Instruction Manual

MODEL 871A

DC DIFFERENTIAL VOLTMETER

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

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P.O. Box 7428 Seattle, Washington 98133

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MODEL 871A
DC DIFFERENTIAL VOLTMETER

871A & 871AB serial no. 123 and above.

1-9. SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

ACCURACY: ± (0.02% of input voltage + 0.001% of range + 10 uv)

INPUT RANGES: 1, 10, 100, and 1000 vdc with 10% overranging capability.

NULL RANGES:

Input Voltage Range	Null Ranges	Input Resistance at Null
1 v	.1, .01, .001 v	Infinite
10 v	1, .1, .01, .001 v	Infinite
100 v	10, 1, .1, .01 v	10 Megohms
1000 v	100, 10, 1, .1 v	10 Megohms

VOLTAGE DIAL RESOLUTION:

Voltage Range	Resolution	
	ppm of range	volts
1	10 ppm	10 uv
10	10 ppm	100 uv
100	10 ppm	1 mv
1000	10 ppm	10 mv

METER RESOLUTION:

Meter Resolution (1/2 of a small scale division)	
Null Range	Resolution
0.001	10 uv
0.01	100 uv
0.1	1 mv
1	10 mv
10	100 mv
100	1 v

AS A CONVENTIONAL VOLTMETER

ACCURACY: ±3% of range

RANGE:

Voltage Range	Input Resistance
1000-0-1000	10 Meg
100-0-100	"
10-0-10	"
1-0-1	"
*0.1-0-0.1	"
*0.01-0-0.01	"
*0.001-0-0.001	1 Meg

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

NOTE: Each range has the capability of measuring 10% overvoltage.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 10 megohms on two highest null ranges for all input ranges; 1 megohm on two lowest null ranges for all input ranges.

REFERENCE ELEMENT: Temperature-compensated zener diode, stability within ±50 ppm per year, and temperature coefficient less than 5 ppm/° C.

REGULATION OF REFERENCE SUPPLY: ±0.001% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY: ±0.002% per hour after 5 minute warmup.

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

KELVIN-VARLEY ACCURACY: ±0.01% of setting from 1/11 of full scale to full scale. Ratio stability of decade resistors, ±25 ppm/year.

RECORDER OUTPUT: Adjustable from 0 to at least +20 mv for full scale right deflection, and from 0 to at least -20 mv for full scale left deflection.

POLARITY: Reversible via front panel switch.

WARMUP TIME: 15 seconds.

RELATIVE HUMIDITY: 0 to 80%.

COMMON MODE REJECTION: 130 db at dc; 85 db at 60 Hz; 70 db at 400 Hz. Up to 1000 volts dc may be applied between common and ground posts without damage. NOTE: Battery operation of Model 871AB provides complete isolation from power system ground, eliminating errors due to ground loops.

OPERATING TEMPERATURE RANGE: Within specifications from 50° F to 104° F (10° C to 40° C); within ±(0.05% of input voltage + 10 uv) outside these limits to 32° F and 122° F (0° C and 50° C).

STORAGE TEMPERATURE RANGE: Model 871A, -40° F to +158° F (-40° C to +70° C); Model 871AB, -40° F to +140° F (-40° C to +60° C).

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

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

INPUT POWER: Model 871A - 115/230 vac ±10%, 50-440 Hz; Model 871AB - 115/230 vac ±10%, 50-440 Hz and rechargeable battery operation (minimum of 30 hours operation on full charge).

SIZE: 7" high x 8-1/2" wide x 11-3/4" deep.

WEIGHT: Model 871A - approximately 12 lbs.
Model 871AB - approximately 14 lbs.

SECTION II

OPERATING INSTRUCTIONS

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

2-2. The location, reference designation, and a functional description of the external controls, terminals, and indicators on the 871A and 871AB DC Differential Voltmeter may be found in Figures 2-1 and 2-2.

2-3. PRELIMINARY OPERATION FOR 871A

2-4. The following procedure prepares the Model 871A for operation.

a. Mechanically zero the meter with the adjustment screw on the front panel. If the instrument has been operating, it must be shut off for at least three minutes prior to this adjustment.

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

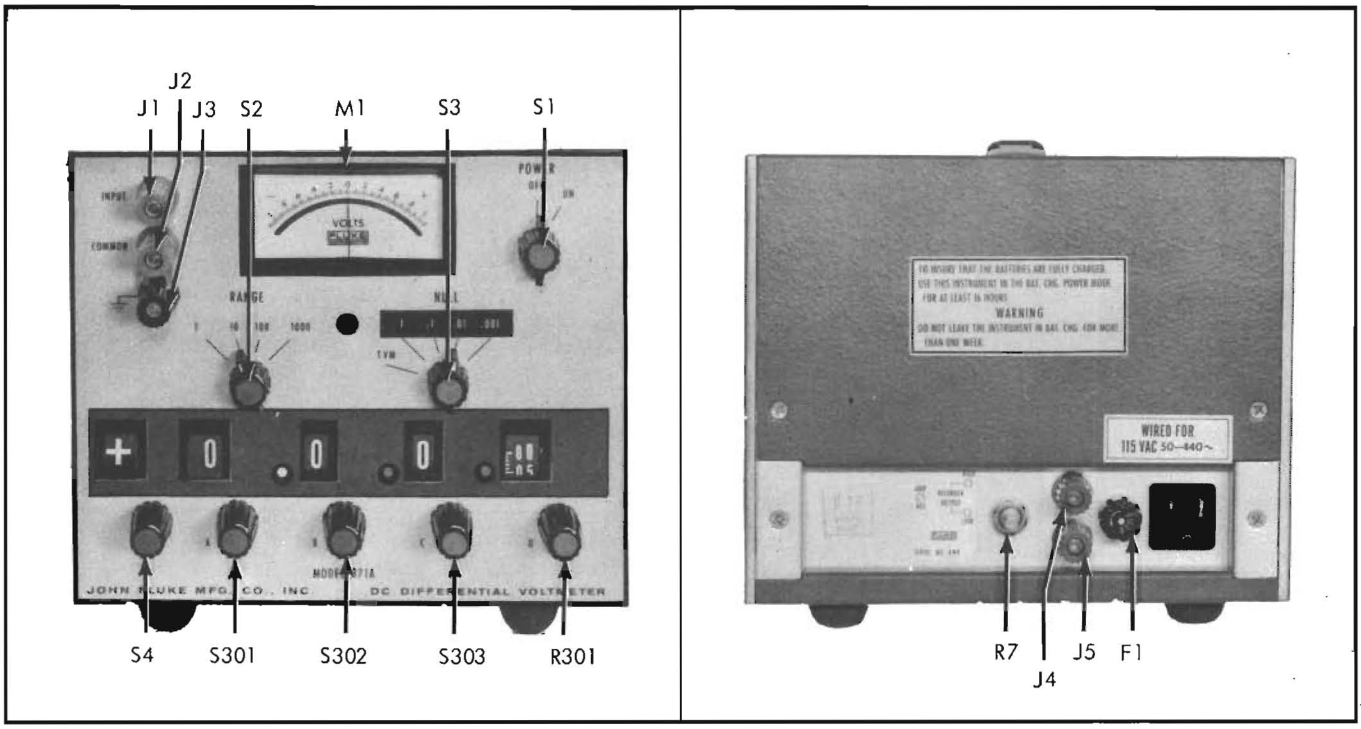


Figure 2-1. LOCATION OF CONTROLS, TERMINALS, AND INDICATORS

CONTROLS TERMINALS AND INDICATORS	REFERENCE DESIGNATION	FUNCTIONAL DESCRIPTION
INPUT and COMMON terminals	J1, J2	Provided for connecting dc voltage to be measured.
Chassis ground terminal	J3	Provided for grounding purposes. A .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.
POWER switch	S1	In the Model 871A, the POWER switch applies ac line voltage to primary circuit of transformer T1 when turned from OFF to ON. In the Model 871AB, positions for 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.
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.
NULL switch	S3	Set to TVM for determining the approximate value of unknown voltage prior to differential measurements. Six null voltage ranges of 100, 10, 1, 0.1, 0.01, and 0.001 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.
A, B, C, and D voltage readout dials	S301, S302, S303, R301	Provide in-line readout of the internal reference voltage.
Polarity switch	S4	Changes polarity of voltmeter to match polarity of unknown voltage. With this switch in the positive position, the polarity of INPUT binding post is positive with respect to COMMON binding post.
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.
Meter	M1	Indicates approximate voltage when voltmeter is in TVM mode and difference between unknown and internal reference voltage when voltmeter is in differential mode.

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

CONTROLS TERMINALS AND INDICATORS	REFERENCE DESIGNATION	FUNCTIONAL DESCRIPTION
RECORDER OUTPUT terminals	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
AMP ADJ control	R7	Varies the output level of the output binding post from 0 to at least 20 millivolts at full scale deflection.
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)

c. Set switches on 871A as follows:

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

2-5. PRELIMINARY OPERATION FOR 871AB

2-6. The following procedure prepares the Model 871AB for operation.

a. Mechanically zero the meter with the adjustment screw on the front panel. If the instrument has been operating, it must be shut off for at least three minutes prior to this adjustment.

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

c. For line operation, set the POWER switch to LINE OPR.

d. For battery operation, set the 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 2-7. If batteries are adequately charged, set POWER switch to BAT OPR-LINE ISOL.

e. Set switches on 871AB as follows:

RANGE	1000
NULL	TVM
polarity	+ (positive)
all voltage readout dials	zero

2-7. 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. The instrument may be operated while the batteries are being charged.

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.

2-8. OPERATION AS A DIFFERENTIAL VOLTMETER

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

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

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

d. If meter reads to left, turn polarity switch to the negative position. The meter needle will deflect to the right.

e. Noting position of decimal point, set four 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 four voltage readout dials.

2-9. OPERATION AS A CONVENTIONAL VOLTMETER

2-10. 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 and the range switch to 1 volt. 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.

FULL-SCALE DEFLECTION	RANGE SWITCH	NULL SWITCH	VOLTAGE DIALS
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

Figure 2-3. VTVM RANGES

c. Set 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. Deflection to the right indicates that unknown dc voltage is of positive polarity.

2-11. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.
b. Connect voltage to be measured 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; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.
c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.
d. Set four voltage readout dials to nominal voltage.
e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.
f. 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.

2-12. RECORDING VOLTAGE EXCURSIONS

2-13. Recorder output binding posts and an output level control are provided on the 871A and 871AB 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.

2-14. USE OF 871A WITH AN A88 ISOLATION AMPLIFIER AND A RECORDER

2-15. To use the Fluke A88 Isolation Amplifier and a recorder with the 871A or 871AB, 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 12.5 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).

g. Turn on the recorder and set recorder gain for a full scale sensitivity equal to or less than 2 volts, but as close to 2 volts as possible.
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 according to paragraph 2-11.

2-16. USE WITH A RECORDER

2-17. To use a recorder with the 871A or 871AB proceed as follows:

a. Using teflon leads, connect RECORDER OUTPUT terminals of differential voltmeter to input terminals of recorder.

