a pair of temperature-compensated zener diodes. The known adjustable reference voltage is provided by a Kelvin-Varley voltage divider with four decades of FLUKE precision wirewound resistors and a high-resolution interpolating vernier that are set accurately by five voltage readout dials to give a six digit readout. In this way, the 11 volts can be precisely divided into increments smaller than 10 microvolts. The unknown voltage is then simply read from the voltage dials. For voltages between 11 and 1100 volts dc, an input attenuator divides the unknown voltage by 100 before it is measured potentiometrically. When used as an accurate ac voltmeter, the 887A operates essentially the same as for dc differential measurements. The ac input voltage is converted to a dc voltage and this dc voltage is measured by comparing it to a known adjustable reference voltage.

1-5. INPUT POWER

1-6. Like most FLUKE instruments, the 887A is normally supplied with dual primary windings connected in parallel for 115 volt line operation. Upon request, the instrument is supplied for 230 volt line operation with the primary windings connected in series. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the power transformer.

1-7. DAMAGE IN SHIPMENT

1-8. Immediately upon receipt, thoroughly inspect the instrument for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-7. SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

DC ACCURACY. ±(0.0025% of input + 0.0001% of range + 5 uv) from 0 to ±1100 vdc at 23° C. (nominal calibration temperature), less than 70% relative humidity. ±(0.005% of input + 5 uv) from 0 to ±1100 vdc within 16° C to 32° C (60° F to 90° F) temperature range, less than 70% relative humidity. Derate accuracy outside this temperature range at 0.00035%/C to extremes of 0° C and 50° C (32° F and 122° F).

NOTE. Thorough error analysis studies were made into total instrument stability taking into account the documented stabilities of individual components and utilizing probability and statistical methods. These studies indicate that typical instrument stability defined as a specification met by 80% to 90% of all instruments) is 20 ppm (0.002%) peak-to-peak per year. An instrument so categorized need be calibrated only once per year to meet all specifications. Additional stability data upon request.

VOLTAGE RANGES. 1, 10, 100, 1000 vac and dc, with 10% overranging capability on each range.

NULL RANGES. 100 uv through 100 v end scale ac and dc, in seven ranges.

DC INPUT RESISTANCE. Infinite at null from 0 to ±11 vdc. 10 megohms above ±11 vdc.

METER RESOLUTION. 1 ppm of range (1 uv maximum).

VOLTAGE DIAL RESOLUTION. 1 ppm of range (1 uv maximum).

AC ACCURACY. At 23° C ±1° C (nominal calibration temperature) relative humidity less than 70%

INPUT VOLTAGE	FREQUENCY		
	30Hz to 5KHz	5KHz to 10KHz	10KHz to 20KHz
.001 to 500V	±(0.05% of input +0.0025% range)	±(0.07% of input +0.005% range)	±(0.15% of input +0.01% range)
500V to 1100V	±0.1% of input	±0.1% of input	±(.15% of input +0.01% range)

Temperature range 13°C to 35°C (55° F to 95° F) relative humidity less than 70%

INPUT VOLTAGE	LOW FREQUENCY		BASIC FREQUENCY		HIGH FREQUENCY		
	5Hz - 10Hz	10Hz - 20Hz	20Hz - 5KHz	5KHz - 10KHz	10KHz - 20KHz	20KHz - 50KHz	50KHz - 100KHz
.001 - 1100V	±(1% of input + 25 uv)	±(0.3% of input + 100uv)	±(0.1% of input + 25 uv)	±(0.15% of input + 25 uv)			
0.1 - 1100V					±0.3% of input		
0.1 - 110V						±0.5% of input	±1% of input

Outside the 13° C to 35° C temperature range the above specifications may be derated at 0.003%/° C (below 5 KHz) or 0.005%/° C (above 5 KHz) to the extremes of 0° C to 50° C (32° F to 122° F)

AS A CONVENTIONAL VOLTMETER

AC ACCURACY. ±3% of range within frequency and voltage ranges listed under "ac accuracy as a differential voltmeter."

DC ACCURACY. ±3% of range.

RANGE

VOLTAGE RANGE	DC INPUT RESISTANCE	AC INPUT IMPEDANCE
1000-0-1000	10 MEG	1 MEG 40 Pf
100-0-100	10 MEG	1 MEG 40 Pf
10-0-10	10 MEG	1 MEG 40 Pf
1-0-1	10 MEG	1 MEG 40 Pf
*.1-0-.1	10 MEG	1 MEG 40 Pf
*.01-0-.01	10 MEG	1 MEG 40 Pf
*.001-0-.001	1 MEG	1 MEG 40 Pf
*.0001-0-.0001	1 MEG	1 MEG 40 Pf

NOTE. 10% overvoltage capability on each range.

* These ranges obtained by using null ranges with all voltage readout dials set to zero.

GENERAL

ELECTRICAL DESIGN. Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR. 10 megohms for two least sensitive null ranges, all input ranges; 1 megohm for two most sensitive null ranges, all input ranges.

REFERENCE ELEMENT. Temperature-compensated zener diode, temperature coefficient less than 1 ppm/° C over operating temperature range.

REGULATION OF REFERENCE SUPPLY. 0.0002% for 10% line voltage change.

STABILITY OF REFERENCE SUPPLY. 0.0005% peak-to-peak per hour. 0.0007% peak-to-peak per day. 0.0013% peak-to-peak per sixty days.

STABILITY OF INSTRUMENT. 0.0025% peak-to-peak per sixty days.

ACCURACY OF OFF-NULL DEFLECTION. ±5% of null range (±3% with voltage dials at zero).

KELVIN VARLEY DIVIDER ACCURACY. ±0.0012% of setting from 1/10 of full scale to full scale. ±0.00012% terminal linearity below 1/10 full scale.

RECORDER OUTPUT. Adjustable from 0 to ±20 mv minimum for full scale right and left deflection.

POLARITY. Front panel switch selects +DC, -DC and AC.

WARMUP TIME. Three minutes.

COMMON MODE REJECTION. 130 db DC; 85 db at 60 Hz; 70 db at 400 Hz. Note: Battery operation of Model 887AB provides complete isolation from power system ground, for elimination of error due to ground loops.

OPERATING TEMPERATURE RANGE. 0° C to 50° C (see accuracy).

STORAGE TEMPERATURE RANGE.
Model 887A, -40° C to +70° C (-40° F to +158° F)
Model 887AB, -40° C to -60° C (-40° F to +140° F)

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

VIBRATION. Meets requirements of MIL-T-945A.

INPUT POWER. Model 887A 115/230 vac ±10%, 50 to 440 Hz; Model 887AB 115/230 vac ±10%, 50 to 440 Hz and rechargeable battery operation (minimum 30 hours operation on full charge).

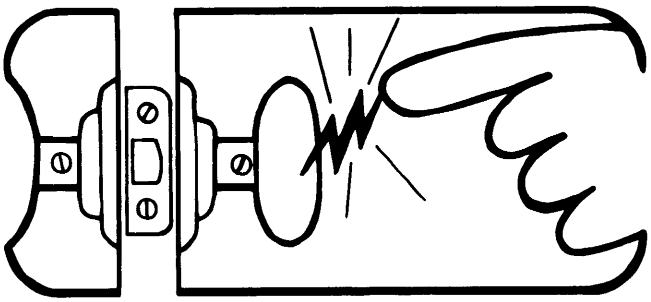
WEIGHT.
Model 887A approximately 13 lbs.
Model 887AB approximately 14 lbs.

SIZE. 7" high, 8 1/2" wide, 14 3/4" deep.

static awareness

A Message From

John Fluke Mfg. Co., Inc.

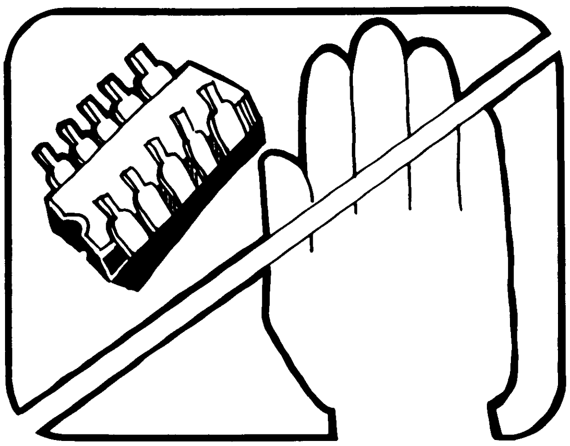


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

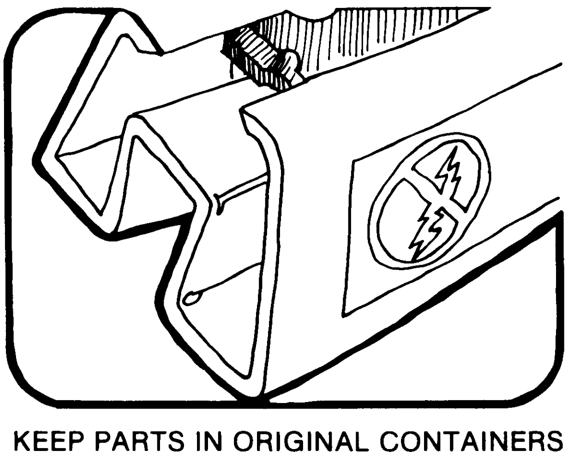
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

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

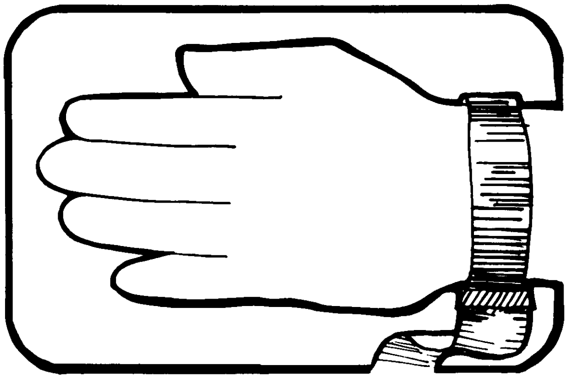
The following practices should be followed to minimize damage to S.S. devices.



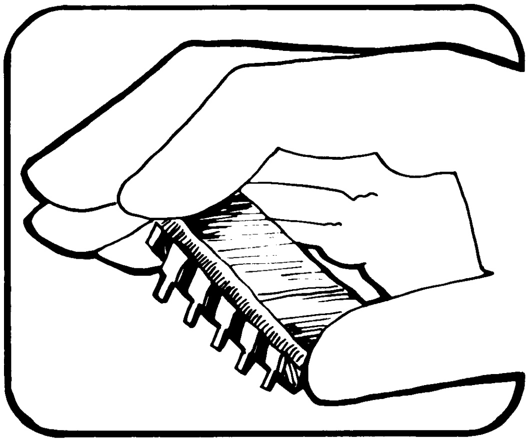
1. MINIMIZE HANDLING



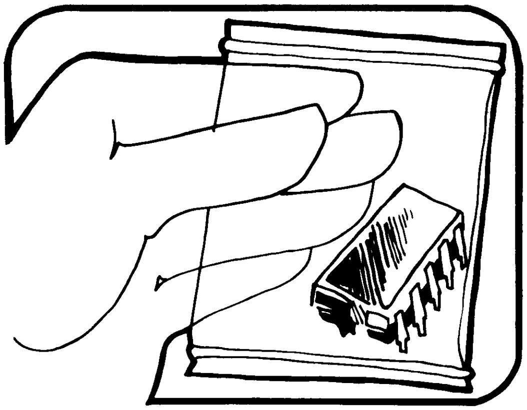
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



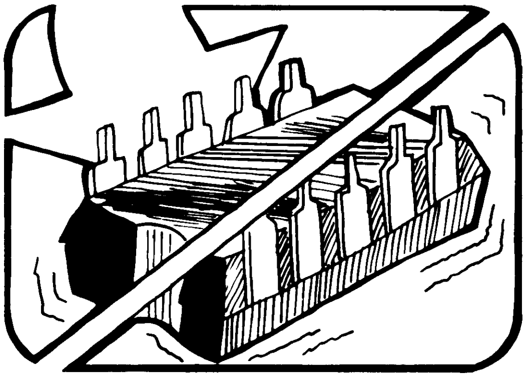
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



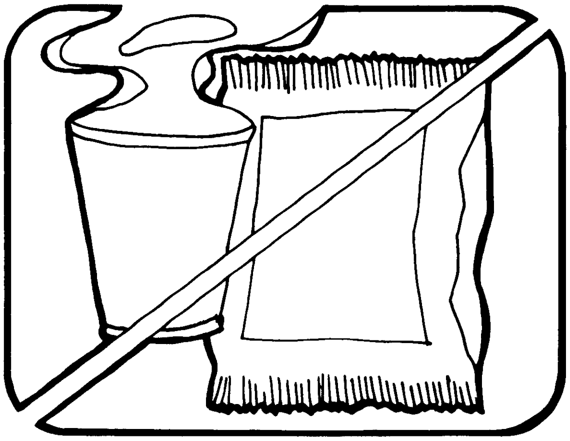
4. HANDLE S.S. DEVICES BY THE BODY



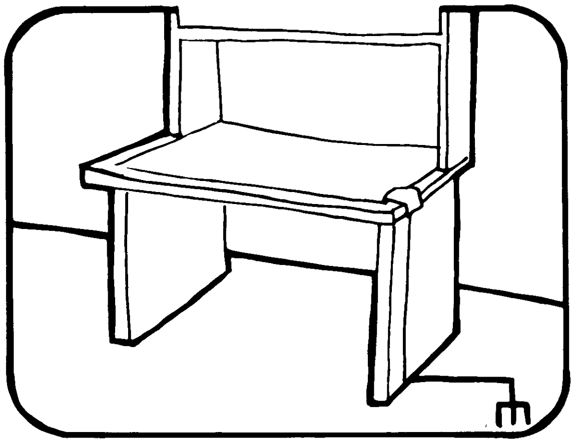
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



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



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



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. 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.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

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SECTION II

OPERATING INSTRUCTIONS

2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS AND INDICATORS

2-2. The location, circuit symbol, and a functional description of the external controls, terminals, and indicators on the 887A and 887AB Precision Differential DC Voltmeter may be found in figure 2-1 and 2-2.

2-3. PRELIMINARY OPERATION FOR 887A

2-4. The following procedure prepares the Model 887A for operation.

a. Connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

WARNING!

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

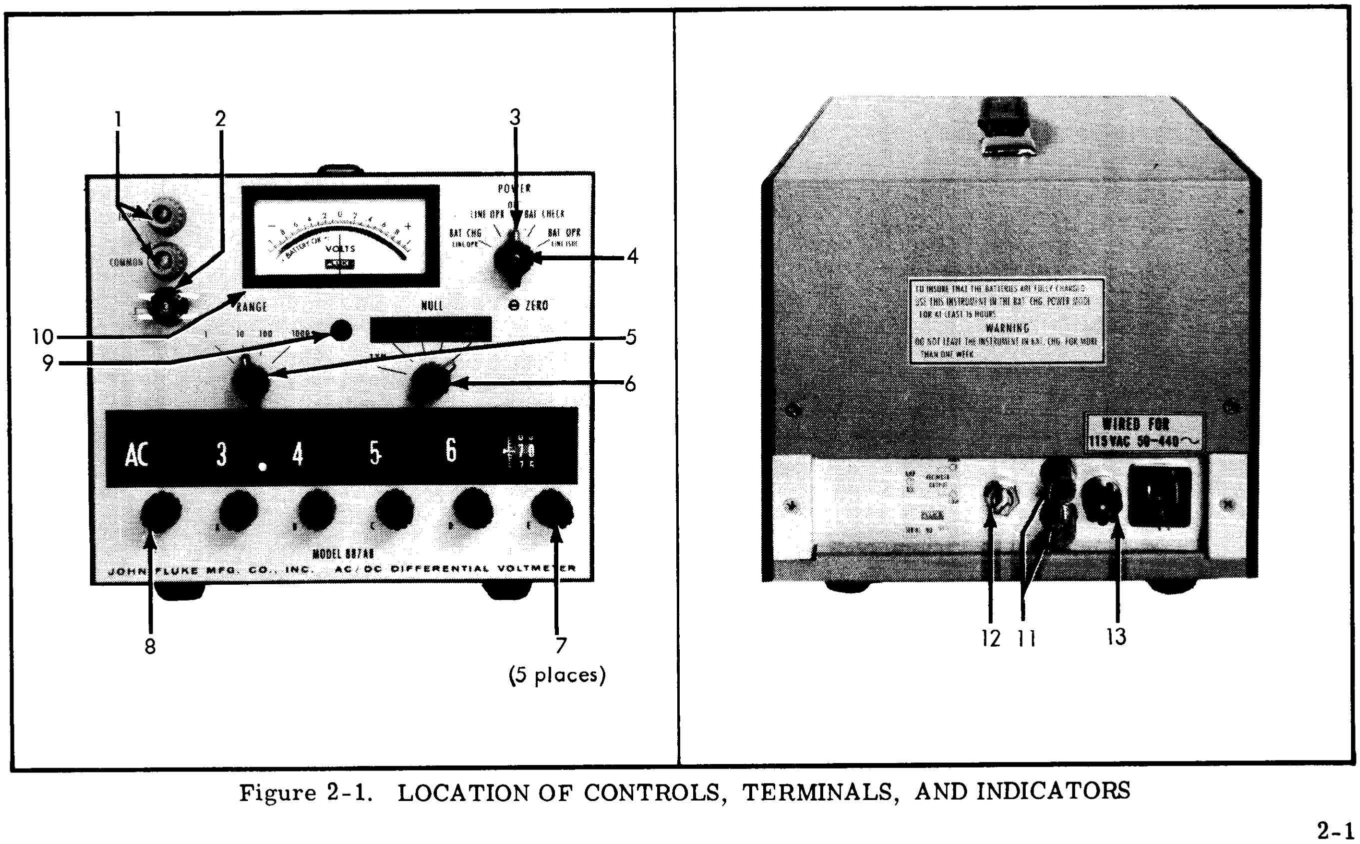


Figure 2-1. LOCATION OF CONTROLS, TERMINALS, AND INDICATORS

INDEX NO.	CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
1	INPUT and COMMON terminals	J1, J2	Provided for connecting ac or dc voltage to be measured.
2	Chassis ground terminal	J3	Provided for grounding purposes. A 0.01 uf capacitor is connected from the COMMON binding post to the chassis ground post. The INPUT post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the circuit should be checked for conflicts in grounding before connecting COMMON binding post to the chassis post.
3	POWER switch	S1	In the Model 887A, the POWER switch applies ac line voltage to primary circuit of transformer when turned from OFF to ON. In the Model 887AB, positions for OFF, BAT CHECK, and three modes of operation (LINE OPR, BAT CHG - LINE OPR, and BAT OPR - LINE ISOL) are available. When set to LINE OPR, ac line voltage is applied to primary circuit of transformer. When set to BAT CHG - LINE OPR, ac line voltage is applied to primary of transformer and batteries are charged at the same time. When set to BAT OPR - LINE ISOL, battery power is applied to the instrument and both sides of primary circuit are open. When set to BAT CHECK, battery power is applied to the instrument, both sides of primary circuit are open, and meter is connected in series with a resistor to measure voltage between reference supply batteries and reference supply output which indicates the condition of the batteries.
4	Electronic ZERO control	R239	A screwdriver adjustment used to zero null detector in the .0001 volt null mode on the 1 volt range and in the .01 volt null mode on the 100 volt range. For best results, input should be shorted prior to zeroing.
5	RANGE switch	S2	Selects desired voltage range, changes null ranges appearing in NULL window, and positions decimal point for voltage readout dials. Voltage ranges of 1, 10, 100, and 1000 volts are available. A voltage 10% higher than range setting may be measured in each range.
6	NULL switch	S3	Set to TVM for determining the approximate value of unknown voltage prior to differential measurements. Seven null voltage ranges (four of which are used for each setting of the RANGE switch) of 100, 10, 1, 0.1, 0.01, 0.001, and 0.0001 volts are used for differential measurements. These ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials.
7	A, B, C, D, and E voltage readout dials	S5, S6, S7, S8, R13	Provide an in-line readout of the amount of internal reference voltage necessary to null the unknown voltage.
8	AC-DC polarity switch	S4	Selects the AC, + (dc), or - (dc) mode of operation. With this switch in the positive position, the polarity of INPUT binding post is positive with respect to COMMON binding post.

Figure 2-2. DESCRIPTION OF CONTROLS, TERMINALS, AND INDICATORS (Sheet 1 of 2)

INDEX NO.	CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
9	Mechanical zero control	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the internal meter terminals have been shorted.
10	Meter	M1	Indicates approximate voltage when 887A is in TVM mode and difference between unknown and internal reference voltage when 887A is in differential mode.
11	RECORDER OUTPUT terminals	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
12	AMP ADJ control	R8	Varies the output level of the output binding post from 0 to at least 20 millivolts at full scale deflection.
13	Fuse	F1	Fuse holder protrudes from instrument to provide easy access to the fuse. The fuse is a 1/16 ampere slow blowing type for 115 volt operation and a 1/32 ampere slow blowing type for 230 volt operation.

Figure 2-2. DESCRIPTION OF CONTROLS, TERMINALS, AND INDICATORS (Sheet 2 of 2)

b. Set switches on 887A voltmeter as follows:

RANGE	1000
NULL	TVM
ac-dc polarity	+ (positive)
all voltage readout dials	0 (zero)
POWER	ON

2-5. PRELIMINARY OPERATION FOR 887AB

2-6. The following procedure prepares the Model 887AB for operation.

a. For line operation, connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

WARNING

> The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short green lead to a good earth ground.

b. For line operation, set POWER switch to LINE OPR.

c. For battery operation, set POWER switch to BAT CHECK. Meter needle should deflect to BATTERY OK region. If meter needle does not stay within BATTERY OK region for 10 seconds, charge batteries as outlined in paragraph 2-9. If batteries are charged, set POWER switch to BAT OPR-LINE ISOL.

d. Set switches on 887AB voltmeter as follows:

RANGE	1000
NULL	TVM
ac-dc polarity	+ (positive)
all voltage readout dials	0 (zero)

2-7. ZEROING INSTRUCTIONS

2-8. From time to time, it may be necessary to adjust the electronic meter zero control. This will normally be done at somewhat more frequent intervals than complete instrument calibration. Proceed as follows:

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

b. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the internal panel meter terminals prior to zeroing.

c. Turn instrument on and allow a 5 minute warmup period.

d. Set RANGE switch to 1, voltage readout dials to zero, and NULL switch to 0.0001.

e. Short INPUT post to COMMON post and adjust electronic ZERO control with a screwdriver for zero meter deflection.

f. Remove short from between INPUT and COMMON post.

2-9. BATTERY CHARGING

a. Connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

b. Set POWER switch to BAT CHG-LINE OPR. After 16 hours, batteries will be fully charged and capable of operating the instrument for at least 30 hours. While the batteries are being charged, the instrument may be operated the same as for line operation.

CAUTION!

> Since overcharging decreases battery life, it is recommended that the batteries be charged for less than 48 hours and never more than 1 week. When used properly, the batteries will give more than 200 charge-discharge cycles of operation.

2-10. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

b. Connect unknown voltage between INPUT and COMMON post.

c. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on meter scale.

d. If meter reads to left, turn ac-dc polarity switch to negative position. The meter needle will deflect to right. This is because polarity of unknown voltage is negative.

e. Noting position of decimal point, set five voltage readout dials to approximate voltage determined in step c. For example, if voltage is approximately 35 volts, decimal point will be between B and C voltage readout dials. Therefore, set A dial to 3 and B dial to 5.

f. Set NULL switch from TVM to successively more sensitive null ranges and adjust voltage readout dials for zero meter deflection in each null position. When meter needle indicates to the right, magnitude of voltage under measurement is greater than voltage set on voltage readout dials. When indication is to the left, voltage is less than that set on readout dials.

g. Read unknown voltage directly from five voltage readout dials.

2-11. OPERATION AS AN AC DIFFERENTIAL VOLTMETER

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

b. Set ac-dc polarity switch to AC.

c. Connect unknown ac voltage between INPUT and COMMON posts. If one side is grounded, always connect it to the COMMON post.

d. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on meter scale.

e. Noting the position of the decimal point, set five voltage readout dials to approximate voltage determined in step d. For example, if the voltage is approximately 35 volts, the decimal point will be between the B and C voltage readout dials. Therefore, set A dial to 3 and B dial to 5.

f. Set NULL switch to successively more sensitive null ranges and adjust voltage readout dials for zero meter deflection in each null position. When meter needle indicates to the right, magnitude of voltage under measurement is greater than voltage set on voltage readout dials. When indication is to the left, voltage is less than that set on readout dials.

g. Read unknown voltage directly from the five voltage readout dials.

2-12. OPERATION AS A CONVENTIONAL VOLTMETER

2-13. If it is desired to use the instrument as a conventional 3% voltmeter only, additional ranges can be made available by converting the NULL ranges to conventional voltmeter ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

b. Consult figure 2-3, and select full scale voltage deflection desired. If approximate value of voltage to be measured is unknown, select the 1000 volt range initially.

c. Set ac-dc POLARITY switch, RANGE switch, NULL switch, and voltage dials as indicated for the range selected.

d. Connect voltage to be measured between INPUT and COMMON posts. If one side is grounded, always connect it to the COMMON post.

e. Read voltage from meter scale. Deflection to right indicates an unknown dc voltage is of positive polarity. An unknown ac voltage will always deflect to the right.

FULL-SCALE DEFLECTION	AC-DC POLARITY SWITCH	RANGE SWITCH	NULL SWITCH	VOLTAGE DIALS
DC:				
1000-0-1000	+	1000	TVM	No effect
100-0-100	+	100	TVM	No effect
10-0-10	+	10	TVM	No effect
1-0-1	+	1	TVM	No effect
0.1-0-0.1	+	1	0.1	All zero
0.01-0-0.01	+	1	0.01	All zero
0.001-0-0.001	+	1	0.001	All zero
0.0001-0-0.0001	+	1	0.0001	All zero
AC:				
0-1000	AC	1000	TVM	No effect
0-100	AC	100	TVM	No effect
0-10	AC	10	TVM	No effect
0-1	AC	1	TVM	No effect
0-0.1	AC	1	0.1	All zero
0-0.01	AC	1	0.01	All zero
0-0.001	AC	1	0.001	All zero

Figure 2-3. TVM RANGES

2-14. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

b. Set ac-dc polarity switch to desired position.

c. Connect voltage to be observed between INPUT and COMMON posts. If one side is grounded, always connect it to the COMMON post. Deflection to the left indicates the voltage being measured is negative dc; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.

d. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.

e. Set five voltage readout dials to nominal voltage.

f. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.

g. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL range setting (disregarding 10% over-range at end of scale). Meter deflection to the right indicates that magnitude of voltage under observation has increased above the nominal value while deflection to the left indicates it has decreased.

2-15. RECORDING VOLTAGE EXCURSIONS

2-16. Recorder output binding posts and an output level control are provided on the 887A and 887AB for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage readout dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the voltmeter will be impaired. Therefore, the FLUKE Model A88 Isolation Amplifier is recommended for this application. The A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder.

2-17. USE OF 887A WITH AN A88 ISOLATION AMPLIFIER AND A RECORDER

2-18. To use the A88 Isolation Amplifier and a recorder with the 887A or 887AB, proceed as follows:

a. Set A88 POWER switch to ON.

b. When batteries are being used as a power source for A88, measure voltage at BATT TEST jacks. If voltage is between 11.7 and 14 volts DC, the batteries are satisfactory for use. However, if battery voltage is below 12.8 volts, batteries are approaching end of their useful life and should be replaced.

c. Connect RECORDER OUTPUT terminals of differential voltmeter to INPUT terminals of isolation amplifier with teflon leads.

d. Connect OUTPUT terminals of isolation amplifier to recorder input terminals.

e. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

f. Short INPUT post to COMMON post and set switches on voltmeter as follows:

RANGE	10
NULL	1
voltage readout dials	1.00000

The meter will indicate full scale (-1.0). This provides up to a maximum of at least 20 millivolts at RECORDER OUTPUT terminals depending on setting of AMP ADJ control.

g. Turn on recorder and set recorder gain so that a recorder input of either ±2 volts or near maximum if maximum is below ±2 volts, will cause recorder deflection desired for full scale deflection of differential voltmeter.

h. Adjust AMP ADJ control on rear of differential voltmeter until recorder deflection obtained is that desired to correspond to full scale deflection of the differential voltmeter.

i. Remove short from INPUT to COMMON post. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed as instructed under paragraph 2-14.

2-19. USE OF 887A WITH A RECORDER

2-20. To use a recorder with the 887A or 887AB proceed as follows:

a. Connect RECORDER OUTPUT terminals of differential voltmeter to input terminals of recorder with teflon leads.

Note!