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) Set switches on voltmeter as follows:

RANGE	10
NULL	.001
polarity	+ (positive)
voltage readout dials	10.0000

(2) Connect either recorder lead to the INPUT binding post, and connect the common side of the voltage to be measured to the COMMON binding post. A deflection of more than full scale (-1.0) indicates excessive leakage.

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 a maximum of at least 20 millivolts at the RECORDER OUTPUT terminals depending on the setting of the AMP ADJ control. Reconnect the recorder to the RECORDER OUTPUT posts.

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

f. Remove short between INPUT and COMMON posts, and connect voltage to be measured to INPUT and COMMON posts. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed according to paragraph 2-11.

2-18. MEASUREMENT OF HIGH RESISTANCE

2-19. The 871A series voltmeter may be used as a megohmmeter for rapid measurements of high resistances from 10 megohms to 100,000 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 and is 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.

2-20. A convenient way of measuring leakage resistance between 10 megohms and 11,000 megohms is to adjust the voltage readout dials so that the meter indicates full scale (-1.0). The unknown resistance is then easily calculated from the readout dial setting. Proceed as follows:

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

b. Set RANGE switch to 10.

c. Set NULL switch to 1.

d. Connect unknown resistance between INPUT post and COMMON post. Use short isolated leads to prevent measuring the leakage resistance between the leads.

e. 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 .1 or .001.

f. Determine value of unknown resistance according to Figure 2-4.

2-21. NOTES ON OPERATION OF 871A AND 871AB

2-22. GROUND LOOP PRECAUTIONS

RANGE OF UNKNOWN RESISTANCE	NULL SWITCH POSITION	UNKNOWN RESISTANCE IN MEGOHMS AT FULL-SCALE (-1.0) METER DEFLECTION
10 megohms to 100 megohms	1	Multiply amount set on voltage readout dials by 10 and subtract 10.
90 megohms to 1090 megohms	0.1	Multiply amount set on voltage readout dials by 100 and subtract 10.
1000 megohms to 11,000 megohms	0.001	Multiply amount set on voltage readout dials by 1000.

Figure 2-4. RESISTANCE MEASUREMENTS AT FULL SCALE DEFLECTION

2-23. Ground loop currents should be avoided to assure measurement accuracy. A potential difference often exists between different points on power system grounds. When this occurs, current may flow from the power system ground through the voltmeter and the equipment being measured and back to the power system ground. To prevent ground loop currents when the system being measured is grounded, do not connect COMMON post to chassis ground post.

2-24. USE OF SHORTING LINK

2-25. A .01 uf capacitor (C1) is connected from the COMMON binding post to the chassis ground binding post, which reduces 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 measurements in the presence of common mode voltages. This charge may cause an error on subsequent 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 incorrect indication.

2-26. INFLUENCE OF AC COMPONENTS

2-27. An ac voltage of several times the unknown dc voltage can be present on the unknown and the 871A or 871AB will indicate well within the specifications, if the frequency is over a few hundred cycles. A double-section, low-pass filter (R201, C201, R202, and C202) at the input of the null detector reduces 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 may be significant. If the low frequency ac component is equal to or less than 1000 times the null range being used, no perceptable error will result. For example, on the .01 volt null range, a 60 Hz ac voltage of up to 10 volts will cause no perceptable error. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 84 Hz), the meter needle will oscillate at the difference frequency. If ac components that affect the accuracy are ever encountered, additional filtering at the input of the instrument will be necessary. For alternating current of a single frequency, a twin-T filter is effective, and has low total series resistance. For an alternating current of various frequencies, an ordinary low pass filter may be used. In either case, the filter should be constructed of high quality capacitors which have high leakage resistance.

2-28. INFLUENCE OF DC COMMON MODE VOLTAGE

2-29. DC common mode errors are caused by leakage currents passing through ground loops. Great care has been taken in the design and construction of the voltmeter to isolate the circuitry from chassis ground. Accurate dc measurements can be made with the 871A and 871AB in the presence of common mode voltages of up to 1000 volts dc. The dc common mode rejection is at least 130 db (3,160,000 to 1), or 0.35 uv error per common-mode-volt, up to 70% relative humidity. Since the leakage resistance varies inversely with dampness, the dc common mode error is typically much less at lower relative humidity. 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 required to charge stray capacitance through the extremely high resistance to ground.

2-30. CHECKING BATTERIES OF 871AB

2-31. If the 871AB is turned off with the batteries completely discharged, the battery voltage may recover with time. It is possible for the batteries to recover sufficiently for the meter to indicate that 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 be noted that the discharge characteristic of nickel-cadmium batteries is very flat, except near full charge and complete discharge. Therefore, when the batteries are checked, the meter indication is not proportional to the remaining ampere-hour capacity of the batteries. Just after the batteries are charged, the meter will indicate near full scale. However, most of the time the meter will indicate near half scale. A few hours before the batteries need recharging, the meter needle will indicate just within the BATTERY OK region.

2-32. MEASUREMENT OF NEGATIVE VOLTAGES

2-33. Because of the polarity switch, voltage which is negative with respect to common, as well as positive voltage, may be measured with equal facility. If the INPUT binding post is connected to ground, either at the front panel or at the source being measured, the accuracy of the voltmeter may be reduced. If the unknown voltage is negative, always connect the grounded side to the COMMON post, and use the polarity switch to obtain the proper result.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. GENERAL

3-3. A block diagram for the 871A/871AB Differential Voltmeter is given in Figure 3-1. As seen in this figure, the main circuits in the instrument are an input attenuator, a dc transistorized voltmeter (tvm), and an extremely accurate 0 to 11 vdc reference. The input attenuator reduces the input voltage of the 100 volt and 1000 volt ranges. The tvm uses a high-sensitivity null detector and an attenuator. A Kelvin-Varley divider is used to adjust the reference voltage from 0 to 11 vdc. Refer to the functional schematic following Section VI for more detail. This schematic is intended to aid in the understanding of circuit theory and in trouble-shooting. The signal flow is from left to right, and the components are arranged functionally.

3-4. The overall operation of the instrument 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 reduces the full-scale voltage in each range to 1 millivolt, which is the sensitivity of the null detector for full-scale meter deflection. To accurately measure the unknown voltage, it is connected across the series combination of the null detector and the 0 to 11 volt reference voltage. The reference voltage is then adjusted with the four voltage readout dials until it matches the unknown voltage as indicated by the null detector. For voltages between 11 and 1100 volts, the input attenuator divides the unknown voltage by 10 on the 100 volt range, and by 100 on the 1000 volt range. The instrument then operates essentially the same as for measurements from 0 to 11 volts.

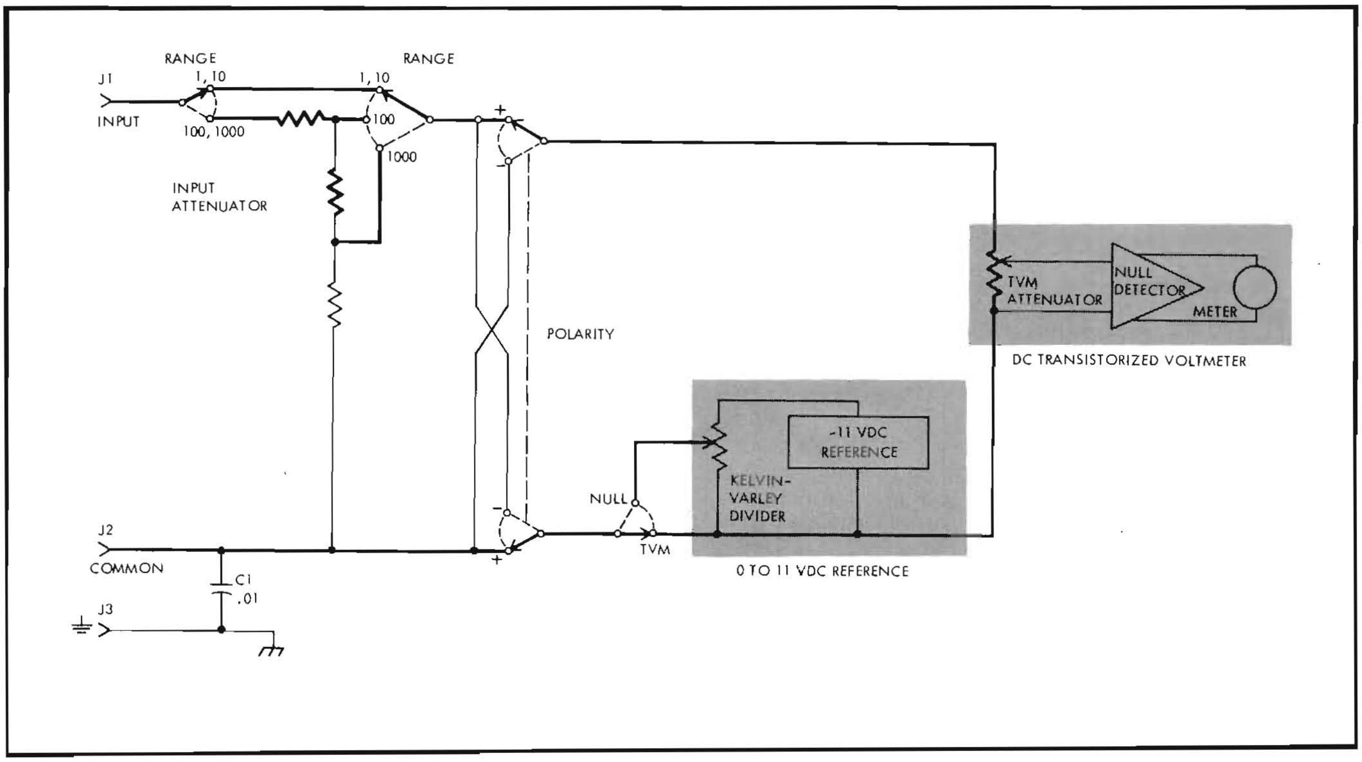


Figure 3-1. 871A DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

3-5. INPUT RESISTANCE OF INSTRUMENT

3-6. For the tvm, low sensitivity, and medium low sensitivity null ranges, the input resistance of the tvm attenuator is 10 megohms (R1 through R6). For the medium high and high sensitivity null ranges, the input resistance of the tvm attenuator is 1 megohm (R3 through R6). However, this is not the input resistance of the 871A. For the 1 and 10 volt ranges, the input resistance is determined by dividing the unknown terminal 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 input attenuator is always connected across the input terminals. Thus, the input resistance is equal to the resistance of the input attenuator which is 10 megohms.

3-7. In order to provide for a more complete understanding of the voltmeter, the following paragraphs describe each section of the circuit in more detail.

3-8. INPUT ATTENUATOR

3-9. Since the instrument contains a 0 to 11 volt reference, the unknown voltage is measured by comparing it directly to a known voltage with the aid of a null detector only on the 1 and 10 volt ranges. On the 100 and 1000 volt ranges, the input attenuator (R101 through R107) divides the unknown voltage by 10 and by 100, respectively, and this attenuated voltage is then measured using the null detector. Thus, after attenuation, the 100 and 1000 volt ranges are equivalent to the 10 volt range. The input attenuator is extremely accurate and has excellent long term stability. The variable resistors R104 and R106 are used during calibration to set the correct division ratio.

3-10. DC TRANSISORIZED VOLTMETER

3-11. GENERAL

3-12. The dc transistorized voltmeter (tvm) is composed of a tvm attenuator and a null detector. The heart of the dc tvm is the null detector in which the dc signal is modulated by a photochopper, amplified by a five stage amplifier, rectified by a transistor switch, and filtered to produce a dc output. High dc negative feedback makes the null detector relatively insensitive to gain variations in the individual transistors. The output of the null detector drives a meter with tautband suspension. The tautband eliminates the friction associated with pivot and jewel meters. 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 reduces the applied voltage to 1 mv, the full-scale sensitivity of the null detector.

3-13. NULL-DETECTOR

3-14. 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 proportional to the output current. At the input to the 871A null detector, R201, C201, R202, and C202 form a double 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 R203 is converted to an alternating voltage by V201, a photochopper. The voltage across R203 is proportional to the current flowing in the meter. The alternating voltage created by V201 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 high input impedance and low noise. The next four stages consist of common-emitter amplification, with overall feedback from Q205 to Q202. A transistor switch, Q209, is gated in synchronization with V201. During the "off" portion of the photochopper cycle, the output of the amplifier is clamped to null detector common potential by Q209. During the "on" portion of the photochopper cycle, the output of the amplifier is filtered by R230 and C214 to provide a dc current for the meter. A portion of the current that flows through the meter is shunted back to the 200 ohm feedback resistor R203, thus completing the feedback loop. The gain of the null detector can be adjusted by means of R231 in the feedback network. The null detector has a basic sensitivity of 1 millivolt. However, to compensate for the loading effect of the tvm attenuator on the input attenuator, the full-scale sensitivity of the null detector is increased for the 100 and 1000 volt ranges according to the table below.

RANGE	NULL POSITION				
	TVM	Lo	Med Lo	Med Hi	Hi
100 V	910uv	910uv	910uv	526uv	526uv
1000 V	1mv	1mv	1mv	910uv	910uv

3-15. TVM ATTENUATOR

3-16. In the tvm mode, one position on the tvm attenuator selected by range switch section S2C provides the necessary reduction of the 1 volt range for proper null detector input. Another position on the tvm attenuator is used for the 10, 100, and 1000 volt ranges because the input attenuator divides the input signal so as to reduce the 100 and 1000 volt ranges to the equivalent of the 10 volt range. In the null mode, the voltage difference (unknown voltage minus the reference voltage - or unknown voltage divided down minus the 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 input of 1 millivolt.

3-17. PHOTOCHOPPER DRIVE CIRCUIT

3-18. Drive for the photochopper is obtained from a free-running multivibrator, Q206 and Q207. During the portion of the cycle that Q207 is on, Q208 is also on, which provides current through T201. When Q208 turns off, the flyback voltage of T201 illuminates neon lamp DS202. Transistor Q209 is driven in synchronization with DS202 through C213, transistor Q209 being off when DS202 is on. Resistor R218 is used to adjust the chopper frequency to 84 Hz, and resistor R219 is used to adjust the duty cycle of DS202. Resistor R227 is used to electrically zero the null detector.

3-19. INFLUENCE OF AC COMPONENTS

3-20. The only ac voltage component that will reduce the accuracy of the 871A 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. If ac components that affect accuracy are ever encountered, additional filtering as outlined in the operating instructions will eliminate the problem.

3-21. RECORDER OUTPUT

3-22. The recorder output is provided by R236, R7, and R237. Recorder output AMP ADJ control R7 provides for adjusting the recorder output voltage up to a maximum of at least 20 millivolts at full-scale deflection (1. 0). The voltage at the RECORDER OUTPUT terminals is proportional to the meter deflection.

3-23. 11 VOLT REFERENCE

3-24. GENERAL

3-25. In making differential voltage measurements between 0 and 11 volts, an internal reference voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 11 volt reference. The 0 to 11 volt reference is composed of a well regulated -16. 5 volt power supply, a range divider, and a four decade Kelvin-Varley divider. The range divider reduces the voltage from a pair of Zener diodes in the -16. 5 volt reference supply to 11 volts for the 10, 100, and 1000 volt ranges, and to 1. 1 volts for the 1 volt range, before the reference voltage is applied to the Kelvin-Varley divider. The Kelvin-Varley divides the input reference voltage into 110, 000 equal increments, thus providing an extremely accurate reference voltage.

3-26. -16. 5 VOLT POWER SUPPLY

3-27. The -16. 5 volt power supply uses a diode (CR101) and a filter network (R108 and C101) to supply unregulated dc voltage to series pass transistor Q101. In the Model 871AB, unregulated dc is supplied directly from a set of two batteries (BT1) in the BAT CHECK and BAT OPR modes. The voltage 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 differential amplifier, Q102 and Q103. The output of the differential amplifier is amplified by Q104, which drives the base of series pass transistor Q101. The voltage drop across the series pass transistor, Q101, is continuously adjusted so as to maintain the two input voltages of the differential amplifier at the same level, and thus maintain the output voltage at a constant value. The -16. 5 volt output is used to provide operating voltages for the null detector and for R117, which supplies a constant current to reference diodes CR103 and CR104. The voltage across the two Zener diodes may be between 12. 0 and 13. 0 volts, and has a stability better than 50 ppm per year and an overall temperature coefficient less than 5 ppm per °C.

3-28. RANGE DIVIDER

3-29. In the 1000, 100, and 10 volt ranges, the Zener reference voltage is connected to the Kelvin-Varley divider through resistors R118 and R119 and range switch sections S2F and S2E. The voltage drop across R118 and R119 reduces the Zener reference voltage to 11 volts at the input of the Kelvin-Varley divider. In the 1 volt range, resistors R120, R121, and R122, selected by range switch sections S2F and S2E, reduce the voltage to 1. 1 volts at the input to the Kelvin-Varley divider.

3-30. KELVIN-VARLEY DIVIDER

3-31. The four Kelvin-Varley decades composed of resistors R301 to R336, and the associated voltage dials A through D provide a means of reducing the reference voltages of 1. 1 and 11 volts to the voltage indicated on the readout dials. The first decade has twelve 5K resistors. Two of these resistors are shunted by the 10K total resistance of the second decade. Between the two wipers of S301 (voltage dial A) there is thus 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 and third decades divide the voltage across their inputs into ten equal parts. The last decade is a variable resistor which sets the last 2 digits. With the null switch in any null range, the output of the Kelvin-Varley divider is connected in series with the null detector, thus providing the accurate 0 to 11 volt or 0 to 1.1 volt reference voltage required.

3-32. POLARITY SWITCH

3-33. The polarity switch S4, as seen in Figure 3-1, reverses the transistorized voltmeter - reference voltage combination with respect to the input. Note that a .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 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. The polarity switch provides equal convenience in measuring positive and negative voltages without the occurance of these problems.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the 871A DC Differential Voltmeter should consist primarily of periodic cleaning and calibration. However, to determine if the instrument is within specifications, it is recommended that its performance be checked just before calibration by using the performance checks given in this section. Information on corrective maintenance is also included.

4-3. TEST EQUIPMENT

4-4. Figure 4-1 lists the recommended equipment and specifications required for performance checking, calibration, and corrective maintenance. If the recommended equipment is not available, other equipment which meets the required specifications may be used.

4-5. PERIODIC MAINTENANCE

4-6. Periodic maintenance consists primarily of occasional cleaning to remove dust, grease, and other contamination. Since the voltmeter is completely enclosed, the need for cleaning is reduced. 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 silicone oil. These switches are also isolated from the chassis with Lexan spacers. The printed circuit boards are coated with a moisture sealant and are isolated from chassis ground by means of polyethelene grommets.

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED	USED FOR
VTVM, RCA Voltohmyst, or equivalent	Accuracy: ±3% dc ±5% ac Input Impedance: 10MΩ, dc 1MΩ, 100 pf, ac	TROUBLESHOOTING ELECTRONIC ADJUSTMENTS
Autotransformer, General Radio Model W5MT3 (Model W5HMT for 230 volt instruments), or equivalent	103 to 127 volts (207 to 253 volts for 230 volt instruments)	TROUBLESHOOTING
DC Differential Voltmeter, Fluke Model 821A, or equivalent	Accuracy: ±0.01% Null Sensitivity: At least 1 mv. Externally-adjustable reference voltage. 20 ppm accuracy of Kelvin-Varley divider.	TROUBLESHOOTING
Standard Cell	Stability: ±0.0004%	TROUBLESHOOTING
Oscilloscope, Hewlett-Packard Model 120B	Vertical sensitivity: 20v/cm Sweep Speed: 1 ms/cm, minimum	ELECTRONIC ADJUSTMENTS
Voltage Calibrator, Fluke Model 332A, or equivalent	Range: 0 to 1000 vdc Accuracy: ±0.005%, minimum (332A is ±0.003%)	PERFORMANCE CHECKING CALIBRATION

Figure 4-1. TEST EQUIPMENT REQUIRED

4-7. To clean the instrument, proceed as follows:

CAUTION

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

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

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

CAUTION

Do not use Metriclene, acetone, lacquer thinner, or any ketone, since they will react with the Lexan switch rotors. Also, be careful not to saturate the switch contacts, which have been lubricated for life.

c. When necessary, clean all exposed dielectric surfaces of switches with denatured alcohol, using a small, stiff-bristled brush which has been wrapped with a clean cloth to prevent saturating the switch contacts.

d. After cleaning, recoat exposed switch insulating material with silicon oil having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

4-8. PERFORMANCE CHECKING

4-9. GENERAL

4-10. The following tests are designed to check the instrument's performance against the specifications. The tests may be used as a routine maintenance procedure, and as an incoming inspection procedure. It is recommended that these performance checks be done just before calibration of the instrument. When used in this way, the performance checks provide a valuable case history on the characteristics of each instrument. Just prior to calibration, the instrument should be within specifications; if not, troubleshooting should be performed to eliminate the cause of the error before calibrating the instrument. Localizing the problem to a particular area of the instrument may be done by an analysis of the performance check results.

4-11. NULL DETECTOR SENSITIVITY CHECK

4-12. The null detector is checked in this procedure by using the instrument's internal reference supply and Kelvin-Varley divider. If the instrument fails to pass this check, it may be 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. Check meter for electrical and mechanical zero according to paragraph 4-42.

b. Short INPUT post to COMMON post.

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

d. Remove the short between INPUT and COMMON posts.