> Do not ground either of the voltmeter RECORDER OUTPUT terminals or either of the recorder input terminals. If any of these terminals are grounded, current will be drawn from the Kelvin-Varley divider and the voltmeter will no longer be accurate.

b. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

c. Check for excessive electrical leakage as follows:

(1) Connect a voltage to the input of the 887A and differentially measure its potential in the most sensitive null range.

(2) Alternately connect and disconnect the recorder leads from the output terminals of the 887A while noting the meter needle deflection. More than one major scale division deflection (10% of null range) indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 887A voltmeter.

(3) Disconnect the voltage.

d. Short INPUT post to COMMON post and set switches on voltmeter as follows:

RANGE	10
NULL	1
voltage readout dials	1.00000

The meter will indicate full scale (-1.0). This provides up to a maximum of at least 20 millivolts at RECORDER OUTPUT terminals depending on setting of AMP ADJ control.

e. Adjust AMP ADJ control until recorder deflection obtained is that desired to correspond to full scale deflection of the voltmeter.

f. Remove short from INPUT to COMMON post. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed as instructed under paragraph 2-14.

2-21. MEASUREMENT OF HIGH RESISTANCE

2-22. One of the features of the 887A voltmeter is its ability to be used as a megohmmeter for rapid measurements of high resistance from 10 megohms to 11,000 megohms with a typical accuracy of 5%. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts when the RANGE switch is set to 10:

$$R_x = R_i \left(\frac{E}{E_m} - 1\right) \text{ megohms}$$

where:

R_x is the unknown resistance in megohms.

E is the voltage indicated by the voltage readout dials.

E_m is the voltage indicated on the meter.

R_i is the input resistance of the TVM circuit in megohms. 10 for the 1 and 0.1 null range and 1 for the 0.01 and 0.001 null range on the 10 volt range.

2-23. For rapid measurement of resistance between 10 megohms and 11,000 megohms, proceed as follows:

a. Perform preliminary operation, paragraph 2-3 or 2-5.

b. Set RANGE switch to 10 and NULL switch to 1.

c. Connect unknown resistance between INPUT post and COMMON post. Use short isolated leads to prevent measurement of leakage resistance between leads.

d. Adjust voltage readout dials for full scale meter deflection (-1.0). If full scale deflection cannot be obtained with NULL switch set to 1, set NULL switch to 0.1 or 0.001.

e. Determine value of unknown resistance from figure 2-4.

Range of Unknown Resistance	Null Switch Position	To Obtain Value Of Unknown In Megohms When Meter Indicates Full Scale
10 MΩ to 100 MΩ	1	Multiply amount set on voltage readout dials by 10 and subtract 10.
90 MΩ to 1090 MΩ	0.1	Multiply amount set on voltage readout dials by 100 and subtract 10.
1,000 MΩ to 11,000 MΩ	0.001	Multiply amount set on voltage readout dials by 1000.

Figure 2-4. RESISTANCE MEASUREMENTS

2-24. NOTES ON MEASURING AC OR DC VOLTAGES

2-25. GROUND LOOP PRECAUTIONS

2-26. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 887A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect 887A COMMON binding post to chassis ground post.

2-27. USE OF SHORTING LINK

2-28. A 0.01 uf capacitor (C1) is connected from the COMMON binding post to the chassis ground post to reduce the effect of circulating ac currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged when making common mode voltage measurements. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider and leakage resistance to ground. Connecting the shorting link from the COMMON post to the ground post for a few seconds will discharge C1 and thus prevent an inaccurate indication.

2-29. BATTERY CHECKING

2-30. If the voltmeter is left in the battery operating mode for an extended period of time, the batteries will become discharged. When the batteries are left in a completely discharged state with the voltmeter turned off, their voltage will recover with time. It is possible that the batteries may have recovered enough for the meter to indicate they are charged when the power switch is first set to battery check. However, after a few seconds, the battery voltage will fall and the meter will indicate that the batteries need to be charged. It should also be noted that the voltage characteristic of the nickel-cadmium batteries is very flat except near full charge and complete discharge. Therefore, when the batteries are checked, the meter needle deflection will not be proportional to the remaining ampere-hour capacity of the batteries. Just after the batteries are charged, the meter needle will indicate near full scale. However, most of the time the batteries are charged, the meter needle will indicate near half scale. A few hours before the batteries need a recharge, the meter needle will indicate just within the battery ok region.

2-31. EFFECT OF COMMON MODE VOLTAGES

2-32. Common mode errors are caused by leakage currents passing through ground loops. Since great care has been taken in the design and construction to insulate the circuitry from chassis ground, accurate dc common mode measurements up to 1000 volts dc above ground can be made with the 887A and 887AB. The dc common mode rejection is at least 134 db (5,000,000 to 1) or 0.2 uv error per common-mode-volt all the way up to 70% relative humidity. However, since the leakage resistance is dependent on dampness, the dc common mode error is typically much less at lower relative humidities. Thus, common mode measurements should be made with a relative humidity below 70%. Also, if the common mode voltage is greater than 50 volts, the measurement should be made several minutes after hookup for best accuracy. This is due to the time it takes to charge stray capacities to ground through the extremely high leakage resistances.

2-33. NOTES ON MEASURING DC VOLTAGES

2-34. EFFECT OF AC COMPONENTS ON DC MEASUREMENTS

2-35. An ac component of several times the unknown dc may be present on the unknown and the 887A will always indicate well within the specifications for frequencies over a few hundred cycles. An ac component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A triple section low pass filter (R201, C201, R202, C202, R203, and C203) is used at the input of the null detector to reduce any ac present on the dc being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the ac component is more significant. If this frequency is below 100 Hertz, the accuracy may no longer be with specifications. For example, a 60 Hertz ac voltage that is 1% of the input will cause an error of approximately 0.001% which is well within the specifications. This 1000:1 rejection of ac also applies until the ac voltage is 1000 times the null range. For example, on the .01 volt null range, the ac rejection of 1000:1 applies up to 10 vac. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 84 Hertz), the meter needle will oscillate at the difference frequency. If ac components that affect the accuracy are ever encountered, additional filtering will be required. For an ac of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an ac variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

2-36. MEASUREMENT OF NEGATIVE VOLTAGES

2-37. Because of a polarity switch, voltage which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the INPUT post is connected to the metal case, either at the 887A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch, the INPUT post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the COMMON post and use the polarity switch to obtain the proper result.

2-38. NOTES ON MEASURING AC VOLTAGES

2-39. ERRORS DUE TO DISTORTION

2-40. The ac to dc converter in the 887A is an average measuring device calibrated in rms. The converter will put out a dc voltage that is proportional to 1.11 times the average value of the ac input voltage. Thus, if the input signal is not a true sinusoid, the 887A reading is probably in error because the ratio of rms to average is usually not the same in a complex wave as in a sine wave. The magnitude of the error is dependent on magnitude of the distortion and on its phase and harmonic relationship with respect to the fundamental. Figure 2-5 indicates how the accuracy will be affected by various harmonics for different percentages of distortion. If the distortion present in the signal is composed of even harmonics and is less than 2%, the error between the 887A reading and true rms is minor. A larger error can occur if the distortion is composed of odd harmonics, especially the third harmonic. Note that for 2% of third harmonic distortion the error in the reading could range from 0 to 0.687%.

Harmonic	% Distortion	% Error From True RMS*	
		Maximum Positive	Maximum Negative
Any even harmonic	0.1	0.000	0.000
	0.5	0.000	0.0001
	1.0	0.000	0.005
	2.0	0.000	0.020
Third harmonic	0.1	0.033	0.033
	0.5	0.167	0.168
	1.0	0.328	0.338
	2.0	0.667	0.687
Fifth harmonic	0.1	0.020	0.020
	0.5	0.099	0.101
	1.0	0.195	0.205
	2.0	0.380	0.420

*Error depends upon phase relationship between harmonic and fundamental, i. e. error can be any value between maximum positive and maximum negative, including zero.

Figure 2-5. PERCENT ERROR DUE TO HARMONIC DISTORTION

2-41. ERRORS DUE TO GROUNDING

2-42. In the 887A there is a 0.01 uf capacitor connected from the COMMON terminal (middle post) to chassis ground. If it is desired to make measurements where the voltage to be connected to the lower input terminal is not at ground potential, a line cord adapter must be used to isolate the 887A chassis from line ground. Otherwise, the 0.01 uf capacitor would place an ac load on the circuit being measured.

2-43. INTERNAL CONVERTER NOISE

2-44. When the instrument is shorted in the ac mode, the converter may produce a residual noise output of approximately 100 uv. This noise voltage will cause an insignificant error as long as ac input signals of 1 mv or larger are applied to the instrument. Figure 2-6 shows a typical half wave of the signal voltage at the output of the converter amplifier. It is easily seen that the noise contributes very little to the average value of the signal and is well within the 2.6% accuracy of the instrument at 1 mv. Also for input signals over 1 mv, the instrument is noise free to within 2 parts per million of the input range. For example, on the 1 volt input range the instrument will contribute less than 2 uv of noise to any measurement.

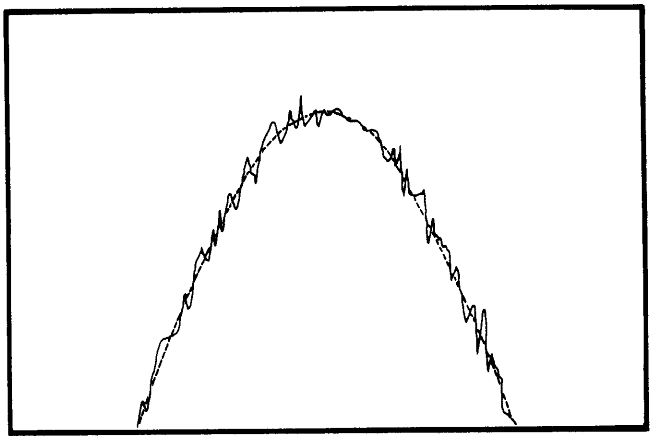


Figure 2-6. SIGNAL VOLTAGE WITH CONVERTER NOISE

2-45. MOST SENSITIVE NULL RANGE ON AC

2-46. The most sensitive null range for each input range should be used with caution when measuring ac voltages. Most ac sources are not stable enough to be used on this range. For example, if 1.0 volt is measured with the range switch set to 1 and the null switch set to 0.0001, the null detector sensitivity is 100 microvolts full scale. Since 100 uv is 0.01% of 1.0 volt, an ac source with a stability worse than ±0.01% will cause the 887A meter pointer to swing from one end of the meter scale to the other. Also, if the input is shorted with the range switch set to 1 and the null switch set to 0.0001, the meter needle may deflect more than full scale due to converter noise. However, as pointed out in paragraph 2-43, converter noise will not impair the accuracy for input signals greater than 1 mv. Thus, any excessive erratic meter needle movement is due to ac source stability.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. Figure 3-1 shows the block diagram for the 887A Differential Voltmeter. As seen in this figure, the circuit is mainly composed of an ac to dc converter, a dc input attenuator, a dc transistorized voltmeter (tvm), and an extremely accurate 0 to 11 volt reference. The dc input attenuator reduces the input voltage by a factor of 100 on the 1000 and 100 volt dc range. The tvm uses a null detector, an attenuator, and a meter to obtain high sensitivity. The 0 to 11 volt reference uses a range divider and a Kelvin-Varley attenuator to make the output of two well regulated zener diodes adjustable. Refer to the functional schematic following Section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

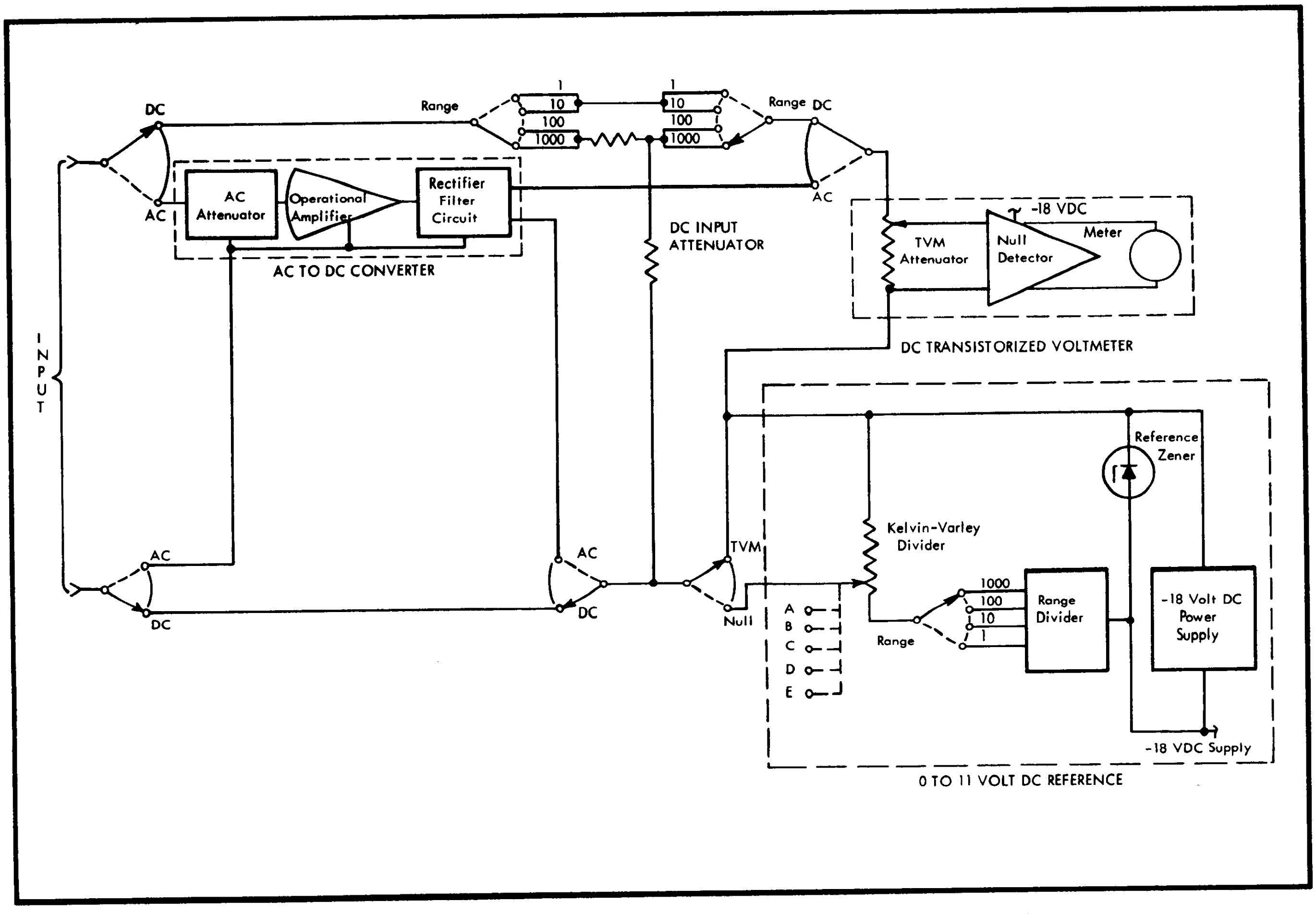


Figure 3-1. 887A DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

3-3. The overall operation of the voltmeter may be summarized as follows. To measure the approximate value of a dc voltage between 0 and 11 volts, the unknown voltage is connected directly across the tvm attenuator. This attenuator is set in such a way that the maximum voltage for each range is reduced to a signal of 1 millivolt (100 microvolts for the 1 volt range in the highest null mode). The signal is then applied to the null detector and causes 100 microamperes to flow through the meter for full scale deflection. To accurately measure this dc voltage, the unknown voltage is connected across the series combination of the tvm and the 0 to 11 volt reference. The reference voltage is then adjusted with the five voltage readout dials until it matches the unknown voltage as indicated by the tvm. For voltages between 11 and 1100 volts, the dc input attenuator divides the unknown voltage by 100. The 883A then operates essentially the same as for measurements from 0 to 11 volts. All ac measurements are made by first converting the ac input voltage to a dc voltage by means of the ac to dc converter. The 887A then operates essentially the same as for approximate and accurate dc measurements.

3-4. In order to provide for a more complete understanding of the 887A voltmeter, the following paragraphs describe each section of the circuit in detail.

3-5. DC INPUT ATTENUATOR

3-6. Since the instrument contains a 0 to 11 volt reference, the unknown voltage is measured by comparing it to a known voltage with the aid of a null detector only on the 1 and 10 volt range. On the 100 and 1000 volt range, the dc input attenuator (R100 through R104) divides the unknown voltage by 100 and this attenuated voltage is then measured by the potentiometric principal. Thus, after attenuation by 100, the 100 and 1000 volt ranges are reduced to the equivalent of 1 and 10 volt ranges. The dc input attenuator is extremely accurate and has excellant long term stability. The 10K variable resistor (R103) is used during factory calibration to setup the proper division ratio. This adjustment can then be performed as required at regular calibration intervals.

3-7. DC TRANSISTORIZED VOLTMETER

3-8. GENERAL

3-9. The dc tvm is composed of an attenuator, a null detector, and meter. The heart of the dc tvm is the null detector in which the dc signal is modulated by an electromechanical chopper, amplified by a five stage resistance-capacitance coupled amplifier, rectified by a transistor switch, and finally filtered to produce a dc output. The null detector has a high amount of negative current feedback. This makes the proportion of the output current feedback approximately equal to the signal voltage divided by the resistance of the feedback resistor, regardless of the amplifier characteristics. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual transistors due to aging, and replacement. The output current from the null detector is indicated on a meter that has tautband suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is eliminated. The tvm attenuator is used to reduce the voltage span of each range to a common range usable by the null detector to produce proper meter deflection.

3-10. NULL DETECTOR

3-11. The null detector is a current feedback amplifier that drives a meter. Any feedback amplifier is essentially a null seeking device. That is, it tends to make the voltage fed back to the input equal to the input voltage. In a current feedback amplifier, the feedback voltage is equal to the voltage drop across a fixed resistor caused by the output current or a portion of the output current. At the input to the 887A null detector R201, C201, R202, C202, R203, and C203 form a triple section low pass filter that reduces any ac component present on the dc voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across feedback resistor R236 is converted to an alternating voltage by G201, an 84 hertz chopper. The voltage across R236 is proportional to the current flowing in the meter. The alternating voltage created by G201 is amplified by a five-stage solid-state amplifier. The first stage is a p-channel field effect transistor (Q201). The field effect transistor provides both high impedance and low noise input characteristics. The next four stages consist of two transistor doubletons (Q202 to Q205). During one portion of the chopper cycle, the output of the amplifier is clamped to approximately null detector common potential by Q206, a transistor switch. The transistor switch is gated in synchronization with the chopper since the gating pulse comes from the voltage that is used to drive the chopper. During the other portion of the chopper cycle, the output of the amplifier is filtered by R-C filter R225-C219 to provide a dc current for the meter. A portion of the current that flows through the meter is shunted back to the 200Ω feedback resistor R236 thus completing the feedback loop. The null detector has a basic sensitivity of 1 millivolt except in the most sensitive null mode for the 1 and 100 volt range where the sensitivity is 100 microvolts. For the two most sensitive null modes in the 100 and 1000 volt range, the sensitivity is boosted 10% to compensate for the loading effect of the tvm attenuator on the dc input attenuator. The output resistance of the dc input attenuator is 100K and the input resistance of the tvm dc attenuator is 1 meg. Thus, when monitoring voltage excursions, much more accurate off null readings are obtained due to the 10% boost in null sensitivity.

3-12. TVM ATTENUATOR

3-13. In the dc tvm mode, two positions on the tvm attenuator selected by range switch section S2H provide the necessary reduction of the 1 and 10 volt ranges for proper null detector input. The same two positions on the tvm attenuator are used for the 100 and 1000 volt ranges because the input attenuator divides the input signal by 100 and thus reduces the 100 and 1000 volt ranges to the equivalent of 1 and 10 volt ranges. In the differential mode, the voltage difference (unknown voltage, or unknown voltage divided by 100, minus reference voltage) is reduced as necessary by positions on the tvm attenuator selected by null switch sections S3H, S3G, and S3E to provide the basic null detector inputs of 1 millivolt or 100 microvolts.

3-14. In the ac tvm mode, null switch section S3H and ac-dc polarity switch section S4E provide connection to only one position on the tvm attenuator regardless of where the range switch is set. Also, in the ac differential mode, the voltage difference (converter output voltage minus reference voltage) is reduced by the same positions on the tvm attenuator as for 1 volt dc differential measurements. This is because the output of the ac-dc converter is 1 volt dc for full input on each range.

3-15. INPUT RESISTANCE

3-16. For the tvm, low sensitivity, and medium low sensitivity modes, the input resistance of the tvm attenuator is 10 megohms (R4 through R7). For the medium high and high sensitivity modes, the input resistance of the tvm attenuator is 1 megohm (R4 through R7). However, this is not the input resistance of the 887A for the dc tvm and dc differential mode. For the 1 and 10 volt range, the input resistance is determined by dividing the unknown voltage by the current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the internally known voltage divided by the resistance of the tvm attenuator. The equation for input resistance can therefore be written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|} = \frac{E_s (R_a + R_s)}{|E_s - E|} - R_s$$

where:

R_{in} = input resistance of voltmeter

E_u = $E_s - I_u R_s$ = terminal voltage of unknown

I_u = current drawn from unknown

E_s = source voltage of unknown

R_s = source resistance of unknown

R_a = input resistance of tvm attenuator

E = voltage indicated by voltage readout dials

$|\ |$ = absolute value (magnitude only)

Thus, the input resistance is essentially infinite (leakage resistance across input is in the order of 10^{12} ohms) at null when E is equal to E_u and E_s. For the 100 and 1000 volt range, the dc input attenuator is always connected across the input terminals. Thus, the input resistance is equal to the resistance of the dc input attenuator which is 10 megohms.

3-17. The input impedance for the ac tvm and ac differential mode depends on the input impedance of the ac to dc converter and its attenuator. The ac input impedance is thus 1 megohm and 40 picofarads.

3-18. CHOPPER DRIVE CIRCUIT

3-19. The chopper drive circuit determines the chopper timing frequency of 84 Hz. The circuit is symmetrical with the transistors biased so that they can conduct simultaneously. However, cross-coupling capacitors C105 and C106 force Q106, Q109 and Q107, Q108 to conduct alternately. This results in a square wave varying from about 0 to 6 volts that drives chopper coil G201. The symmetry and frequency of the waveform are adjusted with R126 and R124 respectively.

3-20. NULL DETECTOR POWER SUPPLY

3-21. The voltage for null detector amplifier stages Q201 through Q205 is supplied by the same -18 volt power supply that is used to power the 0 to 11 volt reference. The voltage for chopper drive circuit transistors Q106 through Q109 is obtained from a half-wave rectifier consisting of diode CR101 and an R-C filter network (R105 and C101) that supplies 6 volts dc. Current determining resistors R238 and R240, diodes CR201 and CR202, and divider resistor R239 provide a compensating voltage for the purpose of adjusting the null detector to zero with R239 when there is no signal input. Diode CR201 keeps one side of R239 at approximately +0.6 volt dc with respect to the null detector common while diode CR202 keeps the other side at approximately -0.6 volt dc.

3-22. EFFECT OF AC COMPONENTS ON DC MEASUREMENTS

3-23. The only ac voltage component that will reduce the accuracy of the 887A is one that either saturates the null detector or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an ac component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency. The low pass filter at the input of the chopper-amplifier will attenuate any ac component. The magnitude of the ac voltage appearing at the output of the filter depends on both its amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a hundred cycles. Below this, the filter may not attenuate the ac component enough. However, this is not as bad as it appears. A 60 cycle ac voltage that is 1% of the input voltage will cause an error of approximately 0.001% which is well within specifications. If ac components that affect accuracy are ever encountered, additional filtering as set forth in the operating instructions will eliminate the problem.

3-24. TVM GAIN AND ZERO ADJUSTMENTS

3-25. Variable resistor R239 in the feedback network provides a means of adjusting the output current of the null detector to zero when there is no input signal. The gain of the null detector is adjusted by means of R230 in the feedback network for the 1 millivolt sensitivity and by means of R231 for the 100 microvolt sensitivity.

3-26. RECORDER OUTPUT

3-27. The recorder output is picked off divider string R226, R8, and R227. Recorder output AMP ADJ control R8 provides a means of adjusting the output voltage up to a maximum of at least 20 millivolts at full scale deflection (disregarding 10% over-range at end of scale). The voltage at the RECORDER OUTPUT terminals is proportional to the meter reading.

3-28. 0 TO 11 VOLT REFERENCE

3-29. GENERAL

3-30. When the 887A is used to make differential dc voltage measurements between 0 and 11 volts, an internal voltage is nulled or matched against the unknown voltage. An extremely accurate reference is therefore required. This is obtained from the 0 to 11 volt reference. The 0 to 11 volt reference is composed of a well regulated -18 volt power supply, a range divider, and a five decade Kelvin-Varley divider. The range divider reduces the voltage from a pair of stable Zener diodes in the -18 volt reference supply to 11 volts for the 10 and 1000 volt dc ranges and to 1. 1 volts for the 1 and 100 volt dc ranges before it is applied to the Kelvin-Varley divider. The Kelvin-Varley divider divides its input voltage (11 or 1. 1 volts) into over 1, 100, 000 equal increments any number of which may be selected by setting the five decades with the five voltage readout dials. The output of the Kelvin-Varley divider, therefore, provides an extremely accurate reference voltage.

3-31. REFERENCE POWER SUPPLY

3-32. -18 VOLT POWER SUPPLY. The -18 volt power supply uses diode CR102 and filter capacitor C101 to supply unregulated dc voltage to series pass transistor Q101. In the Model 887AB, unregulated dc voltage can also be supplied by a set of batteries (BT1) in the BAT OPR and BAT CHECK modes. The -18 volts is regulated by comparing a sample of the output voltage, tapped off divider string R109, R110 and R111, with the voltage from zener reference diodes CR103 and CR104 in a two-stage differential amplifier. Transistor Q103 is a dual transistor, having matched current gain and matched ΔV_{be}, which insures minimum voltage change due to temperature in the -18 volt reference voltage. The output from Q103, which is proportional to the difference between the two inputs, is applied to a second state of differential amplification, Q104 and Q105. The output from Q104 is applied to the base of series pass transistor Q101. The differential amplifier adjusts the voltage drop across the series pass transistor so as to maintain a constant output voltage. The -18 volt provides operating current for the chopper drive multivibrator, and supplies a constant current through R116 and R117 to its own zener reference diodes CR103 and CR104. If the instrument is turned on with the battery voltage below about 5 volts, there is a possibility that transistor Q101 may not begin conduction. Thus, when the power switch is set to BAT CHECK, the meter would indicate an adequate battery change, because all of the voltage drop appears across Q101. When the instrument is first turned on, the base-emitter junction of Q102 is forward biased, and Q102 conducts, which causes transistor Q101 to conduct and become saturated. As the output voltage of the -18 volt supply rises above -11 volts, transistor Q102 becomes biased off, and the differential amplifier controls the conductance of Q101.

3-33. For instrument serial numbers 618-659, 691 and on, zener diodes CR104 and CR105 are enclosed in a proportionally-controlled oven, Q111, Q112, Q113, and associated components. The oven heater is R147. Transistors Q112 and Q113 are connected as a differential amplifier, with the base voltage of Q113 fixed by R153 and R154. The base voltage of Q112 is set by R150 and R155. Since R155 is temperature-sensitive, the base voltage of Q112 varies inversely with temperature. The output from the collector of Q112, which is proportional to the difference between the base voltages of Q112 and Q113, is applied to the base of Q111 and controls the conduction of Q111, which controls heater current. For example, as the oven temperature increases, the resistance of R155 decreases. This causes a more positive output from the collector of Q112, which reduces the conduction of Q111, thus reducing current through the heater R147, and decreasing heating of R147. C108 eliminates oscillations in control circuit.

3-34. RANGE DIVIDER

3-35. In the 1000 and 10 volt dc range, the Zener reference diode voltage is connected directly to the Kelvin-Varley divider through resistors R119 and R120 by means of range switch sections S2J and S2I. The voltage drop across R119 and R120 reduces the Zener reference voltage to 11 volts at the input of the Kelvin-Varley divider. In the 100 and 1 volt dc range, range resistors (R121, R122, and R123) selected by range switch sections S2J and S2I reduce the voltage to 1. 1 volts at the input to the Kelvin-Varley divider. With the ac-dc connection to the range resistors that divide the reference voltage to 1. 1 volts. This 1. 1 volts is then passed to the Kelvin-Varley divider by ac-dc switch section S4G. The voltage applied to the Kelvin-Varley divider is always 1. 1 volts for ac because the maximum output of the ac to dc converter is always 1. 1 volts.

3-36. KELVIN-VARLEY DIVIDER

3-37. The five Kelvin-Varley decades composed of resistors R301 to R366, and associated voltage dials A through E provide a means of making the two precision voltages (11 and 1. 1 volts) adjustable. The first decade has twelve 5K resistors (a 4, 999. 2 ohm resistor and a 2 ohm trimmer). Two of these resistors are shunted by the 10K total resistance of the second decade. Between the two wipers of S5 (voltage dial A) then, there is a total resistance of 5K (10K paralleled by 10K). Thus, the first decade divides the voltage across it into eleven equal parts with one of the equal parts appearing across the two shunted resistors. Similarly, the second, third, and fourth decades divide the voltage across them into ten equal parts. Note that the second, third, and fourth decades each have eleven 1K resistors. The resistors may have the same value because padding resistors R328 - R329 and R315 - R316 are used across the third and fourth decades respectively to keep the proper resistance matching. The last decade, with its associated shunt resistors to keep the proper matching, is a variable resistor which can be set to pick off increments equal to less than 1/100 times the voltage across its input. The Kelvin-Varley resistors are matched for both temperature coefficient and tolerance thus providing an overall accuracy of 0.002% absolute from 1/11 of full scale to full scale. With the null switch in any null range, the output of the Kelvin-Varley divider is connected in series with the TVM attenuator thus providing the accurate 0 to 11 volt or 0 to 1.1 volt reference voltage required.

3-38. ADJUSTMENTS

3-39. Variable resistor R111 is used during final factory calibration to set the reference supply to -18 volts. This adjustment is not exceedingly critical and should have to be done only when a component of the reference supply has been replaced. The voltage from the Zener reference diodes is reduced to 11 volts at the input to the Kelvin-Varley divider by adjusting variable resistor R120 during calibration. Range-divider variable resistor R122 may then be adjusted for 1.1 volts at the input to the Kelvin-Varley divider. The 2 ohm trimmer resistors (odd resistors from R301 to R325) and variable padding resistors R338, R351, and R364 should require adjustment only after a component of the Kelvin-Varley divider has been replaced.

3-40. AC TO DC CONVERTER

3-41. GENERAL

3-42. The ac to dc converter is composed of an attenuator, an operational amplifier, and a rectifier-filter circuit. A pair of diodes in the rectifier-filter circuit are used to convert the unknown ac into pulsating dc. This pulsating dc is then filtered to obtain a dc voltage that is proportional to the average value of the ac input voltage. The output, however, is calibrated to indicate the rms value of a pure sine wave. An operational amplifier with high negative feedback is used to make the rectification characteristics of the diodes linear and stable. The first stage is an n-channel field effect transistor (Q501). The field-effect transistor provides both high impedance and low noise input characteristics. The next four stages consist of two transistor doubletons (Q502, Q503, Q504, and Q506). Transistor Q505 acts as a dynamic load and thus increases the output impedance of the amplifier. The amplifier achieves a midband loop gain of approximately 70 db with a virtually flat frequency response from 20 Hz to 20 kHz. At the output of the amplifier, full wave rectification is used to return negative feedback to the gate of the field-effect transistor. The high negative feedback makes the amplifier practically noise free and relatively insensitive to gain changes in individual stages due to aging and transistor replacement. An attenuator is used to reduce the ac input voltage on the higher ranges to within the operating level of the converter amplifier.

3-43. CONVERTER POWER SUPPLY

3-44. The auxiliary power supply for the converter is composed of Q507, Q508, Q509, and the associated components. Diode CR506 and filter network R542-C523 supply unregulated dc voltage to series pass transistor Q507. In the 887AB, unregulated dc voltage is supplied from a set of batteries, BT2, in the BAT CHECK and BAT OPR modes. The emitter voltage of Q509 is set by Zener diode CR505. The base input to Q509 is taken from a divider string, R538, R539, and R540, which samples the output voltage of the -18 volt supply. Any variation in the -18 volts varies the base drive of Q509, which varies the output from the collector load of Q509. Since the output of Q509 drives Q508, the collector current of Q508 continuously adjusts the conductance of Q507 to maintain the auxiliary voltage constant at the value determined by the setting of R539.

3-45. OPERATION

3-46. All ac measurements are made by first converting the ac input voltage into a dc voltage. The converter provides a dc output of 1 volt when full range voltage is applied to the 887A in each ac range. In the 1 volt ac range, the ac-dc polarity switch and the range switch connect the input binding posts directly to the converter input. The converter gain is of such a value that the dc output voltage is equal to the rms value of the converter input voltage for a sine wave. For the 1000, 100, and 10 volt ac ranges, a separate input attenuator for each range reduces the unknown ac voltage by a factor of 1000, 100, and 10 respectively. The operation of the converter is then the same as for the 1 volt range. Thus, an output of 1 volt dc is provided for full range input of a pure sine wave on any ac range.

3-47. ADJUSTMENTS

3-48. The converter gain is adjusted with R503 in the feedback loop of the operational amplifier. Capacitor C502 in the feedback loop is used to adjust the high frequency response of the converter. The attenuation of the 1000, 100, and 10 volt attenuators are adjusted with R410, R406, and R403 respectively. Capacitors C405, C403, and C401 are used to adjust the high frequency response attenuators. The bias of field-effect transistor Q501 should require adjustment with R508 only when Q501 or a component in its drain-source circuit is replaced. The amplifier output level at the collector of Q506 should require adjustment with R522 only if Q505, Q506, or a component in one of these stages is replaced.

3-49. AC-DC POLARITY SWITCH

3-50. The ac-dc polarity switch is provided for selecting either the ac or dc mode of operation. When the ac-dc polarity switch is set to AC, the ac to dc converter is switched into the circuit by sections S4A, S4B, S4C, and S4D. Also, sections S4H and S4G are used to switch 1.1 volts dc to the Kelvin-Varley divider. Section S4E is used to provide proper attenuation in the tvm attenuator.

3-51. For the dc mode of operation, the ac-dc polarity switch may be set to the positive or the negative dc position. As seen in figure 3-2, the polarity switch reverses the transistorized voltmeter - reference voltage combination with respect to the input. Note that a 0.01 uf capacitor (C1) is connected from the COMMON post to the chassis ground post to reduce the effect of ac circulating currents. If the instrument did not contain a polarity switch, the grounded side of any unknown

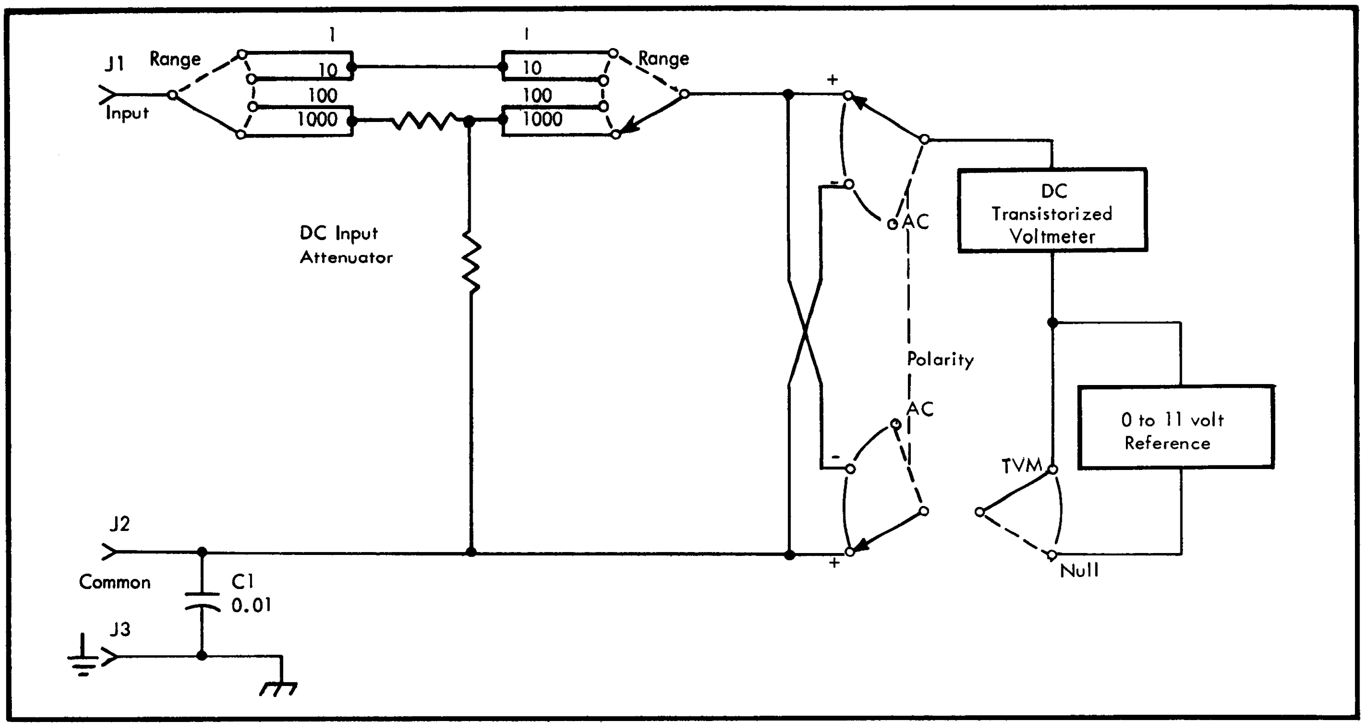


Figure 3-2. FUNCTION OF POLARITY SWITCH

voltage that is negative with respect to ground would have to be connected to the INPUT post. This would ground the INPUT post and effectively place C1 across the input. With this capacitance connected across the circuit being measured several problems would arise. The polarity switch provides equal convenience in measuring positive and negative voltages without the occurance of these problems.

SECTION IV

MAINTENANCE

4-1. PERIODIC MAINTENANCE

4-2. Since the Model 887A and the Model 887AB are completely enclosed units, the need for cleaning is greatly reduced. If the instrument is used in a clean, comparitively dust-free area, routine cleaning will probably not be necessary. If it is necessary to remove the covers, exercise extreme care to avoid introducing dirt or grease from the hands or test instruments. Special care has been taken to prevent leakage across critical switch wafers, areas of some printed circuit boards, and from the printed circuit boards to chassis ground. The POWER, RANGE, NULL, polarity, and all voltage readout switches are vacuum impregnated with Dow Corning silicone oil. These switches are also isolated from the front panel with Lexan spacers. The printed circuit boards are coated with Epocast 8267. Also, the printed circuit boards are isolated from chassis ground by polyethelene grommets.

4-3. Use the following procedures to clean the instrument.

CAUTION!

> Avoid touching polyethelene grommets. The normal accumulation of oil on the hands may be enough to cause excessive leakage.

a. With low-pressure, clean, dry air, remove accumulations of dust and foreign material. Pay particular attention to the input binding posts, binding post wiring, switches, and polyethelene grommets which insulate printed circuit boards from the chassis.

b. Clean the polyethelene grommets, binding posts, and front panel with anhydrous denatured ethyl alchol or a pressure can of Freon TF Degreaser (Miller-Stephenson Chemical Co., Inc.) and, as necessary, a clean cloth or a cotton swab.

CAUTION!

> Do not use Metriclene, acetone, laquer thinner, or any other methyl ethyl ketones. They will react with the Lexan rotors on the switches. Also, be careful not to saturate the switch contacts as they have been lubricated for the life of the switch.

c. As necessary, clean all exposed insulating switch surfaces with denatured alcohol using a small, stiff-bristled brush, wrapped in a clean cloth.

d. After cleaning and waiting until the alcohol has completely dried, recoat the exposed insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes.

4-4. TEST EQUIPMENT REQUIREMENTS

4-5. Test equipment for Calibration is listed in Figure 4-1. In each case this is the recommended equipment and if it is not available comparable equipment may be used.

4-6. THE CALIBRATION CYCLE

4-7. The accuracy of a precision voltmeter such as the Model 887A is dependent upon its ability to stay within acceptable tolerance limits. This ability, or instrument stability, depends on the change in value of the components in the instrument with time. Each instrument will thus have a stability that varies from the average stability of a group of instruments. Measurements of instrument stability indicate that the initial calibration interval should be six months. After the first few calibration intervals, past performance will allow the interval to be adjusted to fit the instrument stability and the degree of usage.

4-8. A Performance Evaluation has been included as the first part of a four part calibration procedure in order to measure instrument stability. This procedure includes a Performance Evaluation Record (Figure 4-18) for recording observations. Pre-Calibration Service and Adjustment is the second part. This part consists of a series of performance checks and calibration adjustments to prepare the instrument for final calibration. The third part, Calibration, consists of a complete ac and dc calibration procedures as well as Kelvin-Varley evaluation and calibration procedure. The final step is the Stability Evaluation which measures the instruments performance with respect to short periods of time.

NOMENCLATURE	SPECIFICATIONS REQUIRED	RECOMMENDED INSTRUMENT
VTVM	Range: 0-40 vac, 0-300 vac Accuracy: ±5% DC Input Characteristics: 10 meg/5 pf AC Input Characteristics: 1 meg/100 pf	RCA Voltohmyst
RMS Voltmeter	Range adequate to measure 200 uv, ±5%, at 120 Hz.	John Fluke Mfg. Co. Model 910A
Autotransformer	103 - 127 v, 1 amp. 207 - 253 v, 1/2 amp.	General Radio Corp. Model W5MT3 Variac
DC Differential Voltmeter	Range: 10 - 20 vdc, ±0.05% Null Range: at least 10 mv.	Almost any John Fluke Mfg. Co. Differential Voltmeter
Standard Cell	Accuracy: ±0.0005%	Guildline Mfg. Co. Model 9152/P4
Reference Voltage Divider	Input voltage: 10-100-1000 vdc Output Voltage: 1-10-100-1000 vdc Accuracy: ±(0.001% + 2 uv) Divider Current Adjustment Range: to a minimum of 1 ppm and a maximum of 5 ppm on all ranges.	John Fluke Mfg. Co. Model 750A
Null Detector	Range: 1 uv to 1 mv, end scale	John Fluke Mfg. Co. Model 845A
AC Source	Voltage output: 1 - 1000 volts Frequency range: 35 Hz to 100 kHz Stability: 0.01%/hr. Distortion: 0.05% or less Resolution: 0.0005% or better.	Optimation Inc. Model AC 104
Counter	Adequate to measure 84 Hz ±2 Hz.	CMC Model 201C
Transfer Standard	Voltage Range: 1 - 1000 volts Frequency response: 400 Hz to 100 kHz Accuracy: 0.01%	John Fluke Mfg. Co. Model 540B
Lead Compensator	Resolution: 0.1 milliohm Divider resistance ratio from 1:1 to 10:1	John Fluke Mfg. Co. Model 721A
Kelvin-Varley Voltage Divider	Input Resistance: 100k Ratio accuracy: 1 ppm Seven decades	John Fluke Mfg. Co. Model 720A
Voltage Standard	Output voltage: 1 - 1000 vdc Output Current: 0-6 ma Stability: ±0.0005%/hr. Resolution: ±0.0005% Accuracy: ±0.004%	John Fluke Mfg. Co. Model 332A

Figure 4-1. TEST EQUIPMENT SPECIFICATIONS

4-9. PERFORMANCE EVALUATION

4-10. DC CHECKS

4-11. NULL DETECTOR CHECK. The null detector is checked in this procedure by using the internal reference supply and Kelvin-Varley divider. This is possible because the reference supply and Kelvin-Varley divider are a few hundred times more accurate than the null detector. If the instrument fails to pass this check, there is a remote chance that the cause is due to a faulty reference supply or Kelvin-Varley divider. In this case, the measurement of an appropriate voltage in the TVM mode will indicate if the null detector is operating properly. Proceed as follows:

a. Set 887A meter to zero with mechanical zero control.

b. Set POWER switch to LINE OPR with 887AB or to ON with 887A and allow a warmup period of 5 minutes.

c. Short INPUT post to COMMON post.

d. Set ac-dc switch to + (positive).

e. Set switches on voltmeter as shown in Figure 4-2. Meter should indicate within 1-1/2 small scale divisions (±3% of null range) of value shown in Figure 4-2.

f. Record meter indications in Figure 4-18.

g. Remove short from between INPUT and COMMON.

<table>
<tr><th colspan="3">VOLTMETER SWITCH SETTINGS</th><th rowspan="2">METER INDICATION</th></tr>
<tr><th>RANGE</th><th>NULL</th><th>VOLTAGE READOUT DIALS
A B C D E</th></tr>
<tr><td>10
1
1</td><td>1.0
.1
.01</td><td>1.0 0 0 00
.1 0 0 0 00
.0 1 0 0 00</td><td>-1.0
-1.0
-1.0</td></tr>
<tr><td colspan="4">Before proceeding, set RANGE switch to 1, NULL switch to .0001, all voltage readout to zero, and null meter by adjusting electronic ZERO control.</td></tr>
<tr><td>1
100
100</td><td>.0001
.1
.01</td><td>0 0 0 1 00
0 0. 1 0 00
0 0. 0 1 00</td><td>-1.0
-1.0
-1.0</td></tr>
</table>

Figure 4-2. SETTINGS FOR NULL DETECTOR CHECK

4-12. DC DIFFERENTIAL VOLTMETER CHECK. The following procedure checks the accuracy of the instrument when used as a DC Differential Voltmeter. The results of each measurement should be recorded in the Performance Evaluation Record, Figure 4-18, to form a permanent history of instrument performance.

a. Connect equipment as shown in Figure 4-3 and adjust the equipment to provide dc voltages of 1, 10, 100, and 1000 volts as outlined in paragraph 4-43.

b. Connect 887A ground post to line ground.

c. Short INPUT post to COMMON post.

d. Set 887A ac-dc POLARITY switch to +, RANGE switch to 1, NULL switch to .0001, and all voltage readout dials to 0 (zero).

e. Null meter by adjusting electronic zero control (R239).

f. Remove short from between INPUT and COMMON posts.

g. Set 887A NULL switch to 0.1 and voltage readout dials to 1.000000.

h. Apply 1 volt dc ±(0.001% + 2 uv) between INPUT and COMMON posts.

i. Adjust 887A voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between .999969 and 1.000031.

j. Set 887A RANGE switch to 10, NULL switch to 1, and voltage readout dials to 10.00000.

k. Apply 10 volts dc ±0.001% between INPUT and COMMON posts.

l. Adjust 887A voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between 9.99973 and 10.00027.

m. Reverse input connections to 887A and set polarity switch to - (negative). Meter reading should remain within ±5 uv of indication in step 1.

n. Reverse input connections and set polarity switch to + (positive).

o. Set 887A RANGE switch to 100, NULL switch to 10, and voltage readout dials to 100.0000.

p. Apply 100 volts dc ±0.001% between INPUT and COMMON posts. Note that the voltage dials on the 332A Voltage Standard must be readjusted for a null on 845A Null Detector due to loading of voltmeter on 750A Reference Divider.

q. Adjust 887A voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between 99.9974 and 100.0026.

r. Set 887A RANGE switch to 1000, NULL switch to 100, and voltage readout dials to 1000.000.

s. Apply 1000 volts dc ±0.001% between INPUT and COMMON posts. Note that voltage dials on the 332A Voltage Standard must be readjusted for a null on 845A Null Detector because the voltmeter no longer loads 750A Reference Divider.

t. Adjust 887A voltage readout dials for a zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between 999.974 and 1000.026.

u. Disconnect 887A from test equipment.

v. Set 887A ac-dc polarity switch to +, RANGE switch to 1, NULL switch to 0.1, and all voltage readout dials to 0 (zero).

w. Differentially measure the voltage of a standard cell. Final indication should be within ±32 uv of correct value.

x. Set RANGE switch to 10, NULL switch to 1 and differentially measure the voltage of two standard cells connected in series. Final indication should be within ±66 uv of correct value.

y. Differentially measure the voltage of three standard cells connected in series. Final indication should be within ±92 uv of correct value.

z. Set up the necessary equipment to provide voltages of 1.111111, 2.222222, ..., 9.999999 volts dc with an accuracy of ±(0.001% + 2 uv). Proceed as follows:

(1) Set POWER switch to STANDBY/RESET on 332A Voltage Calibrator.

(2) Connect equipment as shown in Figure 4-4.

(3) Set 332A VOLTAGE RANGE to 10 and voltage dials to 10.000000.

(4) Set INPUT switch and OUTPUT switch on 750A Reference Divider to 10.

(5) Set 845A Null Detector to 100 MICROVOLTS.

(6) Set 750A STANDARD CELL VOLTAGE switches to voltage of standard cell.

(7) Set 332A POWER switch to ON.

(8) Adjust 332A voltage dials for a null in each successively more sensitive null range on 845A. Zero 845A as necessary.

(9) Voltages of 1.111111, 2.222222, ..., 9.999999 volts dc are available at the OUTPUT terminals of the 720A Kelvin-Varley Divider when all 720A voltage dials are set to 1, 2, ..., 9 respectively.

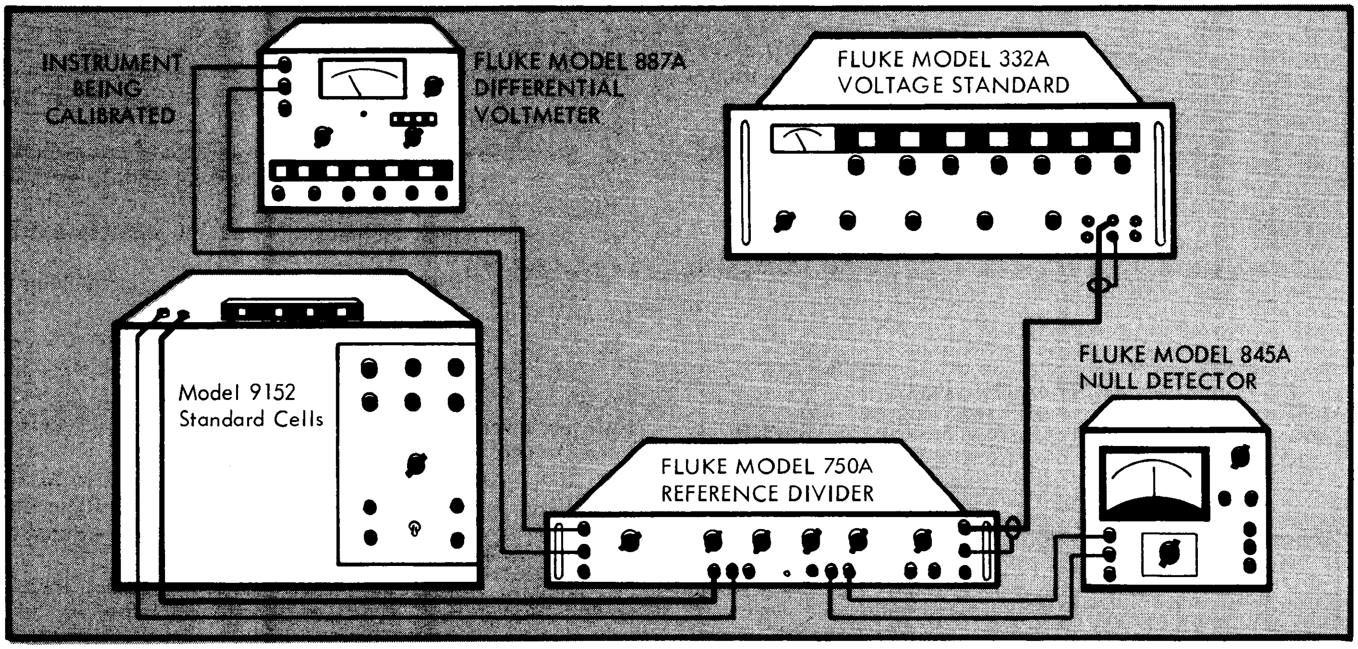


Figure 4-3. EQUIPMENT CONNECTIONS FOR DC CALIBRATION

aa. Set 887A RANGE switch to 10 and NULL switch to .001.

ab. Apply voltages listed in Figure 4-5 between 887A INPUT and COMMON posts, set 887A voltage dials as indicated for applied voltage, and adjust 887A voltage dials for a null on 887A meter. Final voltage dial setting should be within the values listed in Figure 4-5.

4-13. AC CHECK

4-14. The following procedure checks the accuracy of instrument with full input on each ac range at 10 kHz. The results of each measurement should be recorded in the Performance Evaluation Record, Figure 4-18, to form a permanent history of the instrument performance

a. Connect equipment as shown in Figure 4-6 and adjust the equipment to provide 1, 10, 100, and 1000 volts ac rms at 10 kHz such that the average value has an accuracy of 0.02% as instructed in paragraph 4-45.

b. Set polarity switch to AC and voltage readout dials to 10.00000.

c. Complete procedure indicated for each horizontal line of **Figure 4-7.**

PERFORM: 10Hz. 5kHz, 20kHz. 50kHz, 100kHz

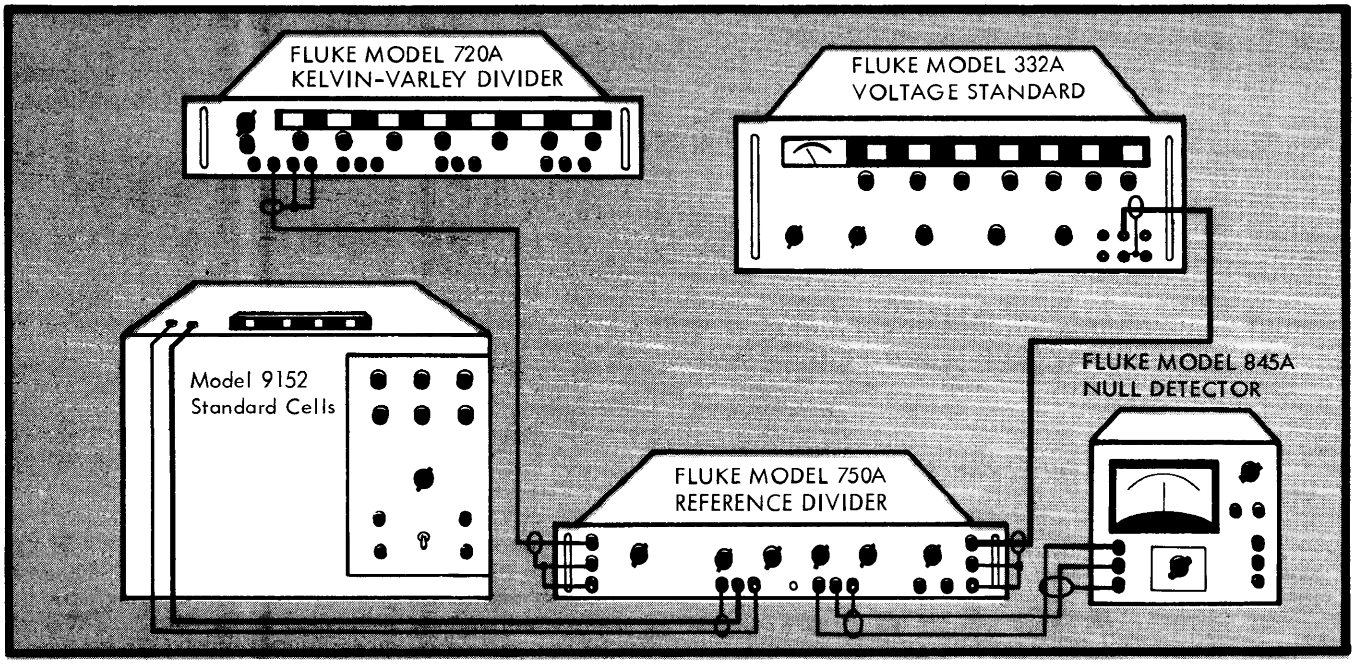


Figure 4-4. REFERENCE SUPPLY AND EXTERNAL KELVIN-VARLEY DIVIDER CHECK SETUP

VOLTAGES APPLIED TO 887A	INITIAL VOLTAGE READOUT DIAL SETTING	FINAL VOLTAGE READOUT DIAL SETTING
1. 111111	1. 11111	1. 11107 to 1. 11115
2. 222222	2. 22222	2. 22215 to 2. 22229
3. 333333	3. 33333	3. 33323 to 3. 33343
4. 444444	4. 44444	4. 44431 to 4. 44457
5. 555555	5. 55555	5. 55540 to 5. 55570
6. 666666	6. 66666	6. 66648 to 6. 66684
7. 777777	7. 77777	7. 77756 to 7. 77798
8. 888888	8. 88888	8. 88864 to 8. 88912
9. 999999	9. 99999	9. 99972 to 10. 00027

Figure 4-5. VOLTAGE READOUT DIAL LIMITS

4-15. PRE-CALIBRATION SERVICE AND ADJUSTMENT

4-16. This procedure contains service checks at critical points within the instrument and a series of minor calibration adjustments to prepare the instrument for final calibration.

4-17. −18 VOLT SUPPLY CALIBRATION

a. Connect 887A to power line through a variable autotransformer.

b. Adjust autotransformer for 115 volts ac output.

c. Set POWER switch to LINE OPR with 887AB or to ON with 887A.

d. Set NULL switch to TVM.

e. Connect a differential voltmeter between circuit common 1, TP1 on schematic and in Figure 4-8, and -18 volt reference supply output, TP26.

f. Set up test differential voltmeter to differentially measure -18.0 volts dc.

g. The correct output voltage should be -18.0 ±0.1 volts. If calibration is necessary, adjust R111 (see Figure 4-9) for a null on test differential voltmeter.

h. Leave test differential voltmeter connected to -18.0 volt reference supply for the next two checks.