VOLTMETER SWITCH SETTINGS						METER INDICATION
RANGE	NULL	VOLTAGE READOUT DIALS A	B	C	D	
10	1.0	1.	0	0	00	-1.0
10	.1	0.	1	0	00	-1.0
10	.01	0.	0	1	00	-1.0
10	.001	0.	0	0	10	-1.0
1	.1	.1	0	0	00	-1.0
1	.01	.0	1	0	00	-1.0
1	.001	.0	0	1	00	-1.0
100	10	1	0.	0	00	-1.0
100	1	0	1.	0	00	-1.0
100	.1	0	0.	1	00	-1.0
100	.01	0	0.	0	10	-1.0
1000	100	1	0	0.	00	-1.0
1000	10	0	1	0.	00	-1.0
1000	1	0	0	1.	00	-1.0
1000	.1	0	0	0.	10	-1.0
10	1	0.	1	0	00	-0.1
10	1	0.	2	0	00	-0.2
10	1	0.	3	0	00	-0.3
10	1	0.	4	0	00	-0.4
10	1	0.	5	0	00	-0.5
10	1	0.	6	0	00	-0.6
10	1	0.	7	0	00	-0.7
10	1	0.	8	0	00	-0.8
10	1	0.	9	0	00	-0.9
10	1	1.	0	0	00	-1.0
10	1	1.	1	0	00	-1.1

Figure 4-2. SETTINGS FOR NULL DETECTOR CHECK

4-13. DIFFERENTIAL MEASUREMENT CHECK

4-14. The following procedure checks the accuracy of the instrument with full input on each range and also with each voltage readout dial set to 1, 2, 3, 4, 5, 6, 7, 8, and 9 on the 10 volt range. This method checks the accuracy with a minimum number of measurements. Proceed as follows:

a. Set meter to zero with mechanical zero control.

b. Set POWER switch to LINE OPR with 871AB, or to ON with 871A, and allow voltmeter to warmup to equilibrium temperature (about 5 minutes).

c. Connect the 332A Voltage Calibrator, or equivalent, to the INPUT and COMMON binding posts of the voltmeter. Connect voltmeter COMMON post to line ground. The voltage source must provide 0 to 1000 volts dc with an accuracy of at least ±0.005%.

d. Set NULL switch to 0.1, and set voltage readout dials to 1.00000.

e. Set RANGE switch to 1.

f. Set 332A for 1.00000 volts dc output.

g. Adjust voltage readout dials for zero meter deflection in successively more sensitive null ranges. Final voltage readout dial setting should be between .99969 and 1.00031.

h. Set RANGE switch to 10, NULL switch to 1, and voltage readout dials to 10.0000.

i. Set 332A for 10.0000 volts dc output.

j. Adjust voltage readout dials for zero meter deflection in successively more sensitive null ranges. Final voltage readout dial setting should be between 9.9969 and 10.0031.

k. Set RANGE switch to 100, NULL switch to 10, and voltage readout dials to 100.000.

l. Set 332A for 100.000 volts dc output.

m. Adjust voltage readout dials for zero meter deflection in successively more sensitive null ranges. Final voltage readout dial setting should be between 99.969 and 100.031.

n. Set RANGE switch to 1000, NULL switch to 100, and voltage readout dials to 1000.00.

o. Set 332A for 1000.00 volts dc output.

p. Adjust voltage readout dials for zero meter deflection in successively more sensitive null ranges. Final voltage readout dial setting should be between 999.69 and 1000.31.

q. Set RANGE switch to 10, and set NULL switch to .001.

r. Set 332A to output voltages listed in Figure 4-3. Set voltage readout dials on voltmeter as indicated for the applied voltage, and adjust the voltage readout dials for a null on the 871A meter. Final voltage readout dial settings should be within the values listed in Figure 4-3.

4-15. CALIBRATION

4-16. GENERAL

4-17. The 871A should be calibrated as often as deemed necessary. However, it is recommended that the instrument be calibrated every six months under usual laboratory conditions. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more frequently. Calibration should be accomplished in a draft free area with an ambient temperature of 73.5 (±2.5)° F. Line voltage should be 115 (±2) volts.

332A OUTPUT VOLTAGE	INITIAL 871A VOLTAGE READOUT DIAL SETTING	FINAL 871A VOLTAGE READOUT DIAL SETTING
1.111111	1.1111	1.1108 to 1.1114
2.222222	2.2222	2.2216 to 2.2228
3.333333	3.3333	3.3324 to 3.3342
4.444444	4.4444	4.4431 to 4.4457
5.555555	5.5555	5.5539 to 5.5571
6.666666	6.6666	6.6647 to 6.6685
7.777777	7.7777	7.7754 to 7.7800
8.888888	8.8888	8.8861 to 8.8915
9.999999	9.9999	9.9970 to 10.0028

Figure 4-3. VOLTAGE READOUT DIAL LIMITS

4-18. For convenience, the calibration procedure is divided into six parts: Preliminary Setup, Null Detector Calibration, 10 Volt Range Calibration, 1 Volt Range Calibration, 100 Volt Range Calibration, and 1000 Volt Range Calibration. Calibration is usually done in the sequence given. The recommended equipment and the specifications required for calibration are shown in Figure 4-1. All calibration controls are identified by decals inside the instrument.

4-19. PRELIMINARY SETUP

a. Set meter to zero with mechanical zero control, if necessary.

b. Set POWER switch to LINE OPR with 871AB, or to ON with 871A, and allow voltmeter to warmup to equilibrium temperature (about 5 minutes).

c. Connect the 332A Voltage Calibrator, or equivalent, to the INPUT and COMMON binding posts of the voltmeter. Connect voltmeter COMMON post to line ground. The voltage source must provide dc voltages of 0 to 1000 volts, with an accuracy of at least ±0.005%.

4-20. NULL DETECTOR CALIBRATION

a. Short INPUT post to COMMON post.

b. Set switches on voltmeter as follows:

RANGE	1
NULL	.001
voltage readout dial C	1

c. Adjust 1 mv gain control R231 for full scale meter deflection to the left (-1.0). The right side panel must be on the instrument when making this adjustment.

d. Remove the short between the INPUT and COMMON posts.

4-21. 10 VOLT RANGE CALIBRATION

NOTE

The 10 volt range must be calibrated before attempting calibration of the 1, 100, or 1000 volt ranges.

a. Set switches on voltmeter as follows:

RANGE	10
NULL	1.0
voltage readout dials	10.0000

b. Set 332A for 10.0000 volts output.

c. Adjust R119 for zero meter deflection in successively more sensitive null ranges. Resistor R111 may be adjusted if there is insufficient range in R119.

4-22. 1 VOLT RANGE CALIBRATION

NOTE

To prevent error due to leakage, use a dielectric screwdriver to adjust R121.

a. Set switches on voltmeter as follows:

RANGE	1
NULL	.1
voltage readout dials	1.00000

b. Set 332A for 1.00000 volt output.
c. Adjust R121 for zero meter deflection in successively more sensitive null ranges. The right side panel must be on the instrument when making this adjustment.

4-23. 100 VOLT RANGE CALIBRATION

NOTE

To prevent error due to leakage, use a dielectric screwdriver to adjust R104.

a. Set switches on voltmeter as follows:

RANGE	100
NULL	10
voltage readout dials	100.000

b. Set 332A for 100.000 volts output.
c. Adjust input attenuator R104 for zero meter deflection in successively more sensitive null ranges.

4-24. 1000 VOLT RANGE CALIBRATION

NOTE

To prevent error due to leakage, use a dielectric screwdriver to adjust R106.

a. Set switches on voltmeter as follows:

RANGE	1000
NULL	100
voltage readout dials	1000.00

b. Set 332A for 1000.00 volts output.
c. Adjust input attenuator R106 for zero meter deflection in successively more sensitive null ranges.

4-25. CORRECTIVE MAINTENANCE

4-26. GENERAL

4-27. Since the 871A DC Differential Voltmeter is a completely transistorized instrument, the possibility of a component failure is greatly reduced. Under normal circumstances, the only thing that will interfere with the operation of the instrument is the need for calibration. However, if the instrument does not perform correctly before or after calibration, the technician may use the information given here as a complete guide for locating and correcting the source of trouble. All equipment required for maintaining the instrument is listed in Figure 4-1.

4-28. TROUBLESHOOTING

4-29. TROUBLESHOOTING TIPS. 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 4-8, the trouble may be isolated to the null detector, reference supply, Kelvin-Varley divider, or input attenuator. 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 4-4. 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.

4-30. VISUAL INSPECTION. Trouble can sometimes be found by a thorough visual inspection. Look for:

a. Accumulations of dirt, dust, moisture, or grease. Remove contamination as outlined in periodic maintenance, paragraph 4-5.
b. Scorched or burned parts. Damage of this type is usually due to a defective component. Determine cause of damage before replacing overheated part.

CAUTION

Avoid touching the polyethelene grommets. Contamination can cause electrical leakage.

c. Cracks, cuts, and other damage to polyethelene grommets. Replace grommets, using a plastic bag over the hand to prevent contamination.
d. Input Divider Resistors (R101, R102, R103, R105, and R107) touching the printed circuit board. When these resistors touch the board, leakage paths are created which can result in error.
e. Loose or intermittent connections.

4-31. VOLTAGE LEVEL CHECKING. When the trouble has been localized to a stage, the defective part may be isolated by voltage level measurements at the transistor terminals. Transistor terminals are identified in Figure 4-5. When making measurements on printed circuit boards, use a sharp probe and press firmly while rotating the probe to break through the insulating coating. Measurements that differ widely from those listed in the transistor voltage chart (Figure 4-6) can be used to localize the trouble to a specific part, in most cases.

CAUTION

When measuring voltage, it is recommended that care be used to prevent momentary short circuits which could damage transistors.

4-32. TROUBLESHOOTING CHECKS. The following troubleshooting checks list several normal conditions that should exist in the instrument. The most probable cause or causes of an abnormal condition is also given.

4-33. Meter Rattle Check. If the meter needle appears to rattle excessively, perform the following check:

a. Set switches on 871A as follows:

RANGE	1
NULL	.001
all voltage readout dials	zero

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of reference supply, evidenced by meter needle drift.	R109, R110, R114, R115, R117, R118, R120, or R122 changing value with temperature change.	Locate faulty resistor by heating with a soldering iron held near resistor, while making a standard cell measurement. Meter drift will indicate faulty resistor.
	Faulty Zener diode.	Monitor voltage across Zener diode pair. If Zener voltage drifts, replace Zener diodes, and R118.
	Q101, Q102, Q103, or Q104 defective.	Check by replacement.
Meter rattle or drift.	Dirty or defective FET, Q201.	Clean input to Q201. Vary operating point slightly with R209, or replace.
	Dirty lucite rod.	Clean.
	Faulty DS202.	Check by replacement.
	Faulty C206.	Check by replacement.
	Moisture, dirt, or other contamination on printed circuit boards, or switches.	Clean instrument according to paragraph 4-5.
	Faulty Zener diode.	Monitor voltage across Zener pair. Replace if rattle exceeds 50 ppm peak-to-peak.
Measurements are out of tolerance on every range except at full scale (1.099100).	One of the Kelvin-Varley resistors is out of tolerance. Leakage from Null Detector to ground.	Check accuracy of Kelvin-Varley divider according to paragraph 4-36. Clean instrument according to paragraph 4-5.
Meter beats with voltage being measured.	Chopper drive circuit out of adjustment.	Adjust photochopper drive frequency according to paragraph 4-40.

Figure 4-4. TROUBLESHOOTING CHART

b. Set POWER switch to LINE OPR with 871AB, or to ON with 871A, and allow a warmup period of 5 minutes.

c. Short INPUT post to COMMON post. Random excursions of meter needle should be less than 1/4 small division peak-to-peak. If rattle is excessive, check field-effect transistor Q201 by replacement, or by slightly varying the operating point of Q201 with R209.

4-34. Reference Voltage Regulation. If the reference voltage is suspected of being faulty, perform the following check:

a. Connect autotransformer to line power.

b. Connect 871A line cord to output of autotransformer.

c. Set POWER switch to LINE OPR with 871AB, or to ON with 871A, and allow a warmup period of 5 minutes.

d. Set autotransformer to 103 volts (207 volts when voltmeter is wired for 230 volt operation) as measured with a VTVM.

e. Set NULL switch to TVM.

f. Differentially measure the -16.5 volt supply between COMMON post and collector of Q101.

g. Set autotransformer to 127 volts (253 volts when voltmeter is wired for 230 volt operation). Output of -16.5 volt supply should change by less than 7 millivolts from step f. If regulation is poor, it is probable due to excessive current load from the reference supply to the null detector.

4-35. Common Mode Measurement Check. If the instrument is suspected of making incorrect measurements in the presence of common mode voltages, perform the following check:

a. Measure the voltage of a standard cell, using the 1 volt range and positive polarity. The standard cell must be floating.

b. Connect 500 vdc from chassis ground post to COMMON post, and wait for 3 minutes.

c. Measure standard cell voltage. If the two measurements differ by more than 25 microvolts, there is excess electrical leakage to ground. Clean instrument according to paragraph 4-5.

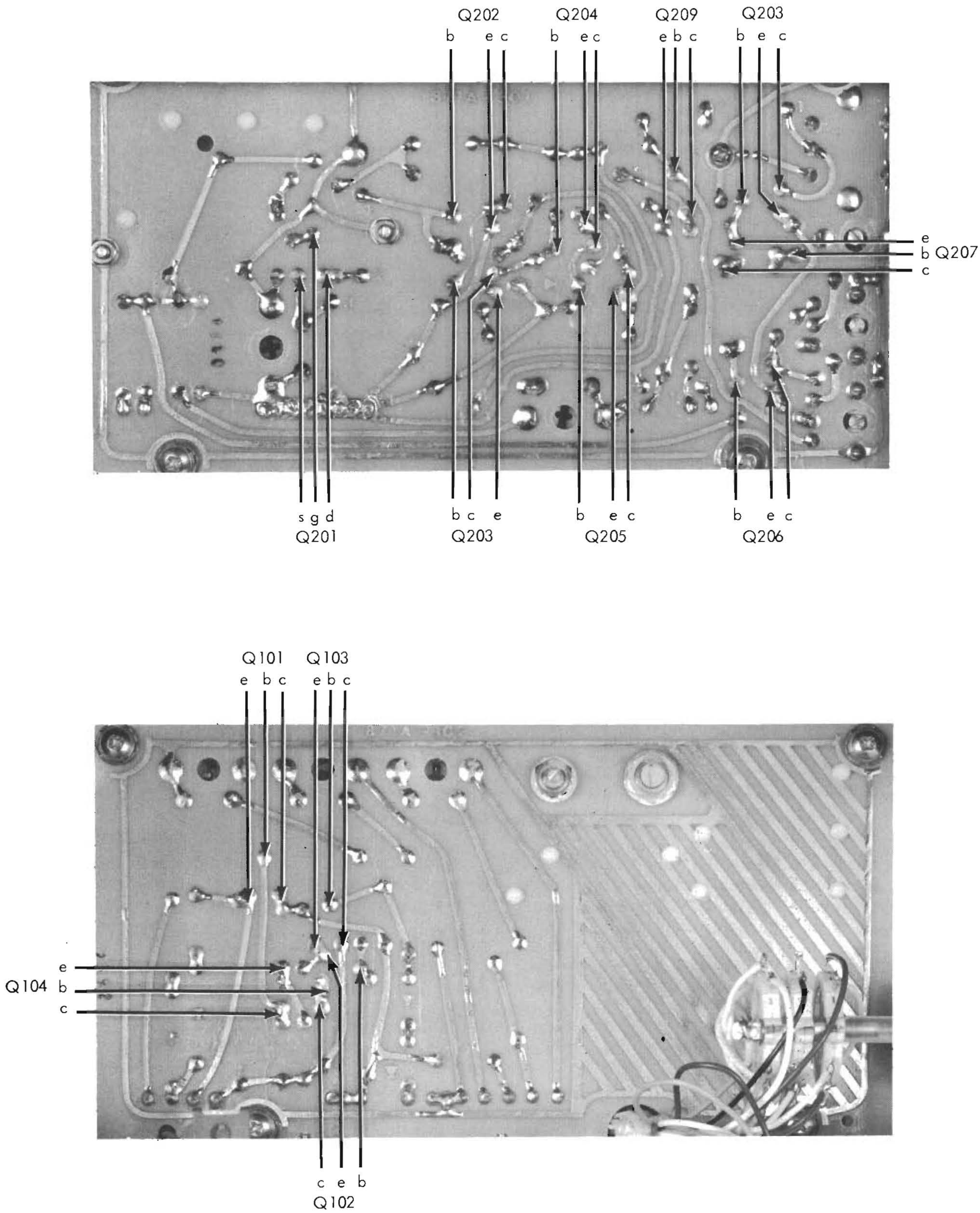


Figure 4-5. LOCATION OF TRANSISTOR TERMINALS

TRANSISTOR	EMITTER (vdc)	BASE (vdc)	COLLECTOR (vdc)
Q101	-27.2 ①	-26.2	-16.6 ②
Q102	-13.4	-13.0	- 6.9
Q103	-13.4	-13.0	0
Q104	- 6.3	- 6.9	-26.2
Q201	0 to -5 (SOURCE)	0 (GATE)	-5 to -11 (DRAIN)
Q202	0	- .54	- .60
Q203	0	- .60	- 1.9
Q204	- 1.6	- 1.9	- 3.0
Q205	- 3.0	- 3.6	- 8.3
Q206	-16.6	-21.2	- 6.6
Q207	-16.6	-18.5	-11.7
Q208	-16.6	-16.6	- 3.6
Q209	0	+ 2.0	0

The above operating voltage levels are measured under the following conditions: (a) line voltage at 115/230 vac, 50 to 440 cps; (b) all voltages measured with a 3%, 10 megohm voltmeter 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 +; (c) some voltages may vary as much as 15 to 20%; (d) bias voltages (difference between emitter and base voltages) should remain approximately the same.

NOTES: ① Emitter of Q101 should be between -23 and -35 vdc for 115/230 vac line operation, -19.5 and -21.0 vdc for BAT OPR (871AB only), and not less than -23.5 vdc for BAT CHG (871AB only) as measured with a VTVM. ② Collector of Q101 should be between -15.8 and -17.9 vdc as measured with a differential voltmeter.

Figure 4-6. TRANSISTOR VOLTAGE CHART

4-36. Kelvin-Varley Divider Check. The Kelvin-Varley divider check requires a connection to the Kelvin-Varley divider inside the instrument. Proceed as follows:

a. Remove bottom panel.
b. Locate input-output common wire. This is the black wire connected to the bottom of S301 (voltage dial A).
c. Jumper from the input-output common wire located in step b. to the 821A common post.
d. Connect the INPUT post to the 821A input post.
e. Set 871A switches as follows:

RANGE	10
NULL	Any null range
polarity	- (negative)
voltage readout dials	10.0000

f. Set 821A polarity switch to - (negative).
g. Set 821A voltage readout dials to 9.9910. With operate-calibrate control set to operate, adjust 821A calibrate control for zero meter deflection in most sensitive null ranges.
h. Set the 871A and 821A readout dials to the values given in Figure 4-7. The panel meter of the 821A should indicate within the maximum deviation column of Figure 4-7 for each step. If the Kelvin-Varley divider is out of tolerance, a resistor is defective and must be replaced.

4-37. ELECTRONIC ADJUSTMENTS

4-38. The following electronic adjustments may occasionally be required.

4-39. ADJUSTMENT OF -16.5 VOLT SUPPLY. Resistor R111 usually requires adjustment when a part is replaced in the -16.5 volt power supply. Resistor R111 is adjusted by performing the 10 volt and 1 volt range calibration (paragraphs 4-21 and 4-22).

4-40. PHOTOCHOPPER FREQUENCY ADJUSTMENT. The photochopper frequency should be adjusted if a part is replaced in the drive circuit, if there is difficulty in zeroing the meter, or if line operation causes the meter to beat with the voltage being measured. Proceed as follows:

a. Set POWER switch to LINE OPR with 871AB or to ON with 871A.
b. Set NULL switch to TVM.
c. Connect oscilloscope between COMMON post and collector of Q208 (test point 1).
d. Set oscilloscope controls as follows:

Vertical sensitivity	20v/cm
Trigger mode	Automatic
Trigger slope	"Int (+)"
Time	2 milliseconds/cm

e. Adjust R218 for a 12 millisecond drive period.
f. Adjust R219 for a duty period of 4 milliseconds.
g. Since R218 and R219 interact slightly, repeat steps e. and f.

4-41. BIAS ADJUSTMENT OF Q201. The bias of field-effect transistor Q201 should be adjusted if it or any

871A Voltage Dial Settings	821A Voltage Dial Settings	Maximum Deviation (± microvolts for 11 vdc in)
100000	99910	1000
999100	99910	1000
90000	9000	900
899100	9000	900
80000	8000	800
799100	8000	800
70000	7000	700
699100	7000	700
60000	6000	600
599100	6000	600
50000	5000	500
499100	5000	500
40000	4000	400
399100	4000	400
30000	3000	300
299100	3000	300
20000	2000	200
199100	2000	200
10000	1000	100
099100	1000	100
09000	0900	100
089100	0900	100
08000	0800	100
079100	0800	100
07000	0700	100
069100	0700	100
06000	0600	100
059100	0600	100
05000	0500	100
049100	0500	100
04000	0400	100
039100	0400	100
03000	0300	100
029100	0300	100
02000	0200	100
019100	0200	100
01000	0100	100
009100	0100	100
00900	0090	100
008100	0090	100
00800	0080	100
007100	0080	100
00700	0070	100
006100	0070	100
00600	0060	100
005100	0060	100
00500	0050	100
004100	0050	100
00400	0040	100
003100	0040	100
00300	0030	100
002100	0030	100
00200	0020	100
001100	0020	100
00100	0010	100
000100	0010	100

Figure 4-7. KELVIN-VARLEY DIVIDER ERROR LIMITS

component in its source-drain circuit is replaced. Proceed as follows:

a. Set POWER switch to LINE OPR with 871AB, or to ON with 871A.
b. Set NULL switch to TVM.
c. Adjust R209 so that the voltage from source to drain of Q201 (test point 2 to test point 3) is 6 volts, as measured with a VTVM.