4-18. −18 VOLT SUPPLY REGULATION

a. Adjust autotransformer to vary line voltage from 102 to 128 volts.

b. Output of reference supply should not vary more than 800 uv.

c. Adjust autotransformer for a line voltage of 115 volts.

4-19. −18 VOLT SUPPLY SHIFT (887AB only)

a. Turn POWER switch from LINE OPR to BAT OPR.

b. Output of reference supply should not vary more than 800 uv.

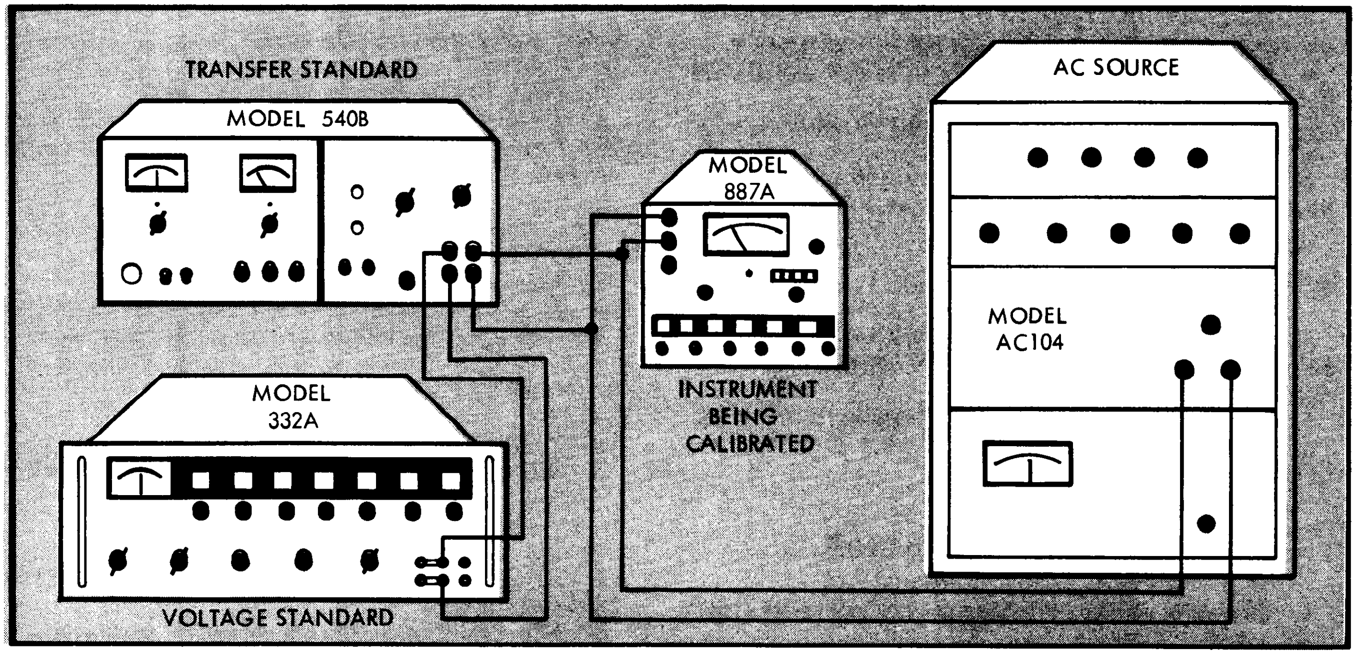


Figure 4-6. EQUIPMENT CONNECTIONS FOR AC CALIBRATION

Set RANGE switch to	Set NULL switch to	Apply the following voltage between INPUT and COMMON posts	Adjust voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between
1	TVM	1 vac, 10 KHz, ±0.02%	.999250 to 1.000750
10	TVM	10 vac, 10 KHz, ±0.02%	9.99250 to 10.00750
100	TVM	100 vac, 10 KHz, ±0.02%	99.9250 to 100.0750
1000	TVM	1000 vac, 10 KHz, ±0.02%	999.000 to 1001.000

Figure 4-7. AC CHECKS

4-20. +18 VOLT SUPPLY CALIBRATION

a. Connect a differential voltmeter between circuit common 2 and +18 volt supply output, TP29 and TP30 in Figure 4-8.

b. Set up test differential voltmeter to differentially measure +18.0 volts dc.

c. The correct output voltage should be +18.0 ±0.1 volts. If calibration is necessary, adjust R539 (see Figure 4-9) for a null on test differential voltmeter.

4-21. +18 VOLT SUPPLY OUTPUT RIPPLE

a. Connect an rms voltmeter between circuit common 2 and +18 volt supply output, TP29 and TP30 in Figure 4-8.

b. Adjust rms voltmeter controls to measure 200 uv ac.

c. Output ripple should be 200 uv or less.

4-22. CHOPPER DRIVE SYMMETRY

a. Connect a differential voltmeter across the drive coil of chopper G201, TP27 and TP28 in Figure 4-8.

b. Remove shorting link between COMMON and ground post.

c. Set up test differential voltmeter to differentially measure 0 ±50 mv dc.

d. The correct voltage should be 0 ±50 mv. If calibration is necessary, adjust R126 for a null.

4-23. CHOPPER DRIVE FREQUENCY

a. Connect an electronic counter between one side of the chopper drive coil and circuit common 1, TP27 or 28, and TP1 in Figure 4-8.

b. Set up counter to measure a frequency of 84 Hz.

c. Counter should indicate 84 ±1 Hz. If calibration is necessary, adjust R124.

4-24. NULL DETECTOR FET VOLTAGE

a. Measure voltage between circuit common 1 and TP31, with a vtvm.

b. Voltage at drain of Q201 should be -10 ±0.5 volts dc. If calibration is necessary, adjust R208.

4-25. NULL DETECTOR OUTPUT CHECK

a. Measure voltage between circuit common 1 and collector of Q205, TP1 and TP32, with a vtvm.

b. Voltage at collector should be between -7 and -10 volts.

4-26. NULL DETECTOR ZERO ADJUSTMENT

a. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in its case, it must be shut off for at least three minutes prior to this adjustment. If out of its case, another method is to short out the internal panel meter terminals prior to zeroing.

b. Turn instrument on and allow a 5 minute warmup period.

c. Set RANGE switch to 1, voltage readout dials to zero, polarity to +, and NULL switch to 0.0001.

d. Short INPUT post to COMMON post and adjust front panel electronic ZERO control with a screwdriver for zero meter deflection.

4-27. NULL DETECTOR NOISE

a. Short INPUT post to COMMON post.

b. Random excursions of meter needle should be less than 1 small division peak-to-peak over a 3 second interval.

4-28. NULL DETECTOR OFFSET

a. Short INPUT post to COMMON post.

b. Remove short while observing meter indication.

c. Null indication should not change by more than 2 uv.

4-29. NEGATIVE POLARITY OFFSET

a. Turn polarity switch from + to -.

b. Null indication should not change by more than 2 uv.

4-30. NULL DETECTOR REGULATION

a. Adjust autotransformer to vary line voltage from 102 to 128 volts.

b. Null indication should not change by more than 2 uv.

c. Adjust autotransformer for a line voltage of 115 volts.

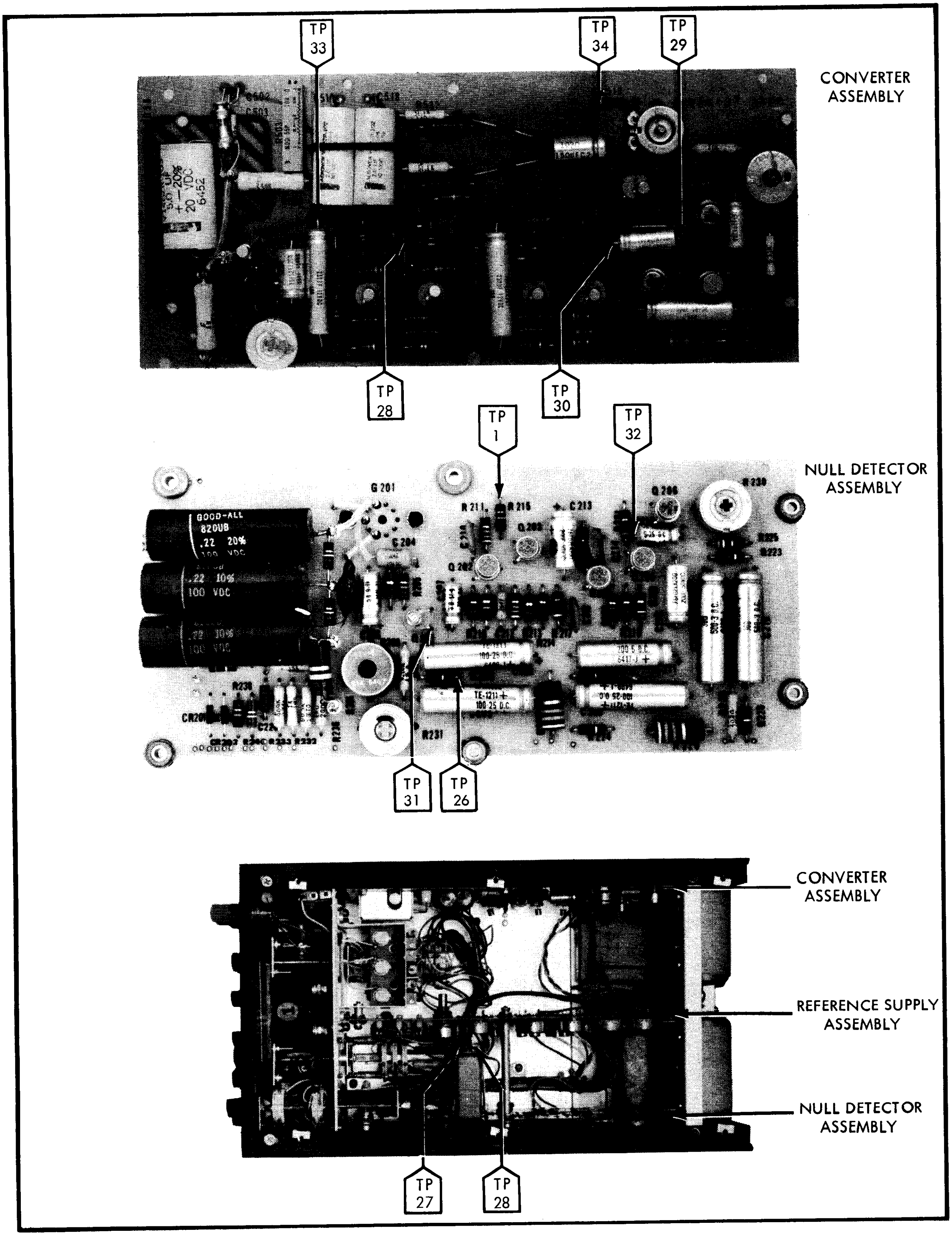
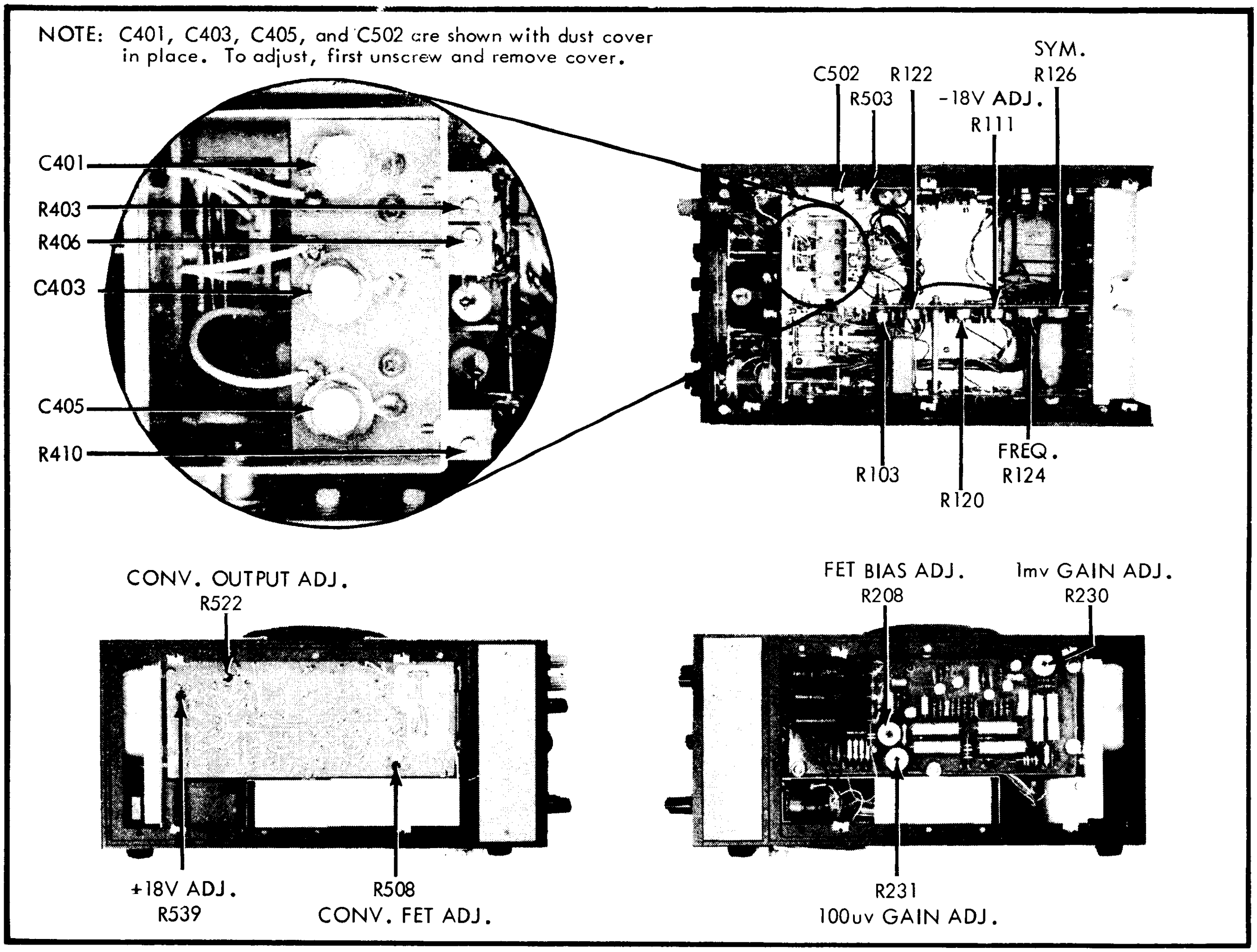


Figure 4-8. CALIBRATION AND MAINTENANCE TEST POINTS



NOTE: C401, C403, C405, and C502 are shown with dust cover in place. To adjust, first unscrew and remove cover.

Figure 4-9. LOCATION OF INTERNAL ADJUSTMENTS

4-31. 1 MV GAIN ADJUSTMENT

a. Set RANGE switch to 1, NULL switch to TVM, polarity switch to +, and voltage readout dials to zero.

b. Apply 1 volt ±0. 2% between INPUT and COMMON posts.

c. Adjust R230 for full scale deflection (+1. 0).

4-32. 100 UV GAIN ADJUSTMENT

a. Set RANGE switch to 1, NULL switch to 0. 0001, polarity switch to +, and voltage readout dials to zero.

b. Short INPUT post to COMMON post.

c. Null meter by adjusting electronic ZERO control.

d. Set voltage readout dial D to 1 and adjust R231 so that meter indicates full scale (-1).

e. Remove short from between INPUT and COMMON posts.

4-33. 100 AND 1000 VOLT NULL SENSITIVITY CHECK

a. Set polarity switch to +.

b. Short INPUT post to COMMON post.

c. Set switches on voltmeter as shown in Figure 4-10.

d. Meter should indicate within 1-1/2 small divisions (±3% of null range) of the value shown in Figure 4-10.

e. Remove short from between INPUT and COMMON posts.

4-34. RECORDER OUTPUT CHECK

a. Set RANGE switch to 100, NULL switch to 10, polarity switch to +, and voltage readout dials to 10. 0000.

b. Short INPUT post to COMMON post.

c. Measure voltage between RECORDER OUTPUT posts with the TVM or VTVM mode of a differential voltmeter.

d. The output voltage should be at least 20 mv with the AMP ADJ control set for maximum output.

e. Remove short from between INPUT and COMMON posts.

4-35. 100 AND 1000 VOLT RANGE CHECK

a. Set RANGE switch to 100, NULL switch to TVM polarity switch to +, and voltage readout dials to zero.

VOLTMETER SWITCH SETTINGS			METER INDICATION
RANGE	NULL	VOLTAGE READOUT DIALS A B C D E	
100	10	1 0. 0 0 00	-1. 0
100	1	0 1. 0 0 $\overline{00}$	-1. 0
100	. 1	0 0. 1 0 $\overline{00}$	-1. 0
100	. 01	0 0. 0 1 $\overline{00}$	-1. 0
1000	100	1 0 0. 0 $\overline{00}$	-1. 0
1000	10	0 1 0. 0 $\overline{00}$	-1. 0
1000	1	0 0 1. 0 $\overline{00}$	-1. 0
1000	. 1	0 0 0. 1 $\overline{00}$	-1. 0

Figure 4-10. 100 AND 1000 VOLT NULL SENSITIVITY CHECK

b. Apply 100 volts ±0. 2% between INPUT and COMMON posts.

c. Meter should indicate within 1 small division of full scale (+1).

d. Set RANGE switch to 1000, meter should indicate within 1 small division of 1/10 of full scale (+0. 1).

4-36. POLARITY REVERSAL CHECK

a. Differentially measure the voltage of a standard cell in the 1 volt range with and without a 100K resistor connected in series in both the positive and negative polarity.

b. All four measurements should agree within 5 uv.

4-37. COMMON MODE CHECK

a. Differentially measure the voltage of a standard cell in the 1 volt range and in the + polarity.

b. Apply approximately 500 dc volts between COMMON and ground posts.

c. After 3 minutes, note change in standard cell reading. The change should not be more than 25 uv.

4-38. CONVERTER FET VOLTAGE

a. Measure voltage between circuit common 2 and drain of Q501, TP29 and TP31 in Figure 4-8, with a vtvm.

b. Voltage drain of Q501 should be +11. 0 ±0. 5 volts. If calibration is necessary, adjust R508.

4-39. CONVERTER OUTPUT VOLTAGE

a. Measure voltage between circuit common 2 and collector of Q506, TP29 and TP34, with a vtvm.

b. Voltage at collector of Q506 should be 9.0 +0.5/-1.5 volts. If calibration is necessary, adjust R522.

4-40. AC SENSITIVITY CHECK

a. Connect equipment as shown in Figure 4-6 and adjust the equipment to provide 1, 10, 100 and 1000 volts ac rms at 10 kHz such that the average value has an accuracy of 0. 02% as instructed in paragraph 4-45.

b. Set polarity switch to AC and voltage readout dials to 10. 00000.

c. Complete procedure indicated for each horizontal line of Figure 4-7.

4-41. CALIBRATION

4-42. DC CALIBRATION

4-43. The following procedures should be performed with the instrument and test equipment in the temperature range of 72° F to 75° F with the relative humidity not more than 70%. DC calibration voltages must be accurate to ±(0. 001% + 2 uv). Connect the test equipment as shown in Figure 4-3 and adjust the controls as follows:

a. Turn on all of the equipment and allow it to warm up for at least 1/2 hour.

CAUTION!

Make sure 332A POWER switch is set to STANDBY/RESET.

b. Set the STANDARD CELL VOLTAGE switches on the Model 750A Reference Divider to voltage of standard cell.

c. Set the INPUT VOLTAGE switch on the Model 750A Reference Divider to 1000V.

d. Set the Model 332A output voltage dials for an output of 1000 volts.

e. Set the Model 845A Null Detector RANGE switch to 100 uv after zeroing the meter with the ZERO control.

f. Set the Model 332A POWER switch to ON.

g. Adjust the Model 332A output voltage dials for a null in each successively more sensitive position of the 845A Null Detector RANGE switch.

h. Output voltages of 0. 1, 0. 5, 1, 5, 10, 100, and 1000 volts are available at the output terminals of the Model 750A Reference Divider. During the calibration procedure, periodically check the Model 845A for a null indication and adjust the Model 332A output voltage if necessary.

4-44. The 13 steps in the table of Figure 4-11 are used to perform the final dc calibration. If adjustments are necessary in Steps 1, 3, or 4, the NULL switch should be returned to the least sensitive position and advanced to successively more sensitive positions while adjusting the indicated control for a null indication on the meter. In all other steps, the desired meter indication is zero.

4-45. AC CALIBRATION

4-46. The following procedure should be performed at a temperature from 72° F to 75° F and a relative humidity of 70% or less.

a. Connect all test equipment as shown in Figure 4-6.

b. Turn on all test equipment and allow it to warmup for at least 1/2 hour.

c. Set 332A Voltage Standard for an output of 1 volt.

d. Null galvanometer of 540B Transfer Standard by adjusting internal reference supply of 540B.

e. Apply output of AC104 AC Source at desired frequency to 540B and null galvanometer by adjusting ac source voltage.

STEP	FUNCTION	MODEL 887A CONTROL SETTINGS			MODEL 887A INPUT CONNECTIONS	TOLERANCE	ADJ.
		RANGE	NULL	READOUT			
1	CALIBRATE 10V Range	10	0. 001	10. 00000	10V Reference Divider	±100 uv	R120
2	CHECK 9. 999100	10	0. 001	9. 999100	10V Reference Divider	±100 uv	
3	CALIBRATE 1V Range	1	0. 0001	1. 000000	1V Reference Divider	±10 uv	R122
4	CALIBRATE 100V Range	100	0. 01	100. 0000	100V Reference Divider	±1 mv	R103
5	CHECK 1000V Range	1000	0. 1	1000. 000	1000V Reference Divider	±10 mv	
6	CHECK Standard Cell	10	0. 001	St. Cell voltage	1 Standard cell	±18 uv	
7	CHECK Standard Cell	1	0. 0001	St. Cell voltage	1 Standard cell	±10 uv	
8	CHECK 2 Standard Cells	10	0. 001	2 cell voltage	2 Standard cells	±30 uv	
9	CHECK 3 Standard Cells	10	0. 001	3 cell voltage	3 Standard cells	±45 uv	
10	CHECK 5V	10	0. 001	5. 00000	5V Reference divider	±75 uv	
11	CHECK 5V BATT OPR	10	0. 001	5. 00000	5V Reference divider	±75 uv	
12	CHECK 0. 5V	1	0. 0001	0. 50000	0. 5V Reference divider	±10 uv	
13	CHECK 0. 1V	1	0. 0001	0. 10000	0. 1 Reference divider	±4 uv	

Figure 4-11. DC CALIBRATION ADJUSTMENTS AND TOLERANCES

f. Apply output of ac source to input of 887A being calibrated.

g. Repeat steps d and e for each calibration voltage and frequency required.

4-47. The 31 steps of Figure 4-12 are used to perform the final ac calibration. It should be noted that odd harmonic distortion will cause a maximum error equal to the percent harmonic distortion divided by the order of the harmonic. For example, third harmonic distortion of 0. 03% will cause an error between -0. 01% and +0. 01% depending on the phase relationship. If excessive harmonic distortion is suspected, check the ac source with a wave analyzer.

4-48. KELVIN-VARLEY DIVIDER EVALUATION

4-49. Kelvin-Varley evaluation requires that connections to the Kelvin-Varley divider be made inside the instrument. Also, Kelvin-Varley evaluation takes a considerable amount of time to perform. Therefore, this check should be performed only if the dc differential voltmeter check (paragraph 4-12) indicates there is a problem or if the Kelvin-Varley has just been calibrated (paragraph 4-50). Proceed as follows:

a. Disconnect 887A from power line. Set POWER switch to OFF and NULL switch to TVM.

b. Remove bottom panel, top-back panel, side panels, and shield protecting polarity switch on left side on instrument. This shield is held in place by one screw accessible from the top of the instrument.

c. Connect the test equipment as shown in Figure-4-13, but with Lead A to the high input, Lead B to the high output, and Lead C to the input-output common test points described in step d.

d. With the aid of Figure 4-15 , locate high input (white wire from TP13 on Kelvin-Varley board to polarity switch), high output (wiper terminal of R366 where brown and yellow wire are connected), and input-output common (TP1 on Kelvin-Varley board) of Kelvin-Varley divider. Unsolder the high input wire from the polarity switch.

STEP	FUNCTION	MODEL 887A CONTROL SETTINGS			MODEL 887A INPUT VOLTAGE	TOLERANCE	ADJUST
		RANGE	NULL	READOUT			
1	CALIBRATE 1V 400 Hz	1	0.001	1.000000	1V 400 Hz	0 to 1 Major Divisions (+0.01) of null	R503
2	CALIBRATE 1V 20 kHz	1	0.001	1.000000	1V 20 kHz	± 1 major division (±0.01%) of null	C502
3	CHECK 1V 400 Hz	1	0.001	1.000000	1V 400 Hz	If within 0 to 1 major divisions go on to step 4. If not, go back to step 1.	
4	CHECK 1V 5 kHz	1	0.001	1.000000	1V 5 kHz	± 1 major division (±0.01%) of null	
5	CHECK 1V 10 kHz	1	0.001	1.000000	1V 10 kHz	± 1.5 major divisions (±0.015%) of null	
6	CHECK 1V 50 kHz	1	0.01	1.000000	1V 50 kHz	±3 major divisions (±0.3%) of null	
7	CHECK 1V 100 kHz	1	0.01	1.000000	1V 100 kHz	±5 major divisions (±0.5%) of null	
8	CHECK 1V 20 Hz	1	0.001	1.000000	1V 20 Hz	±3 major divisions (±0.03%) of null	
9	CHECK 0.1V 400 Hz	1	0.001	0.100000	0.1V 400 Hz	±0.5 major divisions (±0.05%) of null	
10	CHECK 0.1V 10 kHz	1	0.001	0.100000	0.1V 10 kHz	±0.5 major divisions (±0.05%) of null	
11	CHECK 1 mv 10 kHz	1	0.001	0.001000	0.001V 10 kHz	±1 small division (±2%) of null	
12	CALIBRATE 10V 400 Hz	10	0.01	10.00000	10V 400 Hz	0 to 1 major division (+0.01%) of null	R403
13	CALIBRATE 10V 20 kHz	10	0.01	10.00000	10V 20 kHz	±1 major division (±0.01%) of null	C401
14	CHECK 10V 400 Hz	10	0.01	10.00000	10V 400 Hz	If within 0 to 1 major division, go on to step 15. If not go back to step 12.	
15	CHECK 10V 5 kHz	10	0.01	10.00000	10V 5 kHz	±1.5 major divisions (±0.015%) of null.	
16	CHECK 10V 10 kHz	10	0.01	10.00000	10V 10 kHz	±2 major divisions, (±0.02%) of null	
17	CHECK 10V 50 kHz	10	0.1	10.00000	10V 50 kHz	±3 major divisions (±0.3%) of null	
18	CHECK 10V 100 kHz	10	0.1	10.00000	10V 100 kHz	±7 major divisions (±0.7%) of null	

Figure 4-12. AC CALIBRATION ADJUSTMENTS AND TOLERANCES (Sheet 1 of 2)

STEP	FUNCTION	MODEL 887A CONTROL SETTINGS			MODEL 887A INPUT VOLTAGE	TOLERANCE	ADJUST
		RANGE	NULL	READOUT			
19	CALIBRATE 100V 400 Hz	100	0. 1	100. 0000	100V 400 Hz	0 to 1 major division (+0. 01%) of null	R406
20	CALIBRATE 100V 20 kHz	100	0. 1	100. 0000	100V 20 kHz	±1 major division (±0. 01%) of null	C403
21	CHECK 100V 400 Hz	100	0. 1	100. 0000	100V 400 Hz	If within 0 to 1 major division, go on to step 22. If not, go back to step 19.	
22	CHECK 100V 5 kHz	100	0. 1	100. 0000	100V 5 kHz	±1. 5 major divisions (±0. 015%) of null	
23	CHECK 100V 10 kHz	100	0. 1	100. 0000	100V 10 kHz	±2 major divisions (±0. 02%) of null	
24	CHECK 100V 50 kHz	100	1. 0	100. 0000	100V 50 kHz	±4 major divisions (±0. 4%) of null	
25	CHECK 100V 100 kHz	100	1. 0	100. 0000	100V 100 kHz	±7 major divisions (±0. 7%) of null	
26	CALIBRATE 500V 400 kHz	1000	1. 0	500. 000	500V 400 kHz	0 to 1/2 major divisions (+0. 01%) of null	R410
27	CALIBRATE 500V 10 kHz	1000	1. 0	500. 000	500V 10 kHz	±1/2 major division (±0. 01%) of null	C405
28	CHECK 500V 400 Hz	1000	1. 0	500. 000	500V 400 kHz	If within 0 to 1/2 major division go on to step 29. If not, go back to step 26.	
29	CHECK 500V 5 kHz	1000	1. 0	500. 000	500V 5 kHz	±1/2 of major division (±0. 01%) of null	
30	CHECK 500V 20 kHz	1000	1. 0	500. 000	500V 20 kHz	±3 major divisions (±0. 06%) of null	
31	CHECK 1000V 400 Hz	1000	1. 0	1000. 000	1000V 400 Hz	±3 major divisions (±0. 03%) of null	

Figure 4-12. AC CALIBRATION ADJUSTMENTS AND TOLERANCES (Sheet 2 of 2)

e. Turn all equipment on and allow it to warmup to equilibrium temperature (about 1/2 hour).

f. Set voltage dials on 332A Voltage Standard for an output of 33. 0 volts dc.

g. Set 887A voltage readout dials to 000000 and 720A Kelvin-Varley Divider dials to 0000000.

h. Set 845A Null Detector to 100 MICROVOLTS.

i. Set function switch to VOLTAGE OFF on 721A Lead Compensator.

j. Zero 845A Null Detector.

k. Set function switch to $R_S > R_X$ on 721A Lead Compensator.

m. Adjust LOW BALANCE controls on 721A for a null on 845A. It may be necessary to temporarily reduce sensitivity of 845A to find null point on LOW BALANCE controls.

l. Set 887A voltage dials to 10999100 and 720A Kelvin-Varley dials to 109999910.

m. Set function switch to VOLTAGE OFF on 721A Lead Compensator.

n. Zero 845A Null Detector.

o. Set function switch to $R_s > R_x$ on 721A Lead Compensator.

p. Adjust HIGH BALANCE controls on 721A for a null on 845A. It may be necessary to temporarily reduce sensitivity of 845A to find null point on HIGH BALANCE controls.

q. Set 845A Null Detector to 300 MICROVOLTS and change to 100 MICROVOLTS and 30 MICROVOLTS as required.

s. Set 887A voltage readout dials and 720A Kelvin-Varley Divider dials to first positions shown in Figure 4-16.

t. Set function switch to VOLTAGE OFF on 721A Lead Compensator.

u. Zero 845A Null Detector.

v. Set function switch to $R_S > R_X$ on 721A Lead Compensator. The 845A Null Detector indication should be equal to or less than the listed deviation.

w. Repeat steps t through v for remaining switch positions shown in Figure 4-16. If Kelvin-Varley divider is out of tolerance between settings of 1000000 and 0999100, calibrate as set forth in paragraph 4-50. If a resistor-trimmer combination of the first deck can not be adjusted for a null during calibration, a resistor is defective and must be replaced. If Kelvin-Varley divider is out of tolerance for remaining settings, make sure padding trimmers are adjusted correctly (paragraph 4-50) before attempting to replace a resistor.

x. Resolder high input wire to polarity switch.