4-42. NULL DETECTOR ZERO. If the meter zero changes position when the polarity switch is rotated, the null detector is out of electrical zero, and needs adjustment. Proceed as follows:

a. Short INPUT post to COMMON post.
b. Set switches on voltmeter as follows:

RANGE	1
NULL	.001
all voltage readout dials	zero

c. Meter offset should be less than 1/4 small scale division: If not, adjust R227 as necessary to zero the meter.
d. Remove the short from the input: meter offset should remain within 1/3 small scale division in both polarities.
e. After the meter has been zeroed electrically (i. e., the meter needle does not change position when the polarity switch is rotated) it may be necessary to adjust the meter mechanically for exact zero.

4-43. MECHANICAL DRUM ADJUSTMENTS

4-44. Occasionally the need may arise to align the polarity switch drum or one of the voltage dial drums in the readout windows. Also, if the drive gear on a switch or dial shaft is no longer in line with the drum shaft, the gears may bind as the dials are rotated. Align as follows:

a. Remove both side front-covers and the bottom cover from 871A.
b. Stand instrument on rear.
c. Make sure that drive gear on polarity switch shaft and drive gear on shaft of voltage dial D are in line with drum shaft. If not, loosen set screw of drive gear with a 1/16" hex key and align drive gear with drum shaft.
d. Loosen adjusting bracket at left side of instrument and position drum shaft up or down until there is just discernible backlash. That is, until polarity drum just moves when rotated with a finger without moving drive gear on polarity switch shaft.
e. Loosen adjusting bracket at right side of instrument and position drum shaft until there is just discernible backlash for drum of voltage dial D.
f. Turn polarity switch and all voltage dials fully counterclockwise.
g. Loosen set screw of drive gear for drum being aligned and slide drive gear toward back of instrument.

NOTE

See step l. for adjustment of voltage dial D.

h. Insert finger through window and hold drum being aligned in desired position.

i. Insert hex key into set screw of drive gear and lift drive gear into place allowing it to turn counterclockwise as the teeth mesh.

j. When drive gear is in line with drum shaft tighten set screw.

k. Check character alignment in window. If necessary, loosen set screw and rotate drive gear slightly for final adjustment.

l. To align drum for voltage dial D, loosen set screw of drive gear and slide toward rear of instrument.

m. Insert hex key into set screw of drive gear and lift drive gear into alignment with drive shaft while noting how much drum turns.

n. Slide drive gear toward rear of instrument.

o. Position drum so that oo position will line up with pointer when gear is raised into position.

p. Raise drive gear into alignment with drum shaft and position 00 in line with pointer by rotating drive gear slightly before tightening set screw.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

a. The REF DESIG. column indicates the reference designation used on the schematic diagram.

b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.

c. Entries in the FLUKE STOCK NO. column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.

d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.

e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.

f. The number in the TOT. QTY. column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.

g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "∼" is used to indicate an approximate use code. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

a. Reference designation, description, and Fluke stock number.

b. Instrument model and serial number.

c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

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 STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Final Assembly (see Figure 5-1)						
	(Line-powered model)	871A	89536				
	(Battery/line-powered model)	871AB	89536				
	Front Panel Assembly (see Figure 5-2)						
	(871A)	3158-167692	89536		1		
	(871AB)	3158-167916	89536		1		
	Wiring Assembly (see Figure 5-3)						
	(871A)	3158-167700	89536		1		
	(871AB)	3158-167908	89536		1		
	Reference Supply Assembly (see Figure 5-4)	1702-167684	89536		1		
	Null Detector Assembly (see Figure 5-5)	1702-167676	89536		1		
	Kelvin-Varley Resistor Assembly (see Figure 5-6)	3158-167668	89536		1		
BT1	Battery, Ni-Cad 10.5V, 0.5AH (871AB)	4002-160408	06860	500BH	2		
F1	Fuse, 1/16 amp, 125V (not illustrated) slow-blowing (115V operation)	5101-163030	03614	Type MDL	1	3	
	Fuse, 1/32 amp, 230V (not illustrated) slow-blowing (230V operation)	5101-163022	03614	Type MDL	1	3	
J4, J5	Binding post, red	2811-142976	58474	DF31RC	2		
J6	Line plug, 3 pin	2109-160275	73586	M-1550-GS	1		
R7	Res, var, comp, 10K ±10%, 1/2W	4701-162800	12697	Series 37	1		
T1	Transformer, power	5602-167783	89536		1		
	Drum Assembly, polarity	2403-162883	89536		1		
	Drum Assembly, 0-10	2403-162891	89536		3		
	Drum Assembly, 0-100	2403-162909	89536		1		
	Gear, nylon	3155-154682	08863		5		
	Fuseholder	2102-160846	75915	342004	1		
	Knob, 5/8" dia.	2405-158949	89536		5		
	Knob, 1" dia, w/bar	2405-158956	89536		3		
	Bail, wire	3153-163386	89536		1		
	Rubber feet	2819-103309	83478	9102-W	4		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Handle	2404-101857	12136	919-415-173	1		
	Line cord	6005-161638	91934	019-1, SVT, 107-1	1		
	Top cover	3156-167619	89536		1		
	Side cover	3156-167635	89536		2		
	Bottom cover	3156-167627	89536		1		
	Side cover, front	3156-162164	89536		2		
	Battery cover (871AB)	3155-162305	89536		1		

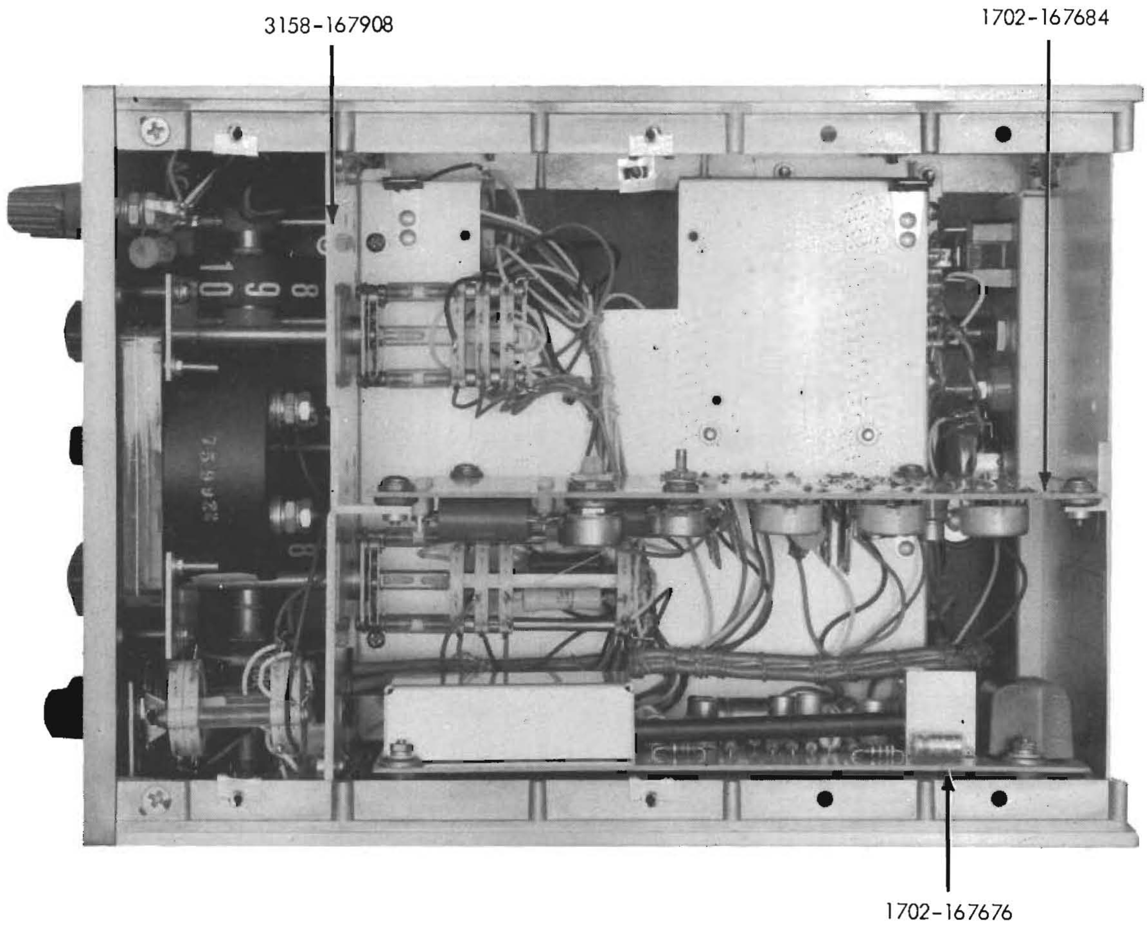


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 3)