4-50. KELVIN-VARLEY DIVIDER CALIBRATION

4-51. The Kelvin-Varley divider should be calibrated only after the Kelvin-Varley divider evaluation (paragraph 4-48) indicates that the Kelvin-Varley divider is out of tolerance. Familiarity with the function and operation of the Model 721A Lead Compensator, and Model 720A Kelvin-Varley divider is essential before proceeding with this procedure. In general, this procedure linearizes the Kelvin-Varley divider. For example, if the reading on the Kelvin-Varley dials is doubled, the Kelvin-Varley output voltage should double, causing the output voltage of the Kelvin-Varley divider to be a linear function of the Kelvin-Varley dial settings. Any deviation from this condition will be corrected by this calibration procedure. In order to linearize a Kelvin-Varley divider two conditions need to be satisfied: (1) the resistors of a decade must have equal resistance. (2) The resistance shunting a decade must be equal to any one resistor of that decade. Because decade A has the greatest effect on linearity, only its resistors are adjusted to equal each other. However, the shunt resistance of each decade is adjusted to satisfy condition (2) above.

4-52. Figure 4-13 shows the setup required to adjust the shunt resistance of decade D. The shunt resistance in this case is composed of R364, R365 and R366. (Resistors R353 and R354 are the first two of decade D.) Proceed as follows:

a. Disconnect the 887A from the power line and remove the top, bottom and side covers. Also remove the aluminum shield located around the polarity (AC/DC) switch.

b. With reference to Figure 4-15, open jumpers U, V, W, X, Y and Z by unsoldering that end of each jumper which is farthest from the associated test point. In this manner, the loosened jumpers provide connection to their associated test points.

c. Solder 1/2-inch lengths of copper single-conductor wire to test points 1 through 13, 15, 16, 19, 22, 24 and 25 on the Kelvin-Varley divider PCB. (These leads will be used as test points during calibration.)

d. With reference to Figure 4-15, unsolder white lead from test point 13 of the Kelvin-Varley divider assembly to the polarity switch. Unsolder the brown and yellow leads from the wiper of R366 (Decade E Potentiometer).

e. Connect the equipment as shown in Figure 4-13.

f. Apply primary power and turn on all equipment.

CAUTION!

> Do not allow the voltage calibrator output voltage to exceed 40 volts, as damage to Kelvin-Varley resistors may result.

g. Adjust the Model 332A Voltage Calibrator for an output of four volts dc.

h. Connect Lead A to test point 14 and Lead B to test point 16.

i. Perform test lead compensation as follows:

(1) Set the Model 845A Zero switch to Zero and the Range switch to 10uV.

(2) Set the Model 720A Kelvin-Varley Voltage Divider FUNCTION switch to OPR and the divider dials to .0000000.

(3) On the 887A Kelvin-Varley assembly, connect lead C to test point 16.

(4) Set the voltage switch on the Model 721A to OFF.

(5) On the Model 845A, place the ZERO switch to OPR and adjust the zero control for a null on the 845A; Then place the ZERO switch to ZERO and the RANGE switch to 30uV.

(6) On the Model 721A, place the VOLTAGE switch to ON and the MODE switch to RSTD > RTEST.

(7) On the Model 845A, set the ZERO switch to OPR.

(8) On the Model 721 Lead Compensator, adjust the LOW BALANCE controls for a null on the Model 845A.

NOTE!

> It may be necessary to reduce the sensitivity of the 845A Null Detector by changing the RANGE switch to a higher range in order to obtain an on scale reading. Final null will be accomplished on the 30uV range of the 845A Null Detector.

(9) On the 845A, set the ZERO switch to ZERO.

(10) On the 720A Kelvin-Varley voltage divider, set the divider dials to .999999X.

(11) On the 887A Kelvin-Varley assembly, connect lead C to lead A (test point 14).

(12) Repeat the preceding steps 4, 5, 6 and 7.

(13) On the Model 721A Lead Compensator, adjust the HIGH BALANCE controls for a null.

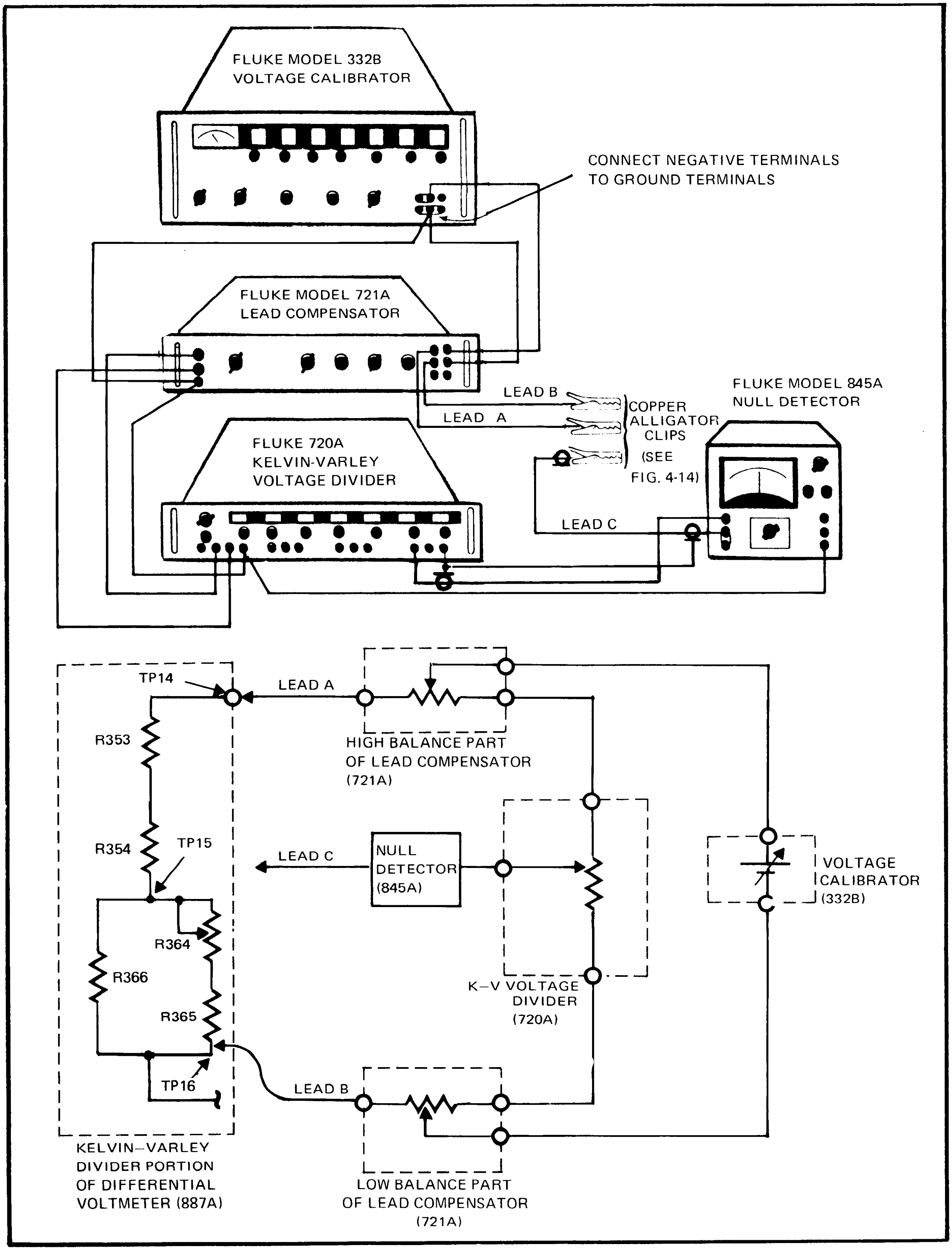


Figure 4-13. KELVIN–VARLEY DIVIDER CALIBRATION – PICTORAL AND SCHEMATIC CONNECTIONS.

NOTE!

It may be necessary to reduce the sensitivity of the Model 845A Null Detector by switching to a higher range, to obtain an on scale reading. Final null will be accomplished on the 30uV range.

(14) On the 845A Null Detector, place ZERO switch to zero.

j. On the 887A Kelvin-Varley assembly, connect lead C to test point 15.

k. Set the dials on the Model 720A Kelvin-Varley Voltage Divider to .5000000.

l. Eliminate errors due to thermal voltages as follows:

(1) On the Model 721A Lead Compensator, place the VOLTAGE switch to OFF.

(2) On the Model 845A Null Detector, place the RANGE switch to 10uV and the ZERO switch to OPR.

(3) On the Model 845A, adjust the ZERO control for a null.

(4) On the Model 845A Null Detector, place the ZERO switch to ZERO.

(5) On the Model 721A Lead Compensator, place the VOLTAGE switch to ON.

m. On the Model 845A, place the RANGE switch to 1 millivolt and the ZERO switch to OPR.

n. On the Model 887A, adjust R364 (adjustment P) to obtain a null (±200uV) on the Model 845A.

o. On the Model 845A, place the ZERO switch to ZERO.

p. On the Model 887A, solder down jumpers Z and Y, and connect lead A to test point 17 and lead B to test point 18.

q. Repeat step i.

r. On the 887A Kelvin-Varley assembly, connect lead C to test point 22.

s. Repeat steps k, l and m.

t. On the Model 887A Kelvin-Varley assembly, adjust R351 (adjustment N) for a null (± 50uV) on the Model 845A. (It may be necessary to decrease the sensitivity of the Model 845A by increasing the RANGE. Final null will be obtained on the 100uV range.)

u. On the Model 887A Kelvin-Varley assembly, solder down jumpers W and X; and connect lead A to test point 20 and lead B to test point 21.

v. Repeat step i.

w. On the Model 887A, connect lead C to test point 25.

x. Repeat steps k, l and m.

y. On the Model 887A Kelvin-Varley assembly, adjust R338 (adjustment m) for a null (± 20uV) on the Model 845A. It may be necessary to decrease the sensitivity of the Model 845A by increasing the range. Final null will be obtained on the 30uV range.

z. On the Model 845A, place the ZERO switch to ZERO.

aa. On the Model 887A, solder down jumper V.

ab. Connect lead A to test point 23 and lead B to test point 24.

ac. On the Model 332A, adjust to OUTPUT VOLTAGE dials for 18 volts dc.

ad. Repeat step h.

ae. On the Model 720A, place the divider dials to .6666667.

af. Make the adjustments given in each horizontal line of Figure 4-17, starting at the top line.

ag. Solder down jumper u and remove test leads from all points of 887A Kelvin-Varley assembly.

ah. Check accuracy of Kelvin-Varley divider using the procedure in paragraph 4-48.

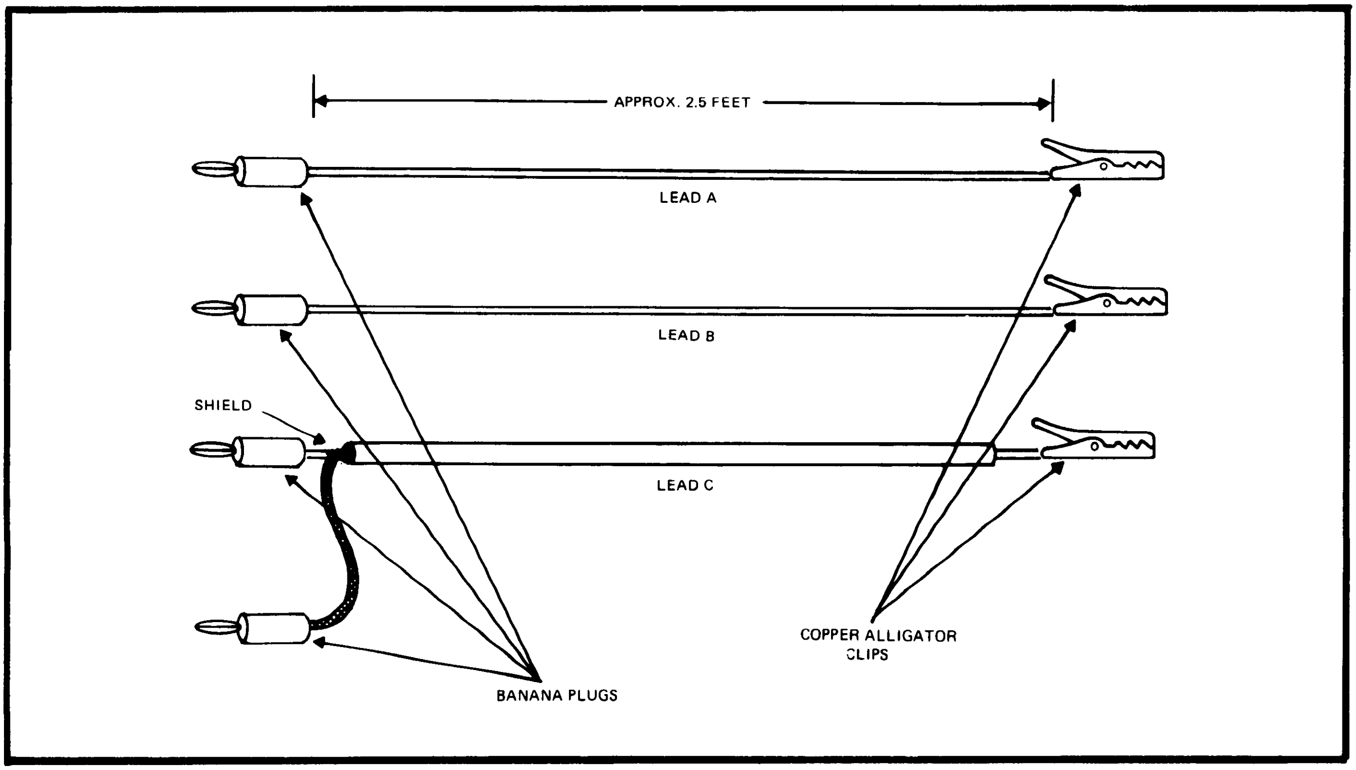


Figure 4-14. TEST LEAD FABRICATION.

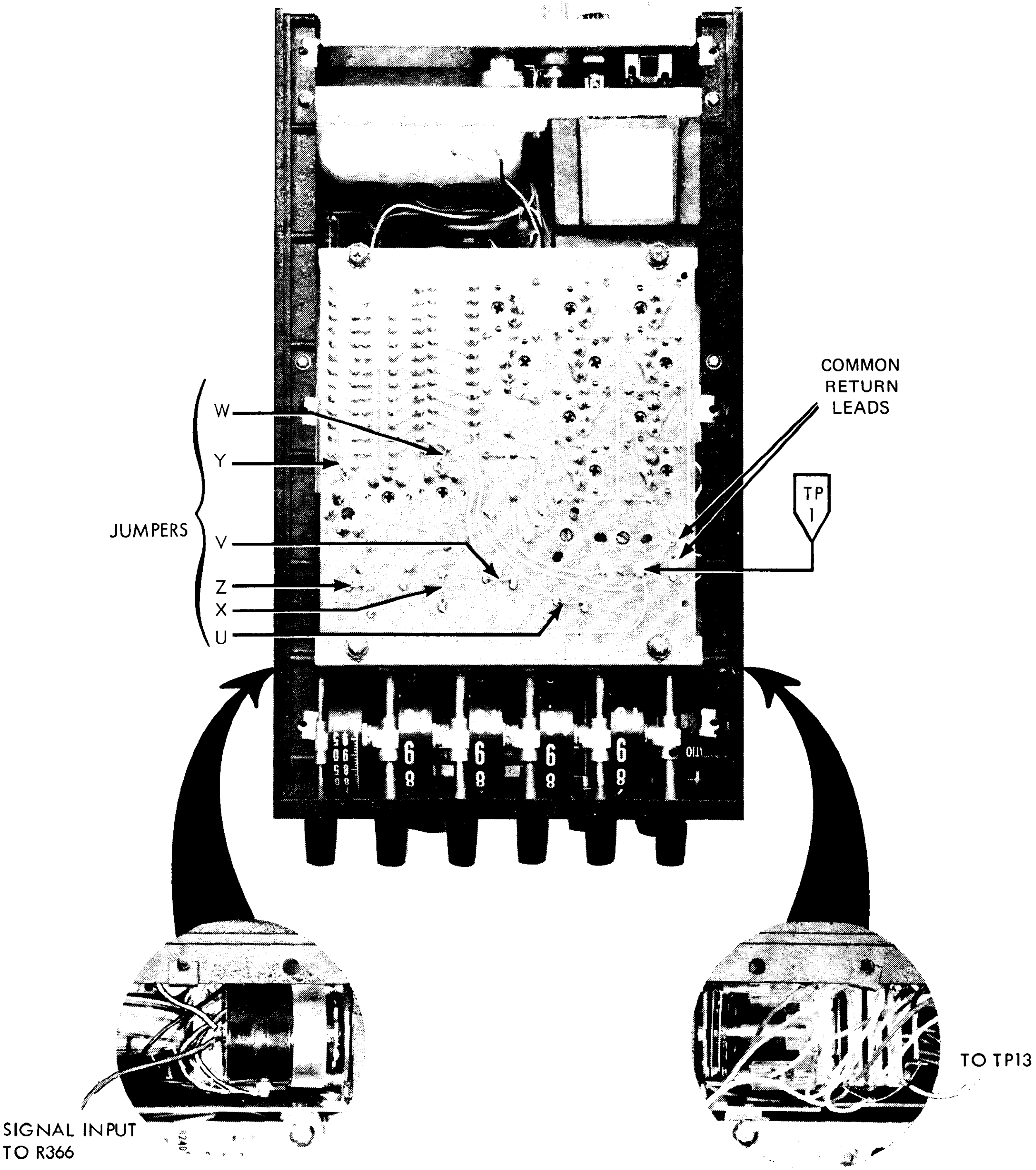


Figure 4-15. KELVIN-VARLEY CONNECTIONS

887A Voltage Dial Settings	Standard Divider Settings	Maximum Deviation for an Input of 33.0 vdc (± microvolts)
1000000	10000000	360
9999100	10000000	360
900000	9000000	324
8999100	9000000	324
800000	8000000	288
7999100	8000000	288
700000	7000000	252
6999100	7000000	252
600000	6000000	216
5999100	6000000	216
500000	5000000	180
4999100	5000000	180
400000	4000000	144
3999100	4000000	144
300000	3000000	108
2999100	3000000	108
200000	2000000	72
1999100	2000000	72
100000	1000000	36
0999100	1000000	36
090000	0900000	36
0899100	0900000	36
080000	0800000	36
0799100	0800000	36
070000	0700000	36
0699100	0700000	36
060000	0600000	36
0599100	0600000	36
050000	0500000	36
0499100	0500000	36
040000	0400000	36
0399100	0400000	36
030000	0300000	36
0299100	0300000	36
020000	0200000	36
0199100	0200000	36
010000	0100000	36
0099100	0100000	36
009000	0090000	36
0089100	0090000	36
008000	0080000	36
0079100	0080000	36
007000	0070000	36
0069100	0070000	36
006000	0060000	36
0059100	0060000	36
005000	0050000	36
0049100	0050000	36
004000	0040000	36
0039100	0040000	36
003000	0030000	36
0029100	0030000	36
002000	0020000	36
0019100	0020000	36
001000	0010000	36
0009100	0010000	36
000900	0009000	36
0008100	0009000	36
000800	0008000	36
0007100	0008000	36
000700	0007000	36
0006100	0007000	36
000600	0006000	36
0005100	0006000	36
000500	0005000	36
0004100	0005000	36
000400	0004000	36
0003100	0004000	36
000300	0003000	36
0002100	0003000	36
000200	0002000	36
0001100	0002000	36
000100	0001000	36
0000100	0001000	36
000090	0000900	36
000080	0000800	36
000070	0000700	36
000060	0000600	36
000050	0000500	36
000040	0000400	36
000030	0000300	36
000020	0000200	36
000010	0000100	36
000000	0000000	0

Figure 4-16. KELVIN-VARLEY DIVIDER ERROR LIMITS

4-53. STABILITY EVALUATION

4-54. The stability evaluation is a three-step procedure intended to measure the instruments stability with respect to time. The evaluation technique is to measure certain performance characteristics at three different times while observing test results for out-of-tolerance indications. To evaluate the dc stability, proceed as follows:

a. Turn the instrument off for at least two hours then turn it on and allow it to warm up for 15 minutes.

(1) In the 1 volt range, short the input, and switch to the 100 uv null sensitivity. If the meter indicates within ±3 uv of null it is in calibration. Readjust the ZERO control for null.

(2) Measure a standard cell in the 1 volt range. The reading must be within 10 uv of the standard cell voltage.

a. The second and third readings of 1 and 2 above should be made within 48 to 96 hours. The instrument should be left on, AB models in the LINE OPER mode.

b. The three readings of step a (1) should all be within ±3 uv of zero. If the readings were greater than ±3 uv. check the Null Detector input for thermals and voltaics.

c. The largest difference between any two of the three standard cell readings in step a (2) must be less than 12 uv. If the difference is greater than 6 uv but less than 12 uv, set the Kelvin-Varley readouts to the average of the two outside readings. Apply the standard cell voltage to the input and adjust R120 for a null. If the difference is greater than 12 uv, it is likely that the reference supply or the reference zener is unstable.

4-55.. The ac stability check should be made with the equipment shown in Figure 4-6. The procedure is the same as for the dc stability evaluation. That is, measure the performance at three different times, comparing the results for excessive drift.

a. Check 1 v, 5 kHz, it should read within ±2 major divisions (±.02%).

b. Check 10v, 5 kHz, it should read within ±2 major divisions (±.02%).

c. Check 100v, 5 kHz, it should read within ±2 major divisions (±.02%).

d. Check 500 v, 5 kHz, it should read within ±1 major division. (±.02%).

Set Voltage Dial A To	Short Test Points	Eliminate Thermal Voltage Errors as in step m	Set 845A Null Detector to 100 microvolts	Adjust Control to Within ±15 microvolts of Null at Point	Remove Short from Between
0	2 to 3	"	"	R301 A	2 and 3
0	1 to 2	"	"	R304 B	1 and 2
2	4 to 5	"	"	R307 C	4 and 5
2	3 to 4	"	"	R309 D	3 and 4
4	6 to 7	"	"	R311 E	6 and 7
4	5 to 6	"	"	R313 F	5 and 6
6	8 to 9	"	"	R315 G	8 and 9
6	7 to 8	"	"	R317 H	7 and 8
8	10 to 11	"	"	R319 I	10 and 11
8	9 to 10	"	"	R321 J	9 and 10
10	12 to 13	"	"	R323 K	12 and 13
10	11 to 12	"	"	R325 L	11 and 12

Figure 4-17 KELVIN-VARLEY "A" DECK ADJUSTMENT

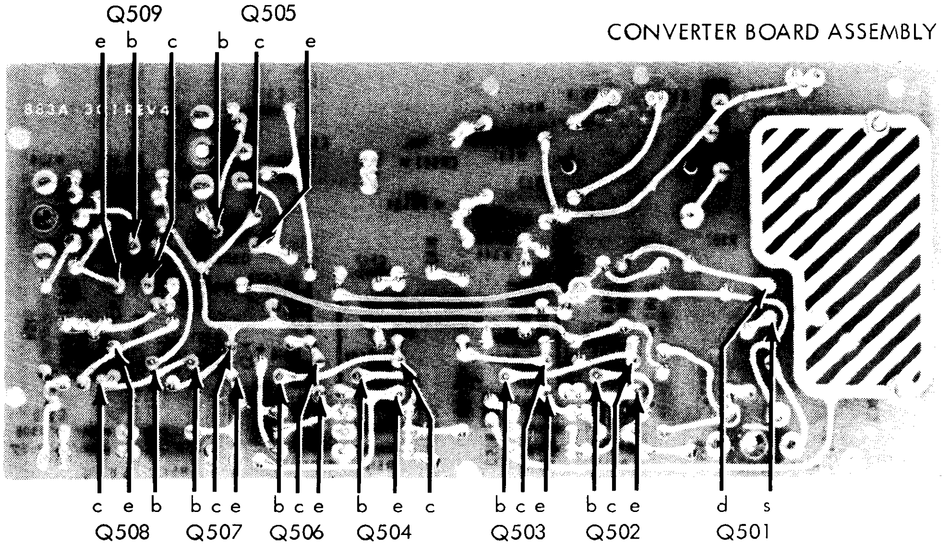
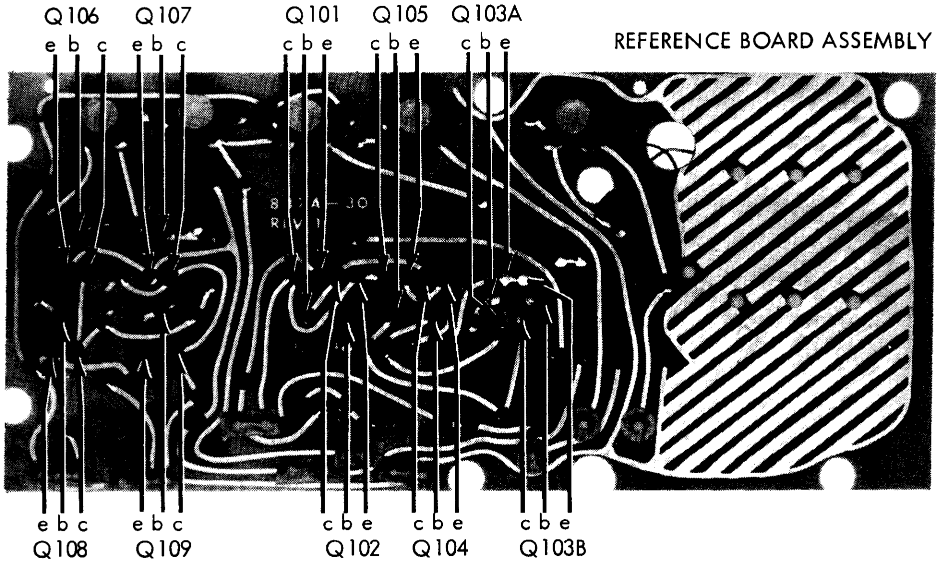


Figure 4-18. LOCATION OF TRANSISTOR TERMINALS (Sheet 1 of 2)

REFERENCE BOARD ASSEMBLY



NULL DETECTOR ASSEMBLY

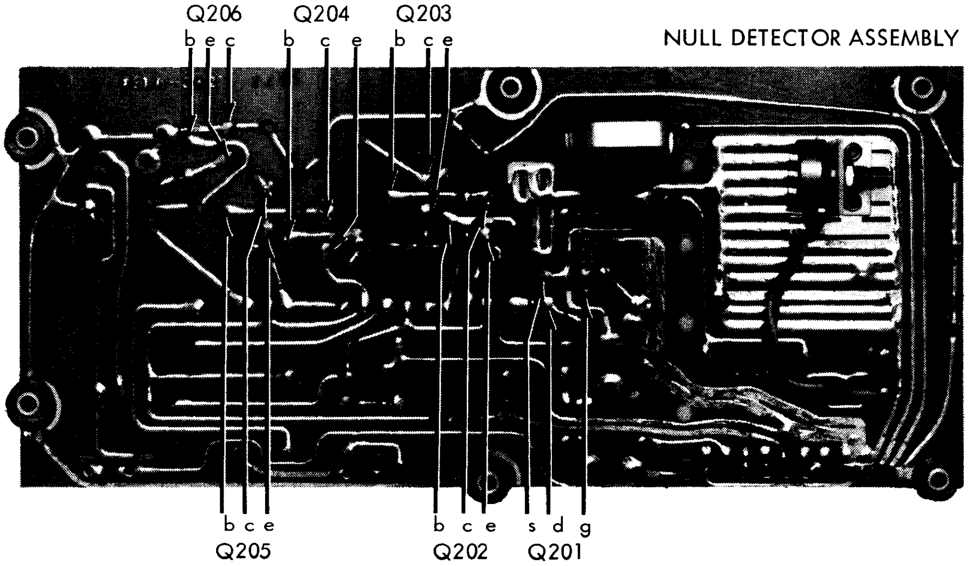


Figure 4-18 LOCATION OF TRANSISTOR TERMINALS (Sheet 2 of 2)

PROCEDURE STEP AND FUNCTION TESTED	TOLERANCES	MEASURED VALUES					
		FIRST CHECK	SECOND CHECK	THIRD CHECK	FOURTH CHECK	FIFTH CHECK	SIXTH CHECK
DATE	---						
4-10. DC CHECKS	---						
4-11. NULL DET CHECK	---						
4-11f. Rng 10 Null 1	-0.97 to -1.03						
4-11f. Rng 1 Null 0.1	-0.97 to -1.03						
4-11f. Rng 1 Null 0.01	-0.97 to -1.03						
4-11f. Rng 1 Null 0.001	-0.97 to -1.03						
4-11f. Rng 100 Null 0.1	-0.97 to -1.03						
4-11f. Rng 100 Null 0.01	-0.97 to -1.03						
4-12. DC DIFF. VM. CHK.	---						
4-12i. 1 Volt Range	.999969 to 1.000031						
4-12l. 10 Volt Range	9.99973 to 10.00027						
4-12m. Polarity Reversal	±5 uv						
4-12q. 100 Volt Range	99.9974 to 100.0026						
4-12t. 1000 Volt Range	999.974 to 1000.026						
4-12w. One Standard Cell	±32 uv						
4-12x. Two Standard Cells	±66 uv						
4-12y. Three Standard Cells	±92 uv						
4-12ab. K-V Check	1.11107 to 1.11115						
4-12ab. K-V Check	2.22215 to 2.22229						
4-12ab. K-V Check	3.33323 to 3.33343						
4-12ab. K-V Check	4.44431 to 4.44457						
4-12ab. K-V Check	5.55540 to 5.55570						
4-12ab. K-V Check	6.66648 to 6.66684						
4-12ab. K-V Check	7.77756 to 7.77798						
4-12ab. K-V Check	8.88864 to 8.88912						
4-12ab. K-V Check	9.99972 to 10.00027						
4-13. AC CHECK	---						
4-13c. 1 vac, 10 kHz	.999250 to 1.000750						
4-13c. 10 vac, 10 kHz	9.99250 to 10.00750						
4-13c. 100 vac, 10 kHz	99.9250 to 100.0750						
4-13c. 1000 vac, 10 kHz	999.000 to 1001.000						

This table is intended to provide a permanent record of the instruments performance. The procedure for evaluation performance is described in paragraph 4-9. The suggested cyclic period of evaluation is six months, although shorter intervals are frequently more desirable.

Figure 4-19 PERFORMANCE EVALUATION RECORD

4-56. TROUBLESHOOTING INFORMATION

4-57. The purpose of troubleshooting is to quickly and accurately correct the cause of any abnormal condition. Thus, servicing should begin with an attempt to localize the general area of trouble. By performing a complete performance check as outlined in paragraph 4-9, the trouble may be isolated to the null detector, reference supply, Kelvin-Varley divider, dc input attenuator, or ac to dc converter. To assist in localizing some of the more common troubles that might occur, the causes and remedies for a number of symptoms are listed in the troubleshooting chart, Figure 4-20. However, an understanding of the theory of operation and frequent reference to the schematic diagram is the best way to locate the cause of any abnormal condition.

SYMPTOM	PROBABLY CAUSE	REMEDY
Drift of reference supply evidenced by null detector meter needle drift when measuring an extremely stable voltage.	A wire wound resistor (R110, R109, R117, R119, R121 or R123) changing value with temperature.	Locate faulty resistor by heating slightly with a soldering iron held near resistor, while looking for a meter needle change of a standard cell measurement.
	Battery Voltage Low.	Charge Batteries
	Faulty Zener diode.	Monitor voltage across Zener diode pair. Look for drift of Zener voltage. Replace if defective.
	Q101, Q102, Q103, Q104, or Q105 defective.	Check by replacement.
Meter rattle or drift.	Field effect transistor Q201 defective.	If meter rattle is excessive, check Q201 by replacing it.
	Chopper G201 defective.	If meter rattle is excessive, check G201 by replacing it.
	Q207 defective	
	Moisture, dirt, or other contamination on printed circuit boards or switches.	Clean instrument as outlined in paragraph 4-3.
Measurements are out of tolerance on every range when Kelvin-Varley divider is dialed to any setting other than 10999100.	Out of adjustment or one of the Kelvin-Varley divider resistors is out of tolerance.	Check accuracy of Kelvin-Varley divider using paragraph 4-49. If these checks indicate an out of tolerance condition, first try adjusting Kelvin-Varley divider using procedure of paragraph 4-51. If Kelvin-Varley divider cannot be adjusted, use out of tolerance data obtained from procedure of paragraph 4-49 to isolate defective resistor.
Meter cannot be brought to zero with ZERO control.	Chopper drive not symmetrical.	Readjust chopper drive circuit using procedure of paragraph 4-22.
	CR201 or CR202 defective.	Check and replace if defective.
Meter beating with voltage under measurement.	Chopper drive circuit out of adjustment.	Adjust chopper drive circuit using procedure of paragraph 4-23.

NOTE: Assuming all dc measurements are normal, the following symptoms are common to ac measurements only.

Figure 4-20 TROUBLESHOOTING CHART (Sheet 1 of 2)

SYMPTOM	PROBALE CAUSE	REMEDY
Measurements are out of tolerance on the 1000, 100, or 10 volt ac range only.	Out of calibration. One or more resistors in the 1000, 100, or 10 volt ac attenuator has shifted in value.	Recalibrate per paragraph 4-45. Recalibrate per paragraph 4-45.
Measurements are out of tolerance on all ranges.	Out of calibration. Transistor Q501, Q502, Q503, Q504, Q505, or Q506 faulty. R501, R504, R530, or R531 has shifted in value.	Recalibrate per paragraph 4-45. Check by measuring dc bias voltages or by replacement. Recalibrate per paragraph 4-45.
Measurements are out of tolerance at some frequencies.	Out of calibration. Faulty frequency compensation capacitor.	Recalibrate per paragraph 4-45. Locate faulty capacitor and replace. If trouble occurs on all ranges, check C501 and C503. If trouble occurs on 1000 volt range only, check C406 and C407. If trouble occurs on 100 volt range only check C404. If trouble occurs on 10 volt range only, check C402.

Figure 4-20. TROUBLESHOOTING CHART (Sheet 2 of 2)

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q101	-30 ①	-29.4	-18.0 ②
Q102	-13	-12.4	- 7.1
Q103	-13	-12.4	- 6.7
Q104	- 6.5	- 7.1	-29.4
Q105	- 6.5	- 6.7	-18.0 ②
Q106	6.9 ⑤	5.9	3.0
Q107	6.9 ⑤	5.9	3.0
Q108	0	.16	3.0
Q109	0	.16	3.0
Q201	-3.3 (SOURCE)	0 (GATE)	-10 (DRAIN)
Q202	-16.6	-16	-12.4
Q203	-13	-12.4	-10
Q204	-18.0 ②	-17.4	-15.4
Q205	-16	-15.4	- 9.5
Q206	0	+ 2.5	0
Q501	7.1 (SOURCE)	5.5 (GATE)	11 (DRAIN)
Q502	0	0.6	3.5
Q503	2.7	3.5	8.2
Q504	0	0.7	3.7
Q505	11.3	11.9	18.0 ④
Q506	3.0 ③	3.7	9.5
Q507	34.0	33	18.0 ④
Q508	1.7	2.2	33
Q509	6.8	6.2	2.2

Figure 4-21 TRANSISTOR VOLTAGE CHART (Sheet 1 of 2)

The above operating voltage levels are measured under the following conditions: (a) Line voltage at 115/230 vac, 50 to 440 Hz. (b) All voltages measured with a 3%, 10 megohm, 5 pf voltmeter unless otherwise indicated. (c) All voltages for Q501 to Q509 are measured from specified terminal to ac to dc converter common. The COMMON post is ac to dc converter common when ac-dc polarity switch is set to AC. (d) All other voltages are measured from specified terminal to reference supply - null detector common. The COMMON post is reference supply - null detector common when in TVM mode or when in a NULL mode with all voltage dials set to 0 and polarity switch set to +. (e) Some voltages may vary as much as 15 to 20%; (f) Bias voltages (difference between emitter and base voltages) should remain approximately the same; (g) All voltages are dc unless otherwise indicated.

NOTES: ① Emitter of Q101 as measured with a differential voltmeter should be between -26 and -34 vdc for ON (887A) and LINE OPR (887AB) at 115/230 vac line, -19. 5 and -21. 0 vdc for BAT OPR (887 AB only), and not less than -23. 5 vdc for BAT CHG (887 AB only) at 115/230 vac line. ② Collector of Q101 and Q105 and emitter of Q204 as measured with a differential voltmeter should be between -17. 9 and -18. 1 vdc. ③ Emitter of Q507 as measured with a differential voltmeter should be between +26 and +35 vdc for ON (887A) and LINE OPR (887AB) at 115/230 vac line, +19. 5 and +21. 0 vdc for BAT OPR (887AB only), and not less than +23. 5 vdc for BAT CHG (887AB only) at 115/230 vac line. ④ Collector of Q507 and Q505 as measured with a differential voltmeter should be between +17. 9 and +18. 1 vdc with less than 200 uv ripple. ⑤ Emitter of Q106 and Q107 as measured with a differential voltmeter should be between +6. 3 and +7. 0 vdc for ON (997A) and LINE OPR (887AB) at 115/230 vac line and +4. 9 and +5. 3 vdc for BAT OPR (887AB only).

Figure 4-21 TRANSISTOR VOLTAGE CHART (Sheet 2 of 2)

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 is accompanied by an illustration identifying each component in the listing. Assemblies and subassemblies are identified in both the list and the illustration with a reference designation beginning with the letter A, (e.g.,A1, A100, A201, etc.). Components are identified by the schematic diagram reference designation (e.g. R1, C107, DS1). Parts not appearing on the schematic diagram are identified by a number of the same series as the other parts of the assembly (e.g. 8, 103, 209).

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. Indention of the item description indicates the relationship to other assemblies, components, etc. See Abbreviations and Symbols, paragraph 5-7, next page.

c. The ten-digit part number by which the item is identified at the John Fluke Mfg. Co. is listed in the FLUKE PART 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 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 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. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer's part number. Or they may be ordered from the John Fluke Mfg. Co factory or authorized representative. 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. Instrument model and serial number.
b. Component description.
c. Component reference designation.
d. John Fluke Mfg. Co. part number.

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. ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

ac	alternating current	mw	milliwatt
Al	aluminum	na	nanoampere
assy	assembly	pf	picofarad
cap	capacitor	piv	peak inverse voltage
car flm	carbon film	plstc	plastic
cer	ceramic	pp	peak-to-peak
comp	composition	ppm	parts per million
conn	connector	rect	rectifier
cps	cycles per second	res	resistor
db	decibel	rms	root-mean-square
dc	direct current	sb	slow-blow
dpdt	double pole double throw	Si	silicon
dpst	double pole single throw	S/N	serial number
elect	electrolytic	sw	switch
fxd	fixed	spdt	single pole double throw
Ge	germanium	spst	single pole single throw
gmv	guaranteed minimum value	Ta	tantalum
Hz	hertz (cycles per second)	tc	temperature coefficient
K	kilohm	tstr	transistor
kc or Kc	kilocycle	ua	microampere
kHz or KHz	kilohertz (kilocycles per sec)	uf	microfarad
kv	kilovolt	uv	microvolt
kva	kilovolt-ampere	va	volt ampere
ma	milliampere	vac	alternating current volts
Mc or MC	megacycle	var	variable
MHz	megahertz (megacycles per sec)	vdc	direct current volts
meg or M	megohm	w	watt
met flm	metal film	wvdc	direct current working volts
mfg	manufacturer	ww	wirewound
mv	millivolt		

PREFIX SYMBOLS

T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K or k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	anto	10^{-18}

QUANTITY SYMBOLS

a or amp	ampere
f	farad
h	henry
hr	hour
Ω	ohm
sec	second
v or V	volt
w or W	watt

SPECIAL NOTES AND SYMBOLS

~	Approximate use code, or serial number.
Use 0000-000000	Part number indicated should be used if replacement is required.

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	FINAL ASSEMBLY-Figure 5-1						
	Line powered model	887A					
	Battery/Line powered model	887AB					
A1	Chassis Assembly (see Figure 5-2)						
A2	Front Panel Assembly (see Figure 5-3)						
A100	Reference Supply Assembly (see Figure 5-4)	1702-195453 (887A-401)	89536	1702-195453	1		
A200	Null Detector Assembly (see Figure 5-5)	1702-163212 (881A-402)	89536	1702-163212	1		
A300	Kelvin-Varley Assembly (see Figure 5-6)	5111-180844 (885A-403)	89536	5111-180844	1		
A400	Attenuator Assembly (see Figure 5-7)	1702-195461 (887A-402)	89536	1702-195461	1		
A500	Converter Assembly (see Figure 5-8)	1702-166058 (883A-401)	89536	1702-166058	1		

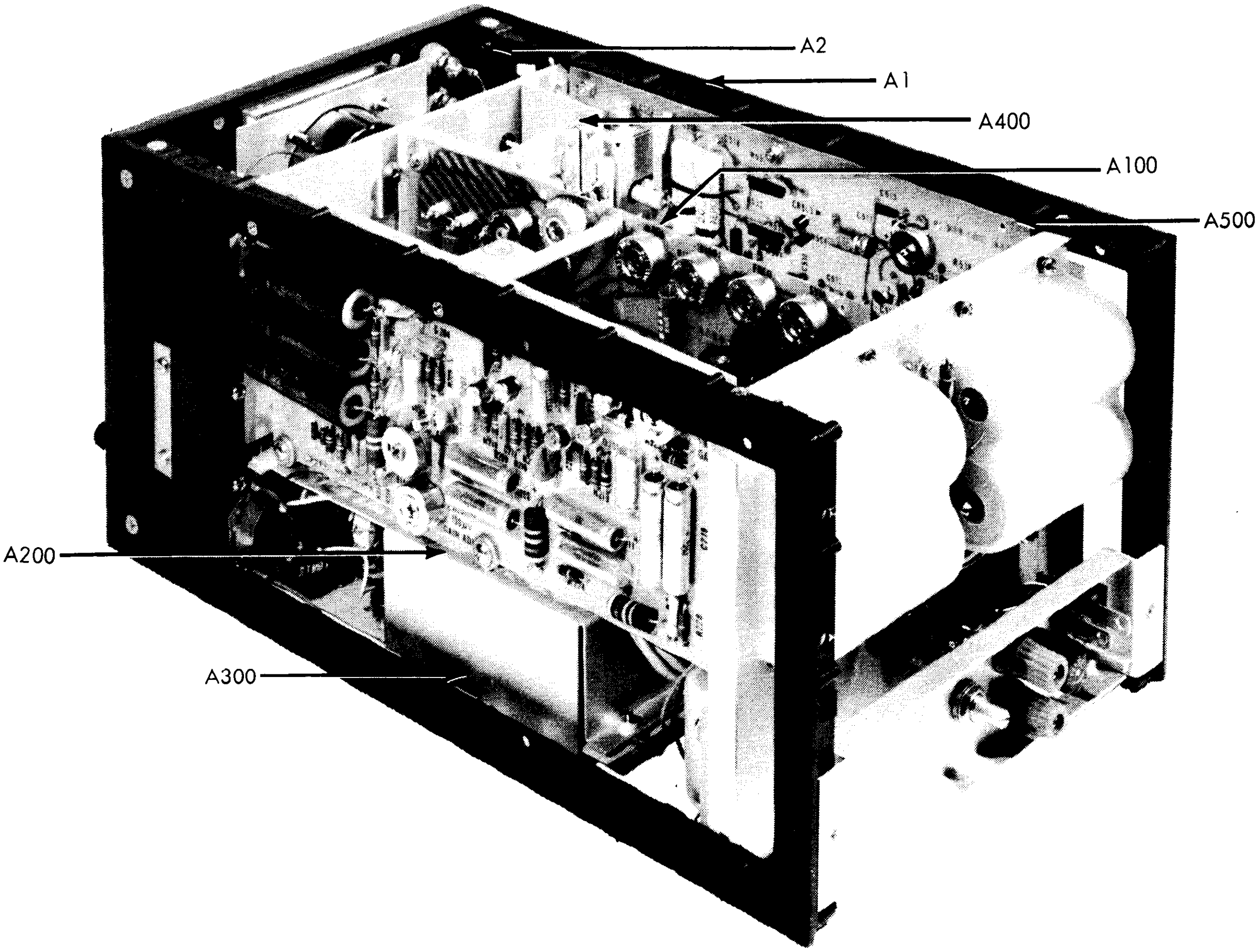


Figure 5-1. FINAL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1	**CHASSIS ASSEMBLY-Figure 5-2**						
BT1	Battery, nickel-cadmium, 9.6V (Model 887AB only)	4002-160408	06860	9.6V/500BH	4		
BT2	Battery, nickel-cadmium, 1.2V (Model 887AB only)	4002-160390	06860	1.2SC L	4		
BT3	Battery, nickel-cadmium, 9.6V (Model 887AB only)	4002-160408	06860	9.6V/500BH	REF		
C2	Cap, plstc, 0.47 uf ±20%, 1000V	1507-161612	56289	210BIG474	1		
C3	Cap, cer, 0.1 uf -10/+80%, 500V	1501-105684	14752	41C92	1		M
	Cap, cer, 0.005 uf ±20%, 1000V (mounted on T1)	1501-105650	56289	C023B102H502M	1		N
CR1, CR2	Diode, type 1N4817 (Model 887AB only)	4802-116111	05277	1N4817	6	2	
F1	Fuse, 1/16 amp, slow blow, 250V (887A only) (for 115V operation)	5101-163030	71400	Type MDL	1	5	
F1	Fuse, 1/32 amp, slow blow, 250V (887A only) (for 230V operation)	5101-163022	71400	Type MDL	1	5	
F1	Fuse, 1/4 amp, slow blow, 250V (887AB only) (for 115 V operation)	5101-166306	71400	Type MDL	1	5	
F1	Fuse, 1/8 amp, slow blow, 250V (887AB only) (for 230V operation)	5101-166488	71400	Type MDL	1	5	
J4, J5	Binding post, red	2811-142976	58474	DF31RC	2		
P2	Plug, 3 prong	2109-160275	01730	M-1550-GS	1		
R2, R3	Res, met flm, 4.5M ±1%, 1W	4705-159418	14298	Type CM-1	2		
R4	Res, met flm, 900K ±1%, 1W	4705-159509	72982	Type MF8C-T0	1		
R5	Res, met flm, 90K ±1%, 1/2W	4705-159426	72982	Type MF7C-T0	1		
R6	Res, met flm, 9K ±1%, 1/2W	4705-159434	72982	Type MF7C-T0	1		
R7	Res, met flm, 1K ±1%, 1/2W	4705-151324	72982	Type MF7C-T0	2		
R8	Res, var, comp, 10K ±20%, 1/2W	4701-162800	12697	Series 37	1		
R9	Res, comp, 62K ±5%, 1/2W (Model 887AB only)	4704-108522	01121	EB6235	2		
R10	Res, comp, 10M ±10%, 1/2W	4704-108142	01121	EB1061	1		M
R12	Res, comp, 10Ω ±5%, 1W (Model 887AB only)	4704-166298	01121	GB1005	1		
R13	Res, comp, 130Ω ±5%, 1W (Model 887AB only)	4704-163055	01121	GB1315	2		
S1	Switch, rotary, 2 pol, 2 pos, 1 section (Model 887A only) (not illustrated)	5105-162693	89536	5105-162693	1		
	Switch, rotary, 8 pol, 5 pos, 4 section (Model 887AB only)	5105-163360	89536	5105-163360	1		
S2	Switch, rotary, 8 pol, 4 pos, 5 section	5105-162719	89536	5105-162719	1		

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
S3	Switch, rotary, 7 pol, 5 pos, 5 section	5105-162669	89536	5105-162669	1		
S4	Switch, rotary, 8 pol, 3 pos, 4 section (not illustrated)	5105-162701	89536	5105-162701	1		
T1	Transformer, power	5602-162818	89536	5602-162818	1		
1	Cover, bottom (not illustrated)	3156-162198	89536	3156-162198	1		
2	Cover, side, front	3158-162164	89536	3158-162164	2		
3	Cover, side, rear	3158-162172	89536	3158-162172	2		
4	Cover, top	3156-162180	89536	3156-162180	1		
5	Fuse holder	2102-160846	75915	34-2004	1		
6	Handle	2404-101857	12136	919-415-173	1		
7	Rubber foot (not illustrated)	2819-103309	83478	9102-W	4		
8	Tilt stand	3153-163386	89536	3153-163386	1		
9	Line Cord	6005-161638	89536	6005-161638	1		

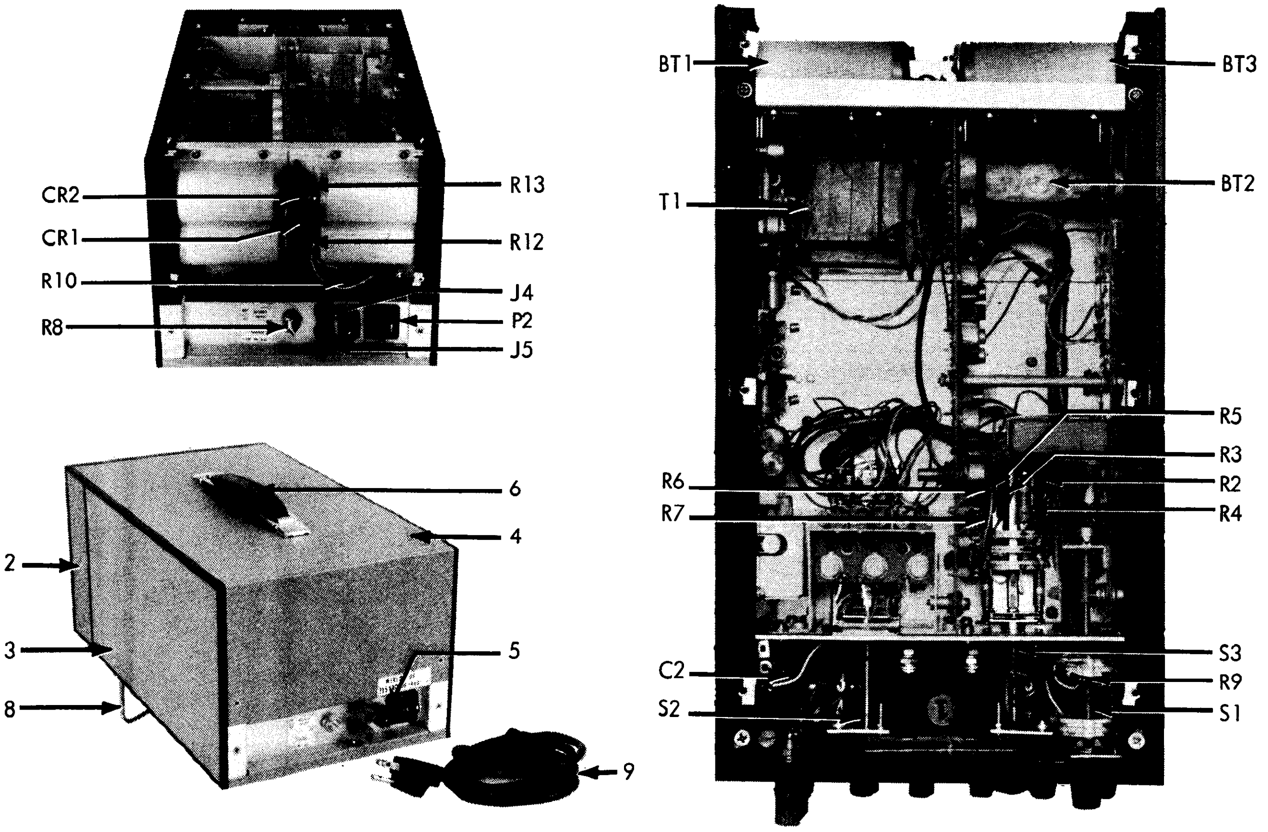


Figure 5-2. CHASSIS ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A2	**FRONT PANEL ASSEMBLY-Figure 5-3**						
C1	Cap, plstc, 0.01 uf ±20%, 1000V	1507-159996	84411	663UW103010W	1		
C4*	Cap, elect, 640 uf -10/+50%, 6.4V	1502-178608	73445	C437ARC640	1		
J1, J2	Binding post, red	2811-149856	58474	BHB10208G22	2		
J3	Binding post, black	2811-149864	58474	BHB10208G21	1		
M1	Meter, 100-0-100 ua 887A (not illustrated) 887AB	 2901-201236 2901-201244	 89536 89536	 2901-201236 2901-201244	 1 1		
R14*	Res, comp, 270Ω ±10%, 1/2W	4704-108241	01121	EB2711	1		
10	Knob, NULL and RANGE	2405-158956	89536	2405-158956	2		
11	Knob, POWER	2405-162347	89536	2405-162347	1		
12	Knob, voltage	2405-158949	89536	2405-158949	6		
13	Null-Range shutter	3156-162263	89536	3156-162263	1		
14	Nylon bushing	2502-160499	96881	AL2-FF	9		
15	Panel, front	1406-162289	89536	1406-162289	1		
16	Decal, front panel 887A (not illustrated) 887AB	 1406-195396 1406-195511	 89536 89536	 1406-195396 1406-195511	 1 1		
17	Shorting link	2811-101220	24655	Type 938L	1		

* C4 and R14 provide meter damping. On some instruments, a different meter is used not requiring external damping. The above listing is the preferred replacement, which requires no damping.