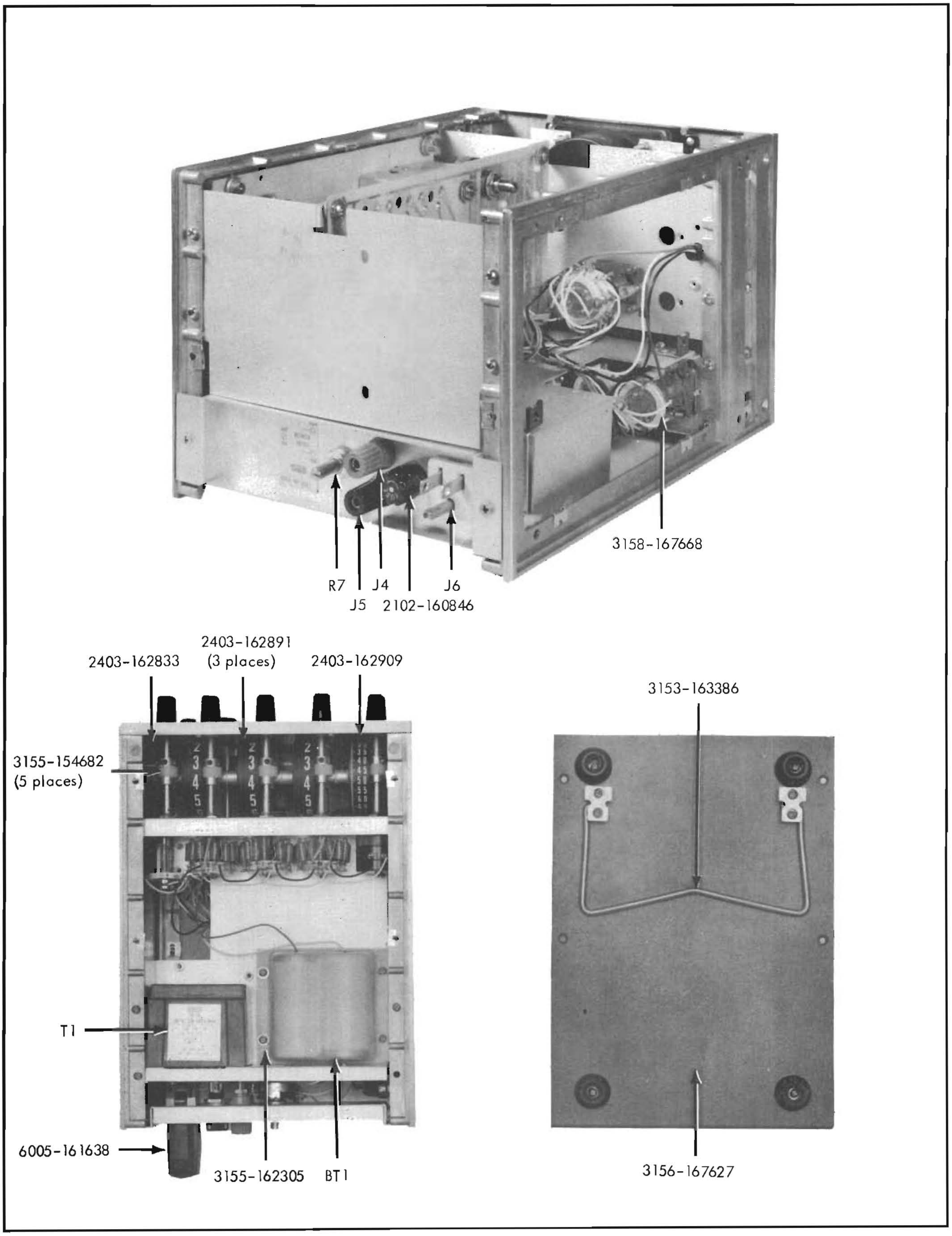


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 3)

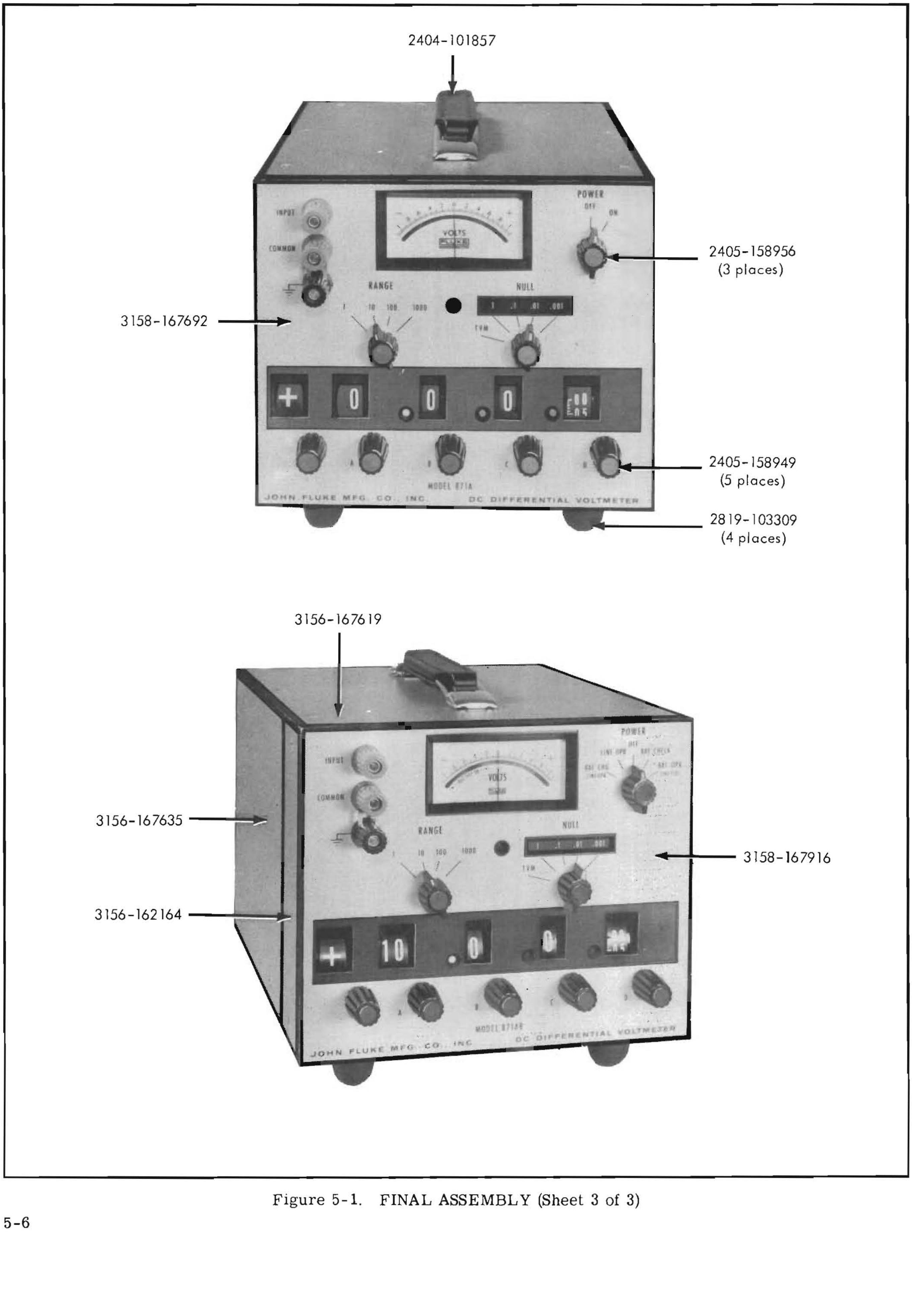


Figure 5-1. FINAL ASSEMBLY (Sheet 3 of 3)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Front Panel Assembly (871A)	3158-167692	89536		1		
	(871AB)	3158-167916	89536		1		
C1	Cap, plastic, .01 uf ±20%, 1000V	1509-159996	84411	663UW103010W	1		
C2	Cap, elect, 640 uf -10/+50%, 6.4V (not illustrated)	1502-178608	73445	ARC640	1		
J1, J2	Binding post, red	2811-142976	56474	DF31RC	2		
J3	Binding post, black	2811-142984	56474	DF31BC	1		
M1	Voltmeter, 100-0-100 ua, 900 ohms	2901-159202	89536		1		
	(871A)	2901-201236	38315	Type MS24T			
	Voltmeter, 100-0-100 ua, 900 ohms	2901-160382	89536		1		
	(871AB)	2901-201244	38315	Type MS24T			
R13	Resistor, 270Ω, 1/2W, 10% (not illus.)	4704-108241	01121	RC20	1		

NOTE:
Delete R13 and C2 for voltmeters 2901-159202 and 2901-160382. R13 and C2 are added to provide external damping for voltmeters 2901-201236 and 2901-201244. External damped meters are preferred replacements.

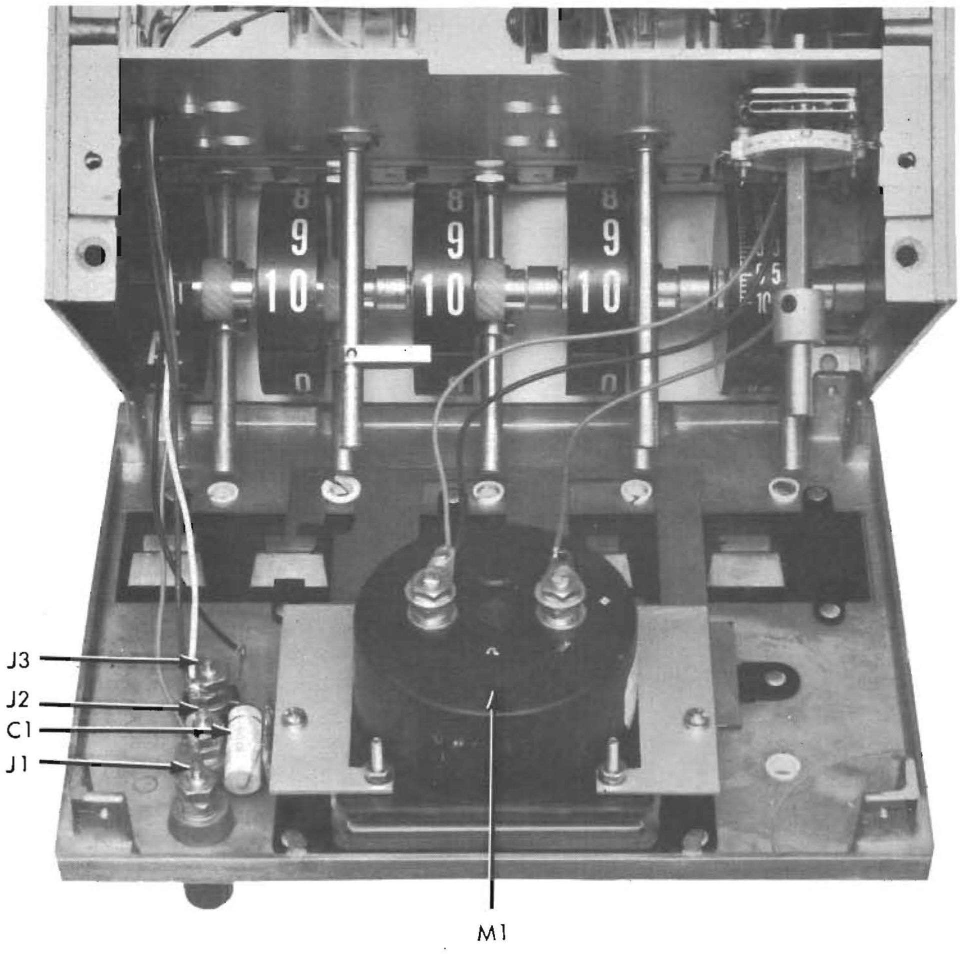


Figure 5-2. FRONT PANEL ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Wiring Assembly						
	(871A)	3158-167700	89536		1		
	(871AB)	3158-167908	89536		1		
R1, R2	Res, met flm, 4.5M ±1%, 1W	4705-159418	14298	CM-1	2		
R3	Res, met flm, 900K ±1%, 1W	4705-159509	19701	Type MF8C-TO	1		
R4	Res, met flm, 90K ±1%, 1/2W	4705-159426	75042	Type CEC-TO	1		
R5	Res, met flm, 9K ±1%, 1/2W	4705-159434	75042	Type CEC-TO	1		
R6	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	1		
R9	Res, comp, 100K ±5%, 1/2W (871AB) (not illustrated)	4704-168054	01121	EB1045	1		
S1	Sw, rot, 2 poles, 2 positions (871A)	5105-162693	89536		1		
	Sw, rot, 8 poles, 5 positions (871AB)	5105-163360	89536		1		
S2	Sw, rot, 6 poles, 4 positions	5105-162677	89536		1		
S3	Sw, rot, 7 poles, 5 positions	5105-162669	89536		1		
S4	Sw, rot, 2 poles, 2 positions	5105-162685	89536		1		