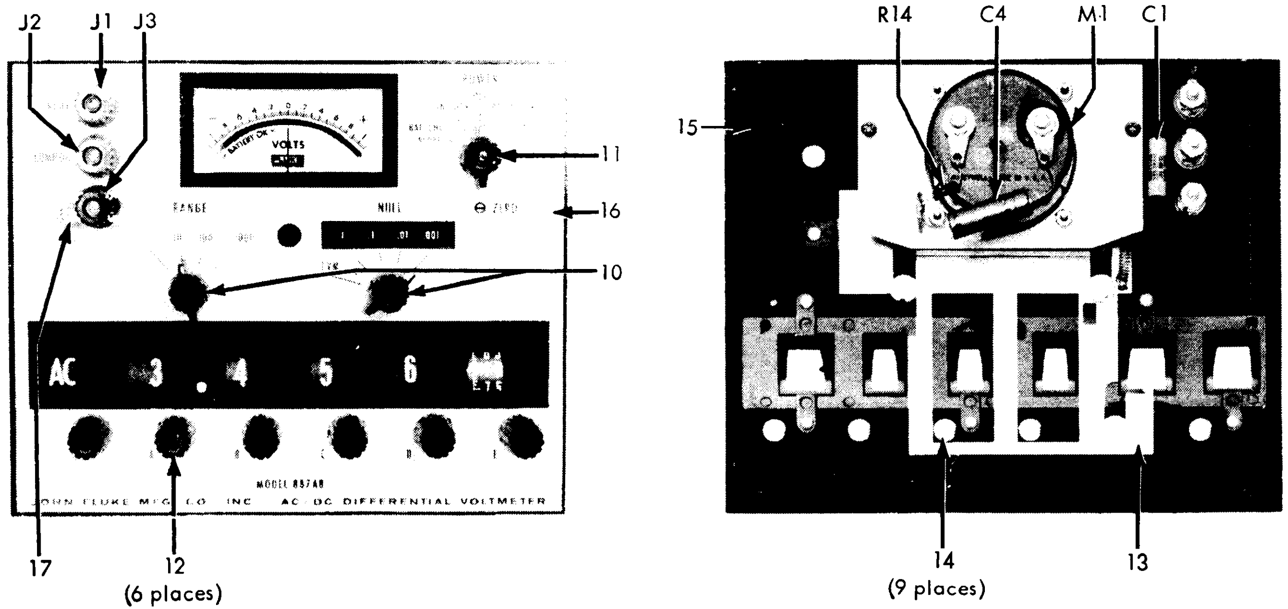


Figure 5-3. FRONT PANEL ASSEMBLY

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A100	**REFERENCE SUPPLY ASSEMBLY-Figure 5-4**	1702-195453 (887A-401)	89536	1702-195453	1		
A101	Zener Diode Oven Assembly Figure 5-5	1702-232728 (887A-405)	89536	1702-232728	1		B
	1 Volt-Divider Set	1702-180901	89536	1702-180901	1		
R121	Res, WW, 49.488K	1					
R123	Res, WW, 6.111K	1					
	Input-Divider Set	4710-195487	89536	4710-195487	1		
R100, R101, R102	Res, WW, 3.3M	1					
R104	Res, WW, 100.05K	1					
	Zener-Resistor Set	4807-176123	89536	4807-176123	1		A
CR103, CR104	Diode, zener	2					A
R109	Res, WW, 8K	1					
R110	Res, WW, 16.5 - 20.4K	1					
R117	Res, WW, 675-830Ω	1					
R119	Res, WW, 6-10K	1					
C101	Cap, elect, 500 uf -10/+50%, 15V	1502-160101	56289	34D507G015FJ2	1	1	
C102	Cap, elect, 250 uf -10/+50%, 64V	1502-185850	73445	C437ARH250	1	1	
C103	Cap, mylar, 0.022uf ±10%, 75v	1507-159400	56289	192P2239R8	1		
C104	Cap, mylar, 0.22uf ±10%, 75V	1507-159392	56289	192P2249R8	2		
C105, C106	Cap, Ta elect, 2.2 uf ±10%, 20V	1508-160226	05397	K2R2C20K	5		
C107	Cap, mylar, 0.22uf ±10%, 75V	1507-159392	56289	192P2249R8	REF		
CR101, CR102	Diode, type 1N4817	4802-116111	05227	1N4817	REF		
CR105	Diode, zener, type 1N961A	4803-113324	07910	1N961A	1	1	
Q101	Tstr, Continental Devices, type CDQ10656	4805-203489	07910	CDQ10656	7	2	
Q102	Tstr, type 2N1303	4805-148619	01295	2N1303	1	1	
Q103	Tstr, matched pair	4805-182246	89536	4805-182246	1	1	
Q104	Tstr, T.I., type SM6419	4805-190389	01295	SM6419	1	1	
Q105	Tstr, type 2N404	4805-163188	01295	2N404	1	1	
Q106, Q107	Tstr, type 2N1307	4805-148643	01295	2N1307	2	1	

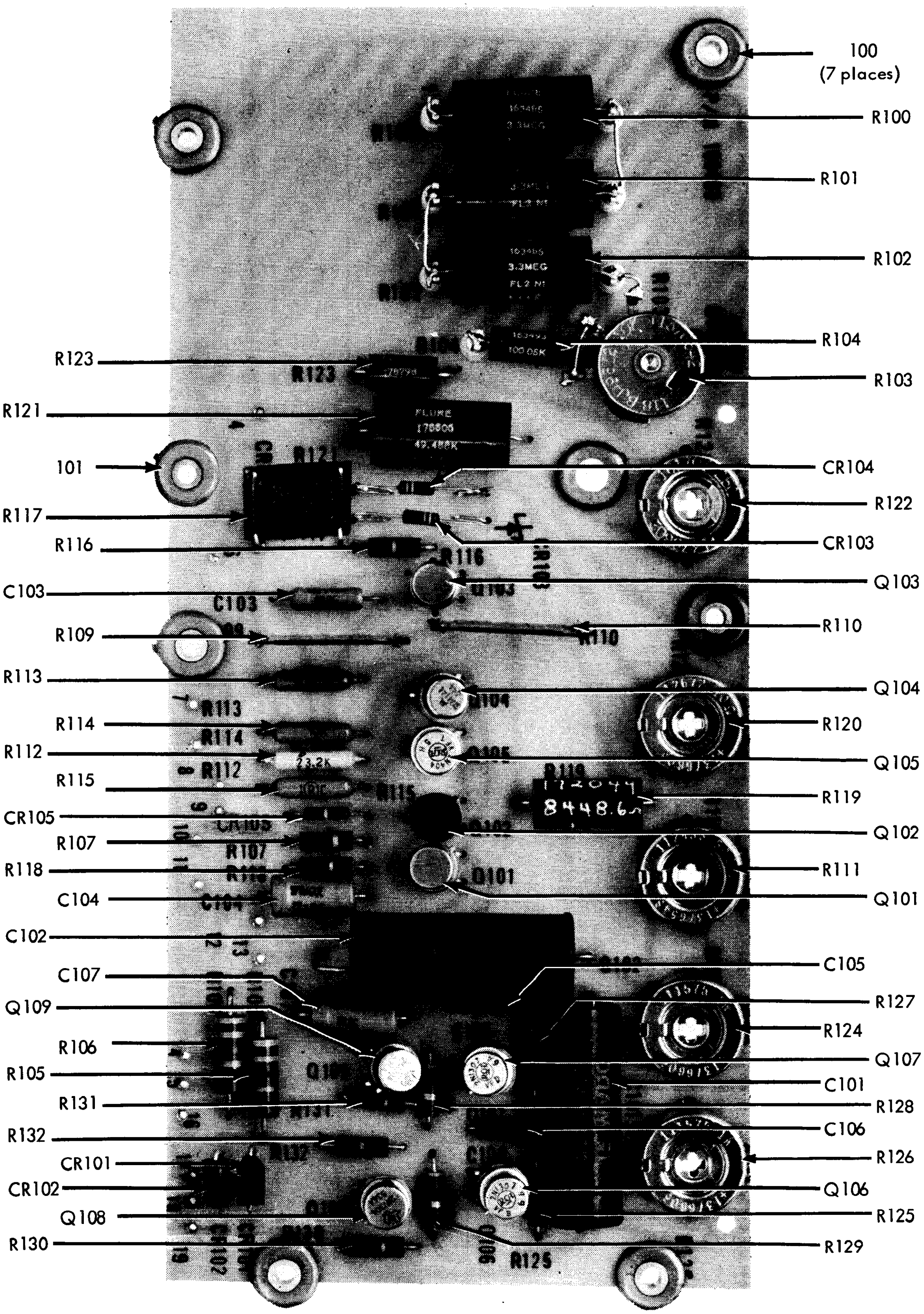


Figure 5-4. REFERENCE SUPPLY ASSEMBLY

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q108, Q109	Tstr, type 2N1304	4805-117127	01295	2N1304	2	1	
R103	Res, var, WW, 10K ±10%, 2W	4702-163147	71450	Type 118	1		
R105	Res, comp, 33Ω ±5%, 1W	4704-163063	01121	GB3305	1		
R106	Res, comp, 330Ω ±5%, 1W	4704-163394	01121	GB3315	1		A
	Res, comp, 150Ω ±5%, 1W	4704-178566	01121	GB1515			B
R107	Res, comp, 1.8M ±10%, 1/2W	4704-108720	01121	EB1851	1		
R111	Res, var, WW, 500Ω ±20%, 1 1/4W	4702-112433	71450	Type 110	1		
R112	Res, met flm, 23.2K ±1%, 1/2W	4705-159459	75042	Type CEC-T0	3		
R113	Res, met flm, 8.06K ±1%, 1/2W	4705-159467	75042	Type CEC-TO	1		
R114	Res, met flm, 10K ±1%, 1/2W	4705-151274	75042	Type CEC-TO	2		
R115	Res, met flm, 23.2K ±1%, 1/2W	4705-159459	75042	Type CEC-TO	REF		
R116	Res, comp, 5.6K ±10%, 1/2W	4704-108324	01121	EB5621	1		
R118	Res, comp, 10Ω ±10%, 1/2W	4704-108092	01121	EB1001	1		
R120	Res, var, WW, 10Ω ±10%, 1 1/4W	4702-112672	71450	Type 110	1		
R122	Res, var, WW, 25Ω ±10%, 1 1/4W	4702-161703	71450	Type 110	1		
R124	Res, var, WW, 1K ±20%, 1 1/4W	4702-111575	71450	Type 110	3		
R125	Res, comp, 2.7K ±5%, 1/2W	4704-109074	01121	EB2725	3		
R126	Res, var, WW, 1K ±20%, 1 1/4W	4702-111575	71450	Type 110	REF		
R127	Res, comp, 2.7K ±5%, 1/2W	4704-109074	01121	EB2725	REF		
R128, R129	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	2		
R130, R131	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	5		
R132	Res, comp, 82Ω ±5%, 1/2W	4704-108746	01121	EB8205	1		E
	Res, comp, 2.7Ω ±10%, 1/2W	4704-108845	01121	EB27G1	1		F
100	Polyethelene grommet	2807-171876	89536	2807-171876	13		
101	Polyethelene grommet	2807-171884	89536	2807-171884	1		

[1] This resistor is factory selected for each instrument. When ordering, include all information on old resistor and/or information on the Reference Supply Board decal.

[2] Factory selected. If replacement is required, replace with a new Zener-Resistor Set.

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	NOTE: The Zener Diode Oven Assembly is installed for serial numbers 618 thru 659 and 691 and on.						
A101	**ZENER DIODE OVEN ASSEMBLY** **Figure 5-5**	1702-232728 (887A-405)	89536	1702-232728	1		B
A102	Zener Diode Oven	5301-232462	89536	5301-232462	1		B
CR103 CR104	Diode, zener, factory selected (not illustrated)	▷1					B
R147	Res, factory selected (not illustrated)	▷1					B
R155	Thermistor, factory selected (not illustrated)	▷1					B
C113	Cap, disc, cer, .01 ±20%, 100V	1501-149153	56289	C023B101F103M	1		B
Q111	Tstr, NPN, silicon	4805-203489	07910	CDQ10656	REF		B
Q112 Q113	Tstr, type 2N3906	4805-195974	04713	2N3906	2		B
R148 R149	Res, comp 3.9K ±5%, 1/4W	4704-148064	01121	CB3925	3		B
R150	Res, met flm, 66.5K ±1%, 1/2W	4705-187955	75042	Type CEC-TO	2		B
R151	Res, comp, 2.7K ±5%, 1/4W	4704-170720	01121	CB2725	1		B
R152	Res, comp, 3.9K ±5%, 1/4W	4704-148064	01121	CB3925	REF		B
R153	Res, met flm, 66.5K ±1%, 1/2W	4705-187955	75042	Type CEC-TO	REF		B
R154	Res, met flm, 23.2K ±1%, 1/2W	4705-159459	75042	Type CEC-TO	REF		B

▷1 If replacement is required, replace with complete Zener Diode Oven, part number 5301-232462, which also includes R109, R110, R117 and R119.

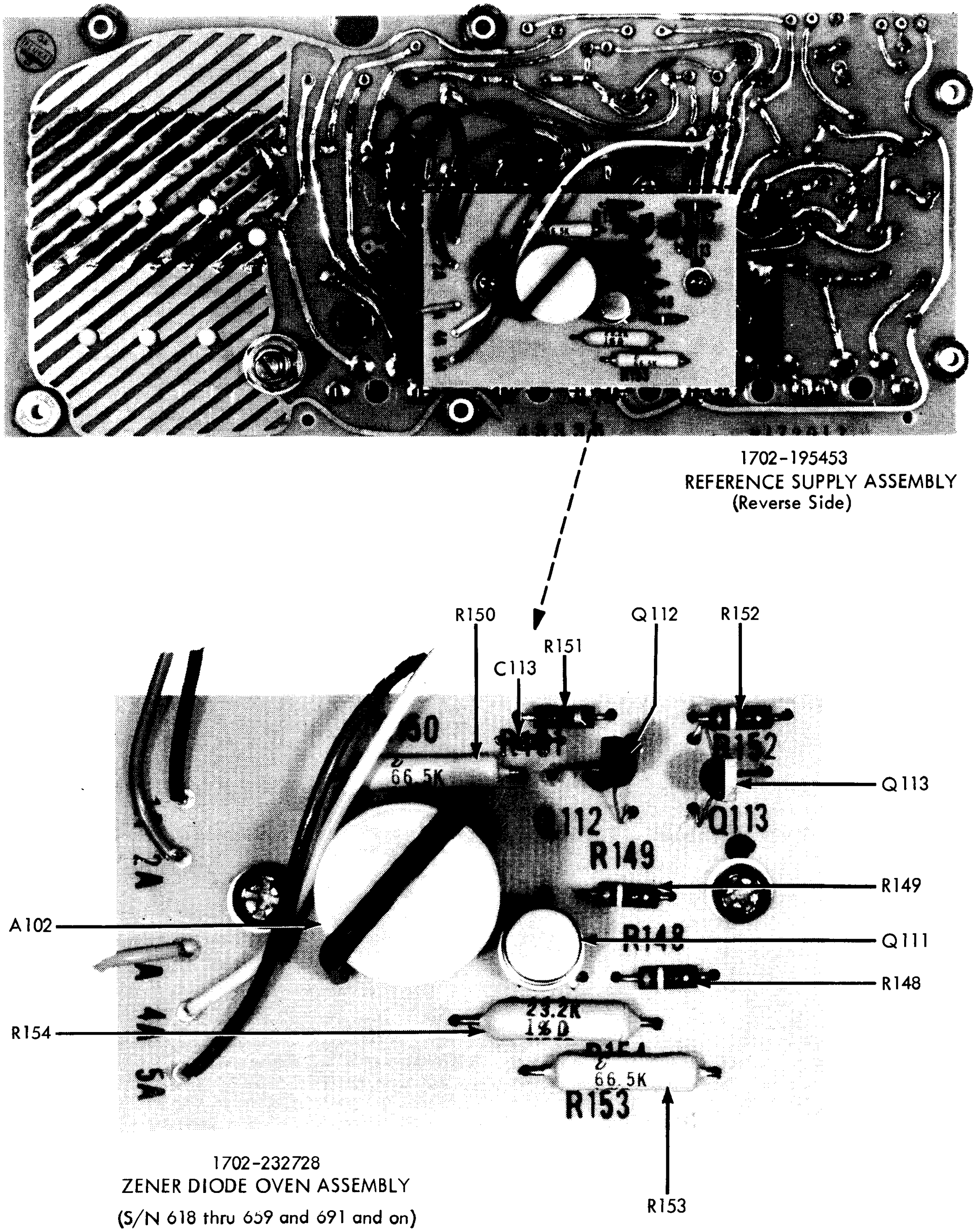


Figure 5-5. ZENER OVEN DIODE ASSEMBLY

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A200	**NULL DETECTOR ASSEMBLY-Figure 5-6**	1702-163212 (881A-402)	89536	1702-163212	1		
C201 Thru C203	Cap, plstc, 0.22 ±10%, 75V (specially treated)	1507-162768	89536	1507-162768	3		
C204	Cap, plstc, 0.047 uf ±20%, 100V	1507-106096	84411	663UW47301	1		
C205	Cap, Al elect, 100 uf -10/+75%, 25V	1502-106518	56289	30D107G025DH4	2	1	I
	Cap, Al elect, 50 uf +50/-10%, 25V	1502-168823	73445	C426ARF50	2	1	J
C206	Cap, Al elect, 40 uf -10/+75%, 6V	1502-105205	56289	30D406G006BB4	1	1	I
	Cap, Al elect, 50 uf +50/-10%, 25V	1502-168823	73445	C426ARF50	REF		J
C207	Cap, Al elect, 5 uf -10/+75%, 25V	1502-152009	56289	30D505G025BA4	2	1	I
	Cap, plstc, 0.47 uf ±20%, 250V	1507-184366	73445	C280AE/P470K	1		J
C208, C209	Cap, Al elect, 100 uf -10/+75%, 25V	1502-106518	56289	30D107G025DH4	1	1	
C210	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	3		
C211	Cap, Al elect, 200 uf -10/+75%, 6V	1502-105189	56289	30D207G006DF4	1	1	
C212	Cap, plstc, 0.0047 uf ±20%, 200V	1507-106054	84411	663UW47202	1		
C213	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	30D206G050DC4	3	1	
C214	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	REF		
C215	Cap, Al elect, 500 uf -10/+75%, 3V	1502-106328	56289	30D507G003DH4	2		
C216	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	REF		
C217	Cap, Al elect, 5 uf -10/+75%, 25V	1502-152009	56289	30D505G025BA4	1	1	
C218	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	30D206G050DC4	REF		
C219	Cap, Al elect, 500 uf -10/+75%, 3V	1502-106328	56289	30D507G003DH4	REF		
C220	Cap, Ta elect, 2.2 uf ±10%, 20V	1508-160226	05397	K2R2C20K	REF		
CR201 CR202	Diode, Continental Devices, type CD13161	4802-113308	07910	CD13161	2	1	
DS201	Lamp, neon, type NE2E (specially treated)	3902-162776	89536	3902-162776	1	1	
G201	Chopper, mechanical, SPDT (specially treated)	5901-162784	89536	5901-162784	1	1	D
	Chopper, electromechanical, SPDT	5901-218255	80640	CH1403/84	1	1	F
Q201	Tstr, field effect, P-channel	4805-159210	17856	U-112	1	1	G
	Tstr, field effect, P-channel	4805-216978	15818	P-1027	1	1	H
Q202 thru Q205	Tstr, Continental Devices, type CDQ10656	4805-203489	07910	CDQ10656	REF		
Q206	Tstr, type 2N1372	4805-116129	01295	2N1372	1		
Q207	Tstr, silicon, PNP	4805-242016	11726	QD401-78E	1	1	J
R201	Res, comp, 220K ±10%, 2W	4704-110197	01121	HB2241	1		

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R202, R203	Res, comp, 220K ±10%, 1/2W	4704-108217	01121	EB2241	2		
R204	Res, comp, 1M ±10%, 1/2W	4704-108134	01121	EB1051	2		
R205	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	4		
R206	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		I
	Res, comp, 2K ±5%, 1/2W	4704-169854	01121	EB2025	1		J
R207	Res, met flm, 8.06K ±1%, 1/2W	4705-159467	75042	Type CEC-TO	REF		I
	Res, met flm, 15.8K ±1%, 1/2W	4705-171983	75042	Type CEC-TO	1		J
R208	Res, var, WW, 5K ±5%, 2W	4702-111609	71450	Type 115	1		I
	Res, comp, 33K ±5%, 1/4W	4704-148155	01121	CB3335	1		J
R209	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	2		
R210	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	EB1821	2		
R211	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	2		
R212	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		
R213	Res, comp, 6.8K ±10%, 1/2W	4704-108399	01121	EB6821	1		
R214	Res, comp, 180Ω ±10%, 1/2W	4704-108571	01121	EB1811	1		
R215	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	EB1531	2		
R216	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	REF		
R217	Res, comp, 9.1K ±5%, 1/2W	4704-160028	01121	EB9125	1		
R218	Res, comp, 27K ±10%, 1/2W	4704-108878	01121	EB2731	2		
R219	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	EB1821	REF		
R220	Res, comp, 39Ω ±10%, 1/2W	4704-160036	01121	EB3901	1		
R221	Res, comp, 7.5K ±5%, 1/2W	4704-108910	01121	EB7525	1		
R222	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	REF		
R223	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	REF		
R224	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		
R225	Res, comp, 3.9K ±10%, 1/2W	4704-161406	01121	EB3921	1		
R226 R227	Res, comp, 47K ±10%, 2W	4704-110015	01121	HB4731	2		
R228	Res, comp, 1.5K ±10%, 1/2W	4704-108159	01121	EB1521	1		
R229	Res, met flm, 402Ω ±1%, 1/2W	4705-150839	75042	Type CEC-TO	1		G
	Res, met flm, 453Ω ±1%, 1/2W	4705-155051	75042	Type CEC-TO	1		H
R230	Res, var, WW, 100Ω ±20%, 1-1/4W	4702-112797	71450	Type 110	1		
R231	Res, var, WW, 10K ±5%, 2W	4702-112862	71450	Type 110	2		
R232	Res, met flm, 90.9K ±1%, 1/2W	4705-162974	75042	Type CEC-TO	1		

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R233	Res, met flm, 909K ±1%, 1/2W	4705-159483	75042	Type CEC-TO	1		
R234	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	REF		
R235	Res, met flm, 8.45K ±1%, 1/2W	4705-159475	75042	Type CEC-TO	1		
R236	Res, met flm, 200Ω ±1%, 1/2W	4705-151480	75042	Type CEC-TO	1		
R237	Res, comp, 6.8M ±10%, 1/2W	4704-108662	01121	EB6851	1		
R238	Res, comp, 56K ±10%, 1/2W	4704-108472	01121	EB5631	1		
R239	Res, var, comp, 100K ±30%, 3/10W (mounted on back of board)	4704-163402	71450	Type 70	1		
R240	Res, comp, 180K ±10%, 1/2W	4704-108431	01121	EB1841	1		
200	Polyethelene grommet	2807-171876	89536	2807-171876	REF		

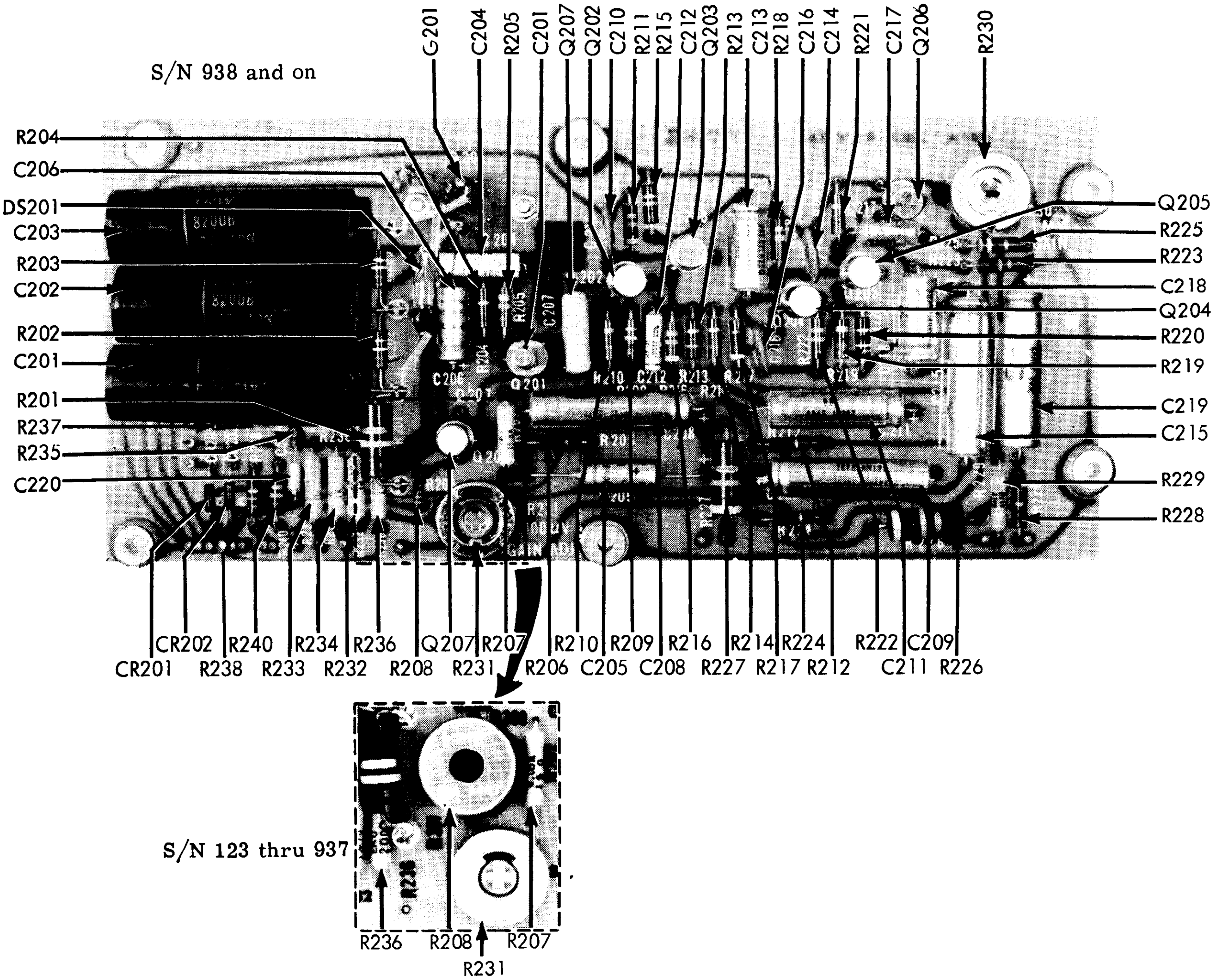


Figure 5-6. NULL DETECTOR ASSEMBLY

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A300	**KELVIN-VARLEY ASSEMBLY-Figure 5-7**	5111-180844 (885A-403)	89536	5111-180844	1		
C301	Cap, plstc, 1 uf ±20%, 200V	1507-106450	82376	RLR-21M	1		
R301	Res, var, WW, 25K ±10%, 5W	4702-182634	71450	Type UPM-AW	2		
R302	Res, WW, 500K ±1%, 1W Res, WW, 500K, 1W	4707-177063 4707-192773	80031 89536	Type WM4SF 4707-192773	2 2		M N
R303	Res, comp, WW, 5.05K ±0.02%, 3/4W	▷1					
R304	Res, var, WW, 25K ±10%, 5W	4702-182634	92376	Type UPM-AW	REF		
R305	Res, WW, 500K ±1%, 1W Res, WW, 500K, 1W	4704-177063 4707-192773	80031 89536	Type WM4SF 4707-192773	REF REF		M N
R306	Res, WW, 5.05K ±0.02%, 3/4W	▷1					
Odd No From R307 to R325	Res, var, WW, 2Ω ±10%, 2W	4702-182410	71450	Type 115 Special	12		
Even No. From R308 to R326	Res, WW, 5K +0.01/-0.03%, 3/4W	▷1					
R327 thru R337	Res, WW, 1K +0.02/-0.018%, 1/4W	▷1					
R338	Res, var, WW, 2Ω ±10%, 2W	4702-182410	71450	Type 115 Special	REF		
R339	Res, WW, 2.499K ±0.02%, 1/2W	▷1					
R340 thru R350	Res, WW, 1K ±0.04%, 1/2W	▷1					
R351	Res, var, WW, 2Ω ±10%, 2W	4702-182410	71450	Type 115 Special	REF		
R352	Res, WW, 2.499K ±0.02%, 1/2W	▷1					
R353 thru R363	Res, WW, 1K ±0.04%, 1/2W	▷1					
R364	Res, var, WW, 1K ±20%, 1-1/4W	4702-111575	71450	Type 110	REF		
R365	Res, met flm, 9.35K ±1%. 1/2W (not illustrated)	4705-159442	75042	Type CEC-TO	1		
R366	Res, var, WW, 2.5K ±0.05%	4711-163154	89536	4711-163154	1		
S5	Switch, rotary, 2 pol, 11 pos, 2 section	5105-162644	89536	5105-162644	1		

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
S6	Switch, rotary, 2 pol, 10 pos, 2 section	5105-162636	89536	5105-162636	2		
S7	Switch, rotary, 2 pol, 2 pos, 2 section	5105-162651	89536	5105-162651	1		
S8	Switch, rotary, 2 pol, 10 pos, 2 section	5105-162636	89536	5105-162636	REF		

1▷ These resistors are factory matched. When ordering, include all information stamped on old resistor, model, serial number and reference designation.

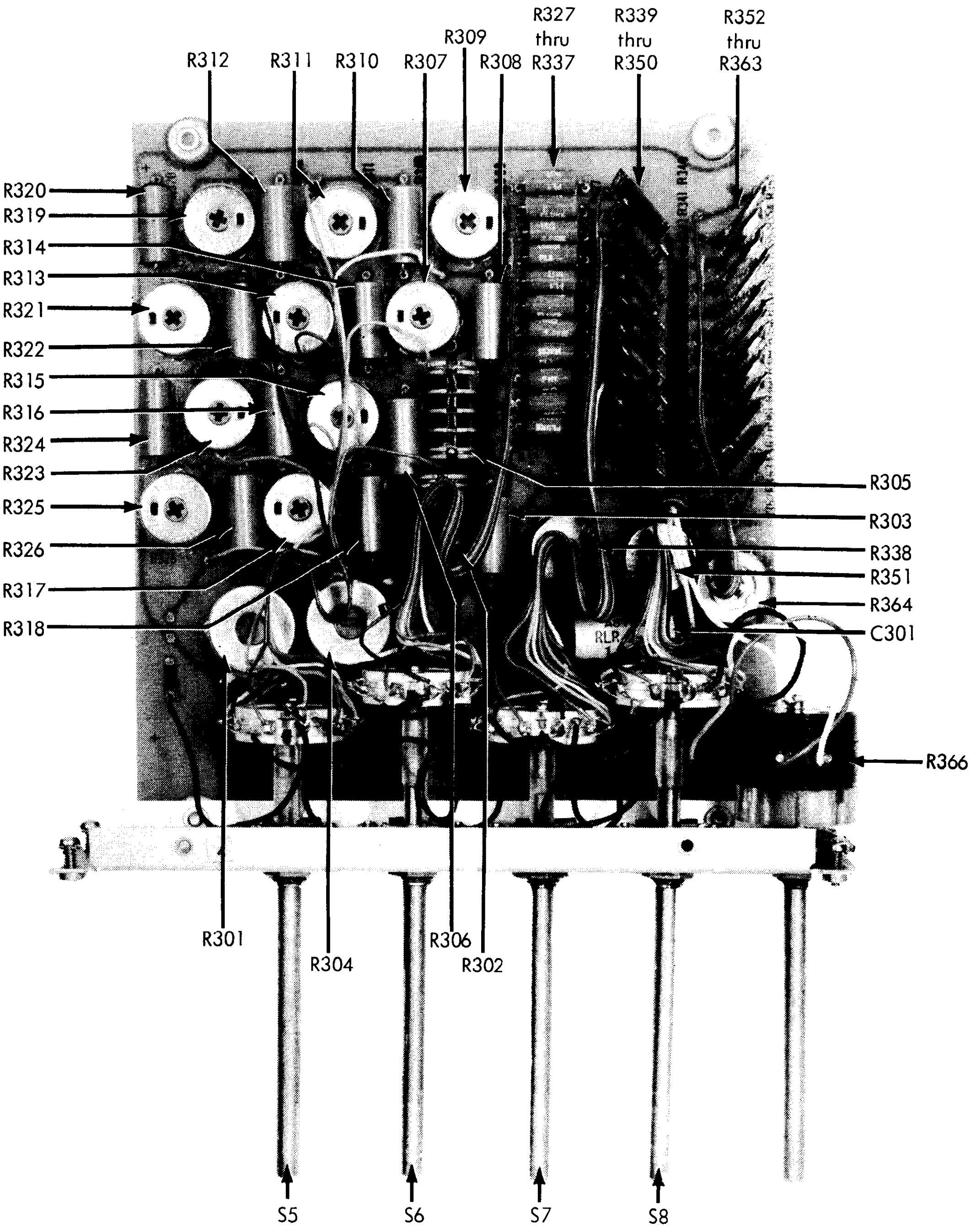


Figure 5-7. KELVIN-VARLEY ASSEMBLY

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A400	**ATTENUATOR ASSEMBLY-Figure 5-8**	1702-195461 (887A-402)	89536	1702-195461	1		
	Resistor Set	4705-159814	89536	4705-159814	1		
R401	Res, met flm, 900K	▷1					
R402	Res, met flm, 109K	▷1					
	Resistor Set	4705-159830	89536	4705-159830	1		
R404	Res, met flm, 990K	▷1					
R405	Res, met flm, 9.88K	▷1					
	Resistor Set	4705-159806	89536	4705-159806	1		
R407, R408	Res, met flm, 500K	▷1					
R409	Res, met flm, 976Ω	▷1					
C401	Cap, var alumina, 1.0 +010 pf, 400V	1509-188698	91273	JMC2903	4		
C402	Cap, cer, 15 pf ±10%, 500V	1501-159947	00656	Type C1-1	2		
C403	Cap, var alumina, 1.0 to 10 pf, 400V	1509-188698	91273	JMC2903	REF		
C404	Cap, mica, 150 pf ±5%, 500V	1504-148478	88419	CD15F151J	1		
C405	Cap, var alumina, 1.0 to 10 pf, 400V	1509-188698	91273	JMC2903	REF		
C406	Cap, cer, 5.1 pf ±5%, 1100V	1501-187682	00656	C1-2	2		
C407	Cap, mica, 3,000 pf ±5%, 500V	1504-161786	88419	CD19F302J	1		
R403	Res, var, met flm, 5K ±20%, 3/4W	4701-159905	73138	Type 78P	1		
R406	Res, var, met flm, 500Ω ±20%, 3/4W	4701-159897	73138	Type 78P	1		
R410	Res, var, met flm, 100Ω ±20%, 3/4W	4701-159889	73138	Type 78B	1		
R411	Res, comp, 82K ±5%, 1/4W	4704-188458	01121	CB8235	1		

▷1 Factory selected. If replacement is required, replace with new resistor set.

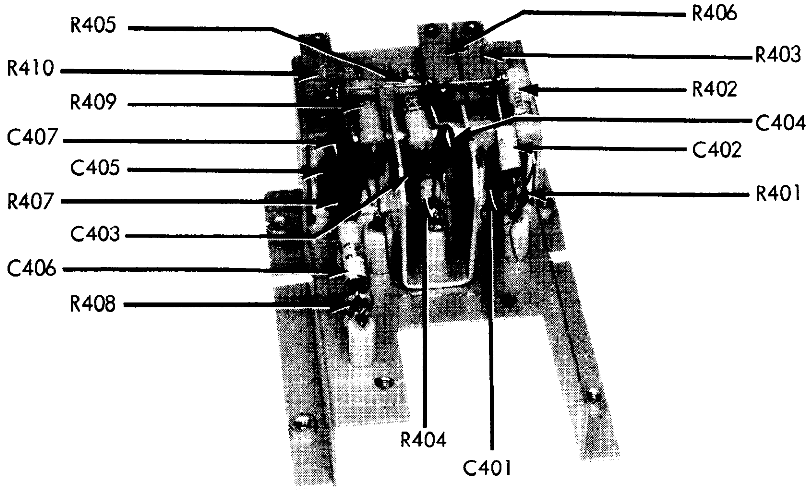


Figure 5-8. ATTENUATOR ASSEMBLY

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A500	**CONVERTER BOARD ASSEMBLY** **Figure 5-9**	1702-166058 (883A-401)	89536	1702-166058	1		
	Resistor Set	4705-159822	89536	4705-159822	1		
R501	Res, met flm, 1M ±1%, 1W	▷1					
R502	Res, met flm, 246K ±1/2%, 1W	▷1					
C501	Cap, cer, 5.0 pf ±5%, 1100V	1501-187682	00656	Type C1-2	REF		
C502	Cap, var, alumina, 1.0 to 10 pf, 400V	1509-188698	91273	JMC2903	REF		
C503	Cap, cer, 15 pf ±10%, 500V	1501-159947	00656	Type C1-1	REF		
C504	Cap, plstc, 5 uf ±20%, 20V	1507-160952	00656	V-146-ZR	1		
C505	Cap, Al. elect, 30 uf +75/-10%, 15V	1502-106492	56289	30D306G015CB4	2	1	
C506	Cap, Al. elect, 250 uf +75/-10%, 12V	1502-160002	56289	30D275G012DH4	2	1	
C507	Cap, mica, 33 pf ±5%, 500V	1504-160317	88419	CD15E330J	1		
C508	Cap, Ta. elect, 68 uf ±20%, 6V	1508-160242	05397	K68P6	1	1	
C509	Cap, mica, 22 pf ±5%, 500V	1504-148551	88419	CD15E220J	1		A
	Cap, mica, 10 pf ±10%, 500V	1504-175216	88419	CD15C0100K	1		B
C510	Cap, Al. elect, 250 uf +75/-10%, 12V	1502-160002	56289	30D275G012DH4	REF		
C511	Cap, Ta. elect, 10 uf ±10%, 20V	1508-160259	05397	K10C20K	1	1	
C512	Cap, plstc, 0.001 uf ±10%, 200V	1507-159582	56289	192P10292	1		
C513	Cap, Ta. elect, 2.2 uf ±10%, 20V	1508-160226	05397	K2R2C20K	REF		
C514	Cap, Ta. elect, 150 uf ±10%, 6V	1508-160234	05397	K150C6K	1	1	
C516	Cap, plstc, 0.00047 uf ±10%, 200V	1507-159574	56289	192P47192	1		A
	Cap, mica. 1500 pf ±5%, 500V	1504-148361	88419	CD19F152J	1		B
C517	Cap, Ta. elect, 150 uf +20/-15%, 1.5V	1508-160945	56289	109D157C2015TO	1	1	
C518,	Cap, plstc, 2 uf ±20%, 10V	1507-160960	00656	V-146-ZR	2		M
C519	Cap, plstc, 2 uf ±10%, 200V	1507-106443	84411	Type X663F	2		N
C520	Cap, Al. elect, 50 uf +75/-10%, 50V	1502-105122	56289	30D506G050DH4	1	1	
C521	Cap, Ta. elect, 2.2 uf ±10%, 20V	1508-160226	05397	K2R2C20K	REF		
C522	Cap, Al. elect, 30 uf +75/-10%, 15V	1502-106492	56289	30D306G015CB4	REF		
C523	Cap, Al. elect, 20 uf +75/-10%, 50V	1502-106229	56289	30D206G050DC4	REF		
CR501	Diode, Transitron type SG5337	4802-161810	03877	SG5337	3	1	M
	Diode, silicon, 100ma at 1.5V, 40 piv	4802-261370	22767	S1330	1	1	N
CR502	Diode, Zener, 6.8V, Continental Devices type CD36554	4803-187195	07910	CD36554	1	1	C
	Diode, Zener, 6.2V	4803-180497	07910	1N753	1	1	D
CR503, CR504	Diode, Transitron type SG5337	4802-161810	03877	SG5337	2	1	

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
CR505	Diode, type 1N4817	4802-116111	05277	1N4817	REF		
CR506	Diode, Zener, 6.8V	4803-187195	07910	CD36554	1		
CR507	Diode, type 1N4817	4802-116111	05277	1N4817	REF		
Q501	Tstr, field effect, N-channel	4805-166223	15818	U-1249	1	1	
Q502	Tstr, C. D. type CDQ23102 Tstr, NPN, silicon	4805-159855 4805-218081	07910 04713	CDQ23102 MPS6520	5 1	 1	C D
Q503 thru Q506	Tstr, C. D. type CDQ23102	4805-159855	07910	CDQ23102	4	1	
Q507	Tstr, T. I. type SM6419 Tstr, silicon, PNP	4805-190389 4805-246462	01295 07263	SM6419 2N4356	REF 2		K L
Q508	Tstr, C. D. type CDQ10656	4805-203489	07910	CDQ10656	REF		
Q509	Tstr, T. I. type SM6419 Tstr, silicon, PNP	4805-190389 4805-246462	01295 07263	SM6419 2N4356	REF REF		K L
R503	Res, var, mf, 10K ±20%	4701-159913	73138	Type 78P	1	1	
R504	Res, WW, 125Ω ±1%, 1/4W	4707-159764	15909	Type R1136	1		
R505	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		
R506	Res, comp, 1M ±10%, 1/2W	4704-108134	01121	EB1051	REF		
R507	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	REF		
R508	Res, var, WW, 10K ±20%, 1-1/4W	4702-112862	71450	Type 110	REF		
R509	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	EB1035	4		
R510	Res, comp, 56K ±10%, 1/2W Res, comp, 33K ±10%, 1/2W	4704-108472 4704-178541	01121 01121	EB5631 EB3331	REF 1		C D
R511	Res, comp, 16K ±5%, 1/2W	4704-159632	01121	EB1635	1		
R512	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	EB1035	REF		
R513	Res, comp, 270Ω ±5%, 1/2W	4704-159616	01121	EB2715	1		
R514	Res, comp, 2.7K ±5%, 1/2W	4704-109074	01121	EB2725	REF		
R515	Res, comp, 8.2Ω ±5%, 1/2W	4704-159590	01121	EB82G5	1		
R516	Res, comp, 68K ±5%, 1/2W	4704-159624	01121	EB6835	1		
R517	Res, comp, 27K ±10%, 1/2W	4704-108878	01121	EB2731	REF		
R518	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	EB3321	1		
R519	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	EB1531	REF		
R520	Res, comp, 470Ω ±5%, 1/2W	4704-108787	01121	EB4715	2		
R520	Res, comp, 220Ω±5%, 1/2W	4704-186031	01121	EB2225	1		O
R521	Res, comp, 62K ±5%, 1/2W	4704-108522	01121	EB6235	REF		P
R522	Res, var, 100K ±30%, 1/2W	4701-160010	71450	Type UPE70	1		
R523	Res, comp, 300Ω ±5%, 1/2W	4704-108829	01121	EB3015	1		
R524	Res, comp, 47Ω ±5%, 1/2W	4704-159608	01121	EB4705	1		

REF DESIG	DESCRIPTION	FLUKE PART NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R525	Res, comp, 470Ω ±5%, 1/2W	4704-108787	01121	EB4715	REF		
R526	Res, comp, 330Ω ±5%, 1/2W	4704-108936	01121	EB3315	2		A
	Res, comp, 150Ω ±5%, 1/2W	4704-186056	01121	EB1515	1		B
R527	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	EB1041	REF		
R528	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	EB1041	1		
R529	Res, comp, 2.7K ±10%, 1/2W	4704-108837	01121	EB2721	1		
R530, R531	Res, WW, 547Ω ±0.1%, 1/4W	4707-159772	15909	Type R1136	2	1	
R532, R533	Res, met flm, 51.1K ±1%, 1/2W	4705-159665	75042	Type CEC-TO	1		
R534	Res, comp, 330Ω ±5%, 1/2W	4704-108936	01121	EB3315	1		
R535	Res, comp, 2.2K ±5%, 1/2W	4704-108506	01121	EB2225	1		
R536	Res, comp, 1.5M ±10%, 1/2W	4704-108175	01121	EB1551	1		
R537	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	REF		
R538	Res, met flm, 10K ±1%, 1/2W	4705-151274	75042	Type CEC-TO	REF		
R539	Res, var, WW, 3K ±20%, 2W	4702-153429	71450	Type 115	1		
R540	Res, met flm, 5.11K ±1%, 1/2W	4705-159657	75042	Type CEC-TO	1		
R541	Res, comp, 1.1Ω ±5%, 1/2W	4705-163717	01121	EB11G5	1		
R542	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	EB1035	REF		
R543	Res, comp, 24K ±5%, 1/2W	4704-108654	01121	EB2435	1		
R544	Res, comp, 22M ±10%, 1/2W	4704-108233	01121	EB2261	1		
R545	Res, comp, 130Ω ±5%, 1W	4704-163055	01121	GB1315	1		

▷1 These resistors are factory matched. When ordering include all information stamped on old resistor, model, serial number and reference designation.

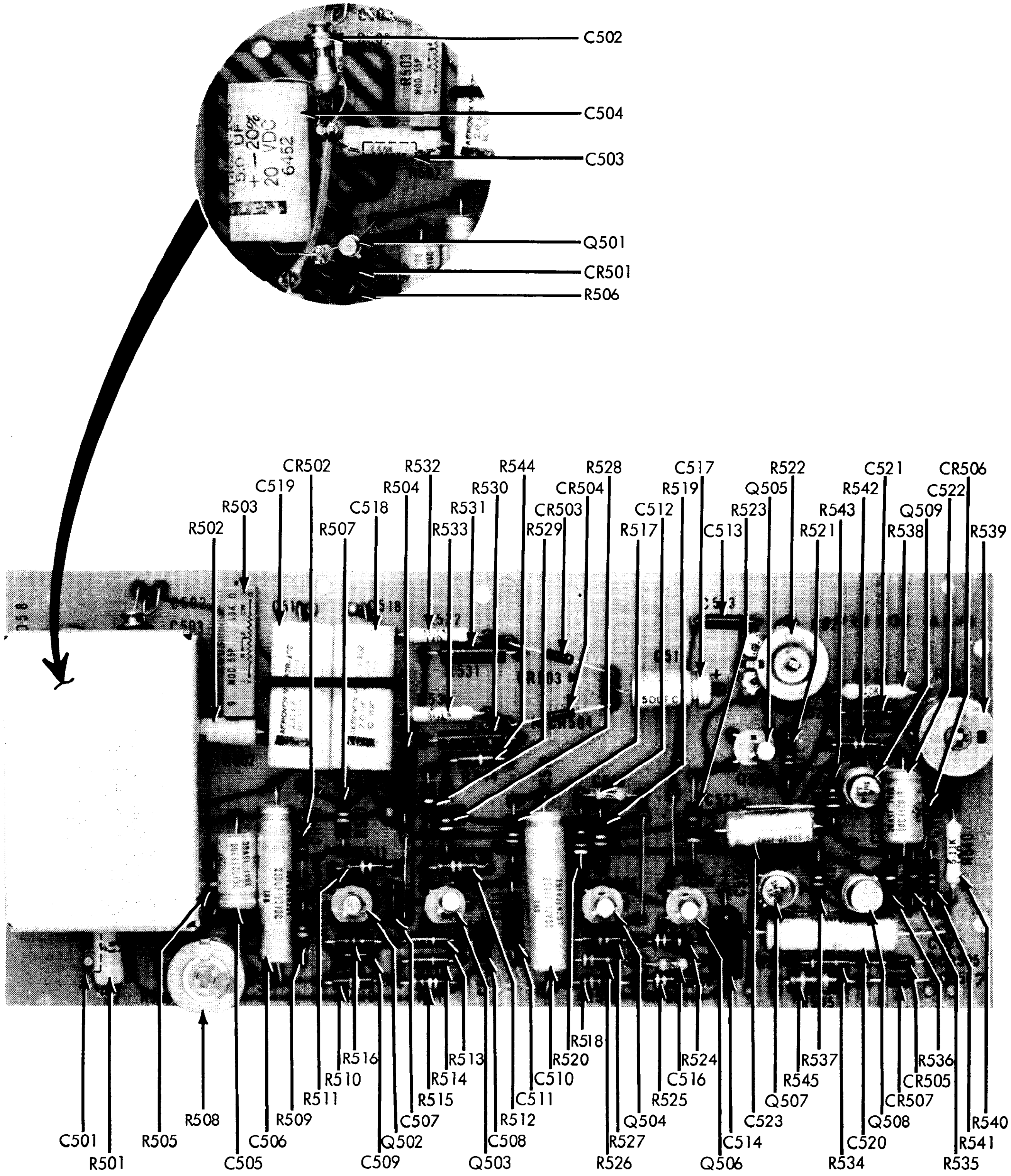


Figure 5-9. CONVERTER BOARD ASSEMBLY

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 887A & 887AB. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the 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.

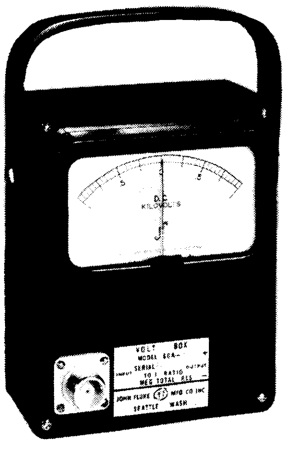
USE CODE	EFFECTIVITY
No Code	Model 887A and 887AB serial number 123 and on
A	Model 887A & 887AB serial number 123 to 617, 655 to 690.
B	Model 887A & 887AB serial number 618 to 656, 691 and on.
C	Model 887A & 887AB serial number 123 to 537.
D	Model 887A & 887AB serial number 538 and on.
E	Model 887A & 887AB serial number 123 to 435.
F	Model 887A & 887AB serial number 436 and on.
G	Model 887A & 887AB serial number 123 to 257.
H	Model 887A & 887AB serial number 258 and on.
I	Model 887A & 887AB serial number 123 to 937.
J	Model 887A & 887AB serial number 938 and on.
K	Model 887A & 887AB serial number 123 to 977.
L	Model 887A & 887AB serial number 978 and on.
M	Model 887A & 887AB serial number 123 to 1212.
N	Model 887A & 887AB serial number 1213 and on.
O	Model 887A serial number 123 to 2348. Model 887AB serial number 123 to 2769.
P	Model 887A serial number 2349 and on. Model 887AB serial number 2770 and on.

SECTION VI

ACCESSORIES

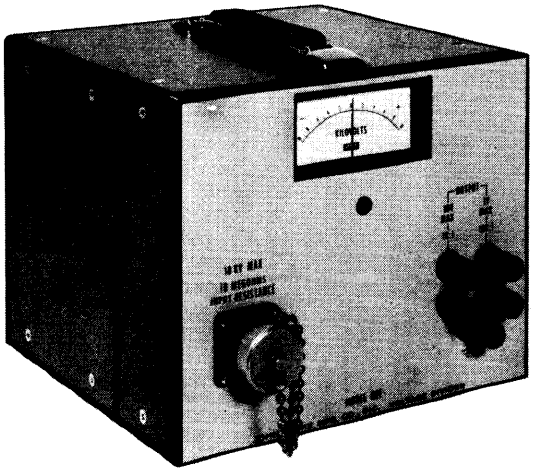
6-1. PRECISION VOLTAGE DIVIDERS

6-2. The FLUKE 80A, 80D, and 80E Voltage Dividers provide the FLUKE 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30, 000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80D dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80D and 80E models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.



MODEL 80A

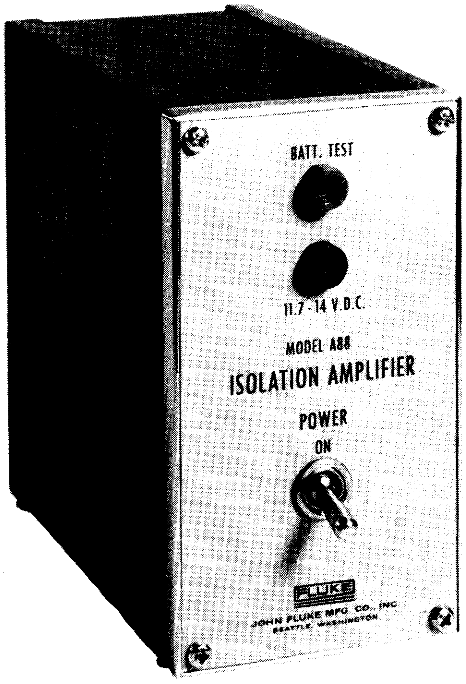
MODEL 80D



MODEL 80E

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio			Division Ratio Accuracy	Stability of Division Accuracy Per Year
				500V Out	10V Out	1V Out		
80A-1	1 KV	1 M	1 ma	2:1	——	——	±0.015%	——
80A-2	2 KV	2 M	1 ma	4:1	——	——	±0.015%	——
80E-5	5 KV	5 M	1 ma	—	500:1	5,000:1	±0.01%	±0.01%
80E-10	10 KV	10 M	1 ma	—	1000:1	10,000:1	±0.01%	±0.01%
80D-30	30 KV	30 M	1 ma	60:1	3000:1	30,000:1	±0.01%	±0.01%

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80E	7" high 8-1/2" wide 8" deep	MS3102A-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80D	13" high 9-3/4" wide 16" deep	Special 5" ceramic standoff with mating 6" guard supplied	Insulated binding post on 3/4" centers for both outputs



MODEL A88 ISOLATION AMPLIFIER

6-3. ISOLATION AMPLIFIER

6-4. The FLUKE Model A88 all solid-state isolation amplifier is designed to provide isolation between the output of a differential voltmeter and the input of a recorder. Thus, the A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder. The A88 is also excellent for making accurate dc microvolt and nanoampere measurements in the presents of common mode voltages up to 1100 vdc and 3 vac, 50 to 500 cycles.

GAIN: 1 volt output per microampere input.

GAIN ACCURACY: ±2%.

INPUT CURRENT RANGE: 0 to 2 microamperes.

INPUT VOLTAGE RANGE: 0 to 2 millivolts nominal.

INPUT RESISTANCE: 950 ohms (±5%).

OUTPUT VOLTAGE RANGE: 0 to 2 volts open circuit.

OUTPUT RESISTANCE: 1000 ohms (±5%).

INPUT ISOLATION FROM CHASSES: Greater than 5 x 10^{11} ohms at 25°C (77°F), 60% RH and 1 x 10^{10} ohms at 50°C (122°F), 80% RH.

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
Sales and Service Locations — International
Sales Representatives — U.S. and Canada

List of Abbreviations and Symbols

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

Federal Supply Codes for Manufacturers (Continued)

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisberg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884 - use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

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

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

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

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571 - use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

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

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
Ross Milton, Co., The
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Division
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, MA

07261
Aumet Corp.
Culver City, California

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

07344
Bircher Co., Inc.
Rochester, New York

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

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933 - use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

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

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988 - use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, MN

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

Federal Supply Codes for Manufacturers (Continued)

11711
General Instrument Corp
Rectifier Division
Hickville, New York

11726
Qualidyne Corp.
Santa Clara, California

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

12300
Potter-Brumfield Division
AMF Canada LTD.
Guelph, Onatrio, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
Budd Co. The, Polychem Products
Plastic Products Div.
Bridgeport, PA

12615
U.S. Terminals Inc.
Cincinnati, Ohio

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

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

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

13606 - use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

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

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

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors, formerly
Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics Fabricators, Inc.
Downey, California

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

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

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

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

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

18736
Voltronics Corp.
Hanover, New Jersey

18927
G T E Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

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

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

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

25088
Siemen Corp.
Isilen, New Jersey

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

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co. Corporate H.Q.
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
A B Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

Federal Supply Codes for Manufacturers (Continued)

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

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

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp, formerly
Torrington Mfg. Co.
Torrington, Connecticut

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

64834
West Mfg. Co.
San Francisco, Californai

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

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

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

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

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

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

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

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village, Chicago, Illinois

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

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

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

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

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

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Beckman Instruments Inc.
Helipot Division
Fullerton, California

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

73445
Amperex Electronic Corp.
Hicksville, LI, New York

73559
Carling Electric Inc.
West 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.
Components Corp
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
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
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

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

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

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

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

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp., Mepco Div.
A North American Phillips Co.
Morristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183 - use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Stevens, Arnold Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81439
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

Federal Supply Codes for Manufacturers (Concluded)

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
Carr Co., The United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Division
Eatontown, New Jersey

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

83478
Rubbercraft Corp. of America, Inc.
West Haven, Connecticut

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

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

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products,
of Malden Inc.
Stoneham, Massachusetts

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

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

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

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co. Div of
P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211 - use 56365
Square D Co.
Chicago, Illinois

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

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737 - use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

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

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154 - use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

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

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

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

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

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

97913
Industrial Electronic Hdware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect. Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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460 Colfax Ave.
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CHANGES:

- SER. NO. 618-659, 691, and on
  - [illegible] changed to 150Ω from 330Ω
  - Zener Oven Assembly added.
- SER. NO. 618 and on
  - [illegible] changed to 150Ω from 330Ω
  - [illegible] changed to 10pf from 22pf
  - [illegible] changed to 1500pf from 470pf
- SER. NO. 436 and on
  - R132 changed to 2.7Ω from 82Ω
- SER. NO. 536 and on
  - R516 changed to 33k from 56k
- C4 & R14 installed only when Minn-Honeywell meters are used.
- For SER. NO. 123 thru 937:
  - C206 was 100uf
  - C208 was 40uf
  - C207 was 8uf
  - Q207 not installed
  - R207 was 8.06k
  - R206 was 1k
  - R208 was 5k pot.
- For SER. NO. 123 thru 257:
  - R229 was 402Ω
- For SER. NO. 123 thru 1212:
  - C3 was 0.1 uf
  - R10 was installed
- FOR SER. Nos. 2349 AND ON (887A) & 2770 AND ON (887AB), R520 WAS 470 Ω

VOLTAGE RANGE	NULL RANGE			
	LO	MED LO	MED HI	HI
1	0.1	0.01	0.001	0.0001
10	1.0	0.1	0.01	0.001
100	10	1.0	0.1	0.01
1000	100	10	1.0	0.1

NOTES:

REFERENCE DESIGNATIONS

BT1-3
C1-4, 101-107, 113, 201-220, 301, 401-407, 501-514, 516
CR1-2, 101-106, 201-202, 501-507
DS201
F1
G201
J1-6
M1
P1-2
Q101-109, 111-113, 201-207, 501-509
R2-14, 100-107, 109-132, 147-155, 201-240, 301-366, 401-411, 501-545
S1-6
T1

ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED

INDICATES +18V RETURN

INDICATES +6V AND -18V RETURN

● INDICATES INTERNAL ADJUSTMENT

CHASSIS GROUND

IDENTIFIES TEST POINT

INDICATES JUMPER

FUNCTIONAL SCHEMATIC DIAGRAM

MODEL 887A & AB

DIFFERENTIAL VOLTMETER

SER. NO. 123 & ON

REV. G

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133