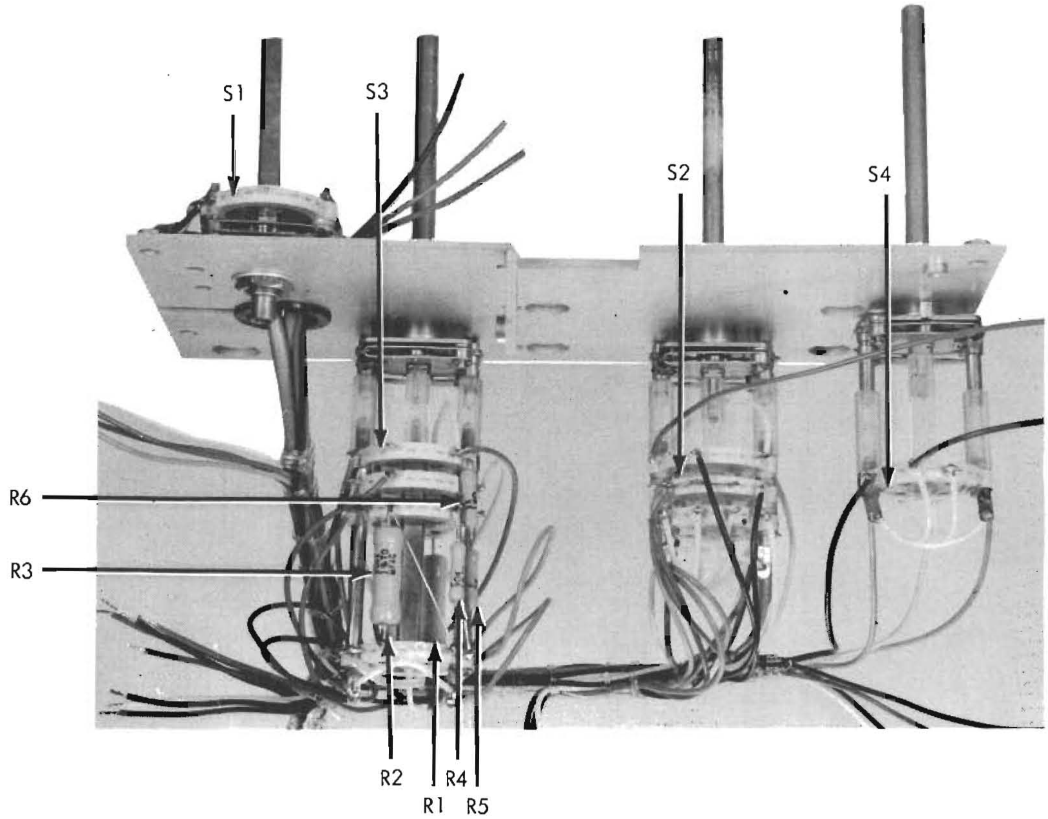


Figure 5-3. WIRING ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Reference Supply Assembly	1702-167684	89536		1		
	Zener-Resistor Set	3158-175091	89536		1		
CR103, CR104	Diode, zener, aged, type 1N3497	▷1	89536		2		
R117	Res, WW, 675Ω ±1%, 1/2W	▷2	89536		1		
R118	Res, WW, 7. 5K to 10K Factory Selected	▷2	89536		1		
C101	Cap, Al, elect, 150 uf -10/+150%, 50V	1502-160119	88419	BR150-50	1		F
	Cap, Al, elect, 160 uf -10/+50%, 64V	1502-170274	73445	C437ARH160	1	1	G
C102	Cap, Al, elect, 20 uf -10/+75%, 50V	1502-106229	06001	76F02LK200			F
	Cap, Al, elect, 50 uf -10/+50%, 25V	1502-168823	73445	C426ARF50	2	1	G
CR101, CR102	Diode, Si, 100 PIV, 1A (CR102 used on 871AB only)	4802-116111	14099	SCE1	2	1	
Q101	Tstr, NPN, Si	4805-150359	95303	2N3053	2		~D
	Tstr, NPN, Si	4805-153551	07910	CDQ10449	3		~D
	Tstr, NPN, Si	4805-117135	95303	2N2270	1	1	E
Q102, Q103	Tstr, NPN, Si	4805-153551	07910	Same as Q101	REF		F
	Tstr, NPN, Si	4805-168708	33173	2N3391	2	1	G
Q104	Tstr, PNP, Si	4805-190389	04713	SM4144	1	1	
R101, R102, R103	Res, WW, 3M ±.03%, 1W	4707-165670	89536		3		
R104	Res, var, WW, 2K ±20%, 3W	4702-167247	71450	BJ49715	1		
R105	Res, WW, 898. 84K ±. 03%, 1W	4707-165654	89536		1		
R106	Res, var, comp, 250Ω ±30%, 0. 3W	4701-166983	71450	Type 70 (Without Switch)	1		
R107	Res, WW, 99. 91K ±. 05%, 1/4W	4707-165662	89536		1		
R108	Res, comp, 270Ω ±10%, 1/2W	4704-108241	01121	EB2711	1		
R109	Res, met flm, 4. 99K ±1%, 1/2W	4705-148890	75042	Type CEC-TO	1		
R110	Res, met flm, 16. 2K ±1%, 1/2W	4705-170928	75042	Type CEC-TO	1		
R111	Res, var WW, 1K ±20%, 1-1/4W	4702-111575	71450	Type 110	1		
R112	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	4		

▷1 If replacement is required, replace with a new Zener-Resistor Set.

▷2 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.

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R113	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	3		
R114	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	Same as R112	REF		
R115	Res, comp, 5.6K ±10%, 1/2W	4704-108324	01121	EB5621	3		
R116	Res, comp, 1M ±10%, 1/2W	4704-108134	01121	EB1051	1		D
	Res, comp, 680K ±10%, 1/2W	4704-108340	01121	EB6841	1		J
R119	Res, var, WW, 25Ω ±10%, 1-1/4W	4702-161703	71450	Type 110	1		
R120	Res, WW, 49.45K ±.03%, 1W	4707-167353	89536		1		
R121	Res, var, WW, 100Ω ±20%, 1-1/4W	4702-112797	71450	Type 110	2		
R122	Res, WW, 6.111K ±.03%, 1W	4707-163436	89536		1		
R123	Res, comp, 120Ω ±10%, 1W	4704-109827	01121	GB1211	1		
R124	Res, comp, 3.9K ±5%, 1/4W	4704-148064	01121	CB3925	1		I
	Polyethelene grommet	2807-171876	89536		9		
	Polyethelene grommet (not illustrated)	2807-171884	89536		1		

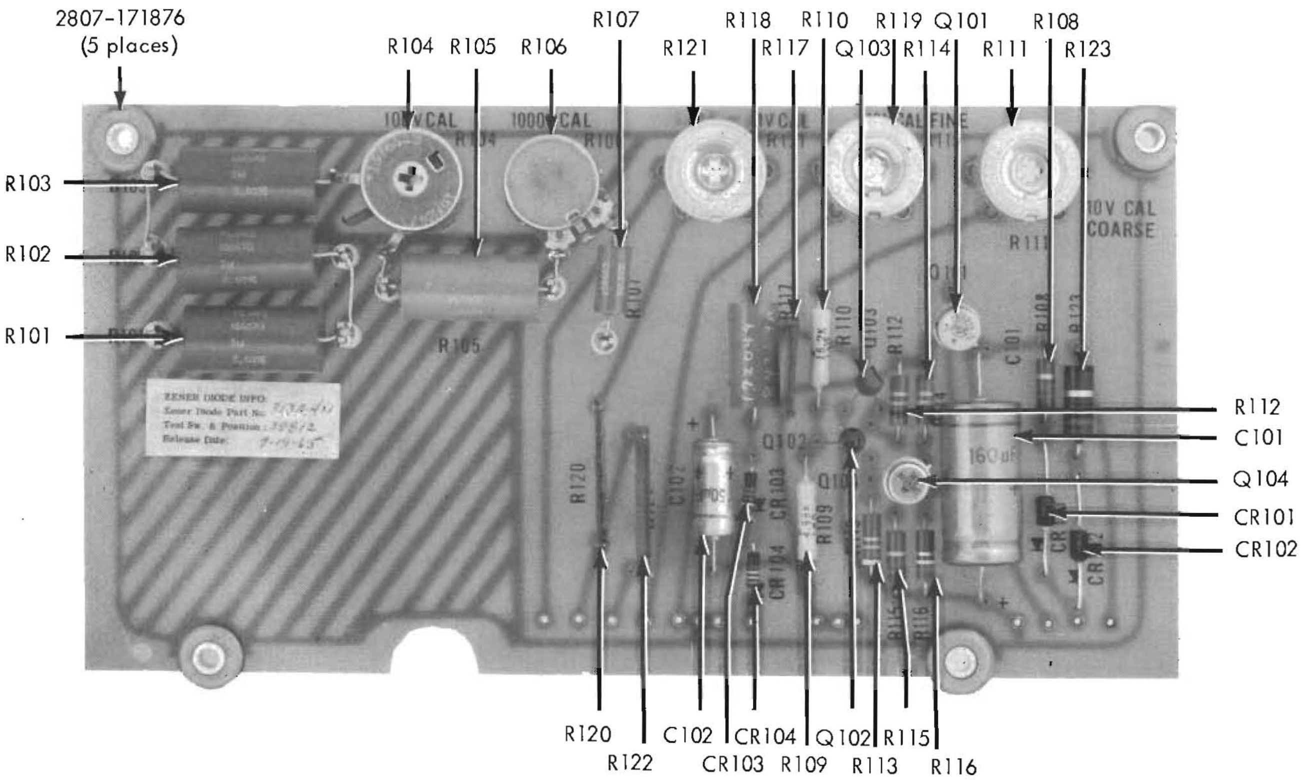


Figure 5-4. REFERENCE SUPPLY ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Null Detector Assembly	1702-167676	89536				
C201	Cap, plastic, .1 uf ±20%, 120V	1507-167460	99217	Type SEC	1		
C202	Cap, plastic, .22 uf ±20%, 120V	1507-167452	99217	Type SEC	1		
C203	Cap, plastic, .047 uf ±20%, 100V	1507-106096	84411	663UW47301	2		
C204	Cap, Al, elect, 100 uf -10/+75%, 25V	1502-106518	56289	30D107G025DH4	1	1	
C205	Cap, Al, elect, 40 uf -10/+75%, 6V	1502-105205	56289	30D406G006BB4	1		A
	Cap, Al, elect, 50 uf -10/+50%, 25V	1502-168823	73445	Same as C102	REF	1	B
C206	Cap, Al, elect, 5 uf -10/+75%, 25V	1502-152009	56289	30D505G025BA4	3		A
	Cap, Al, elect, 10 uf -10/+50%, 25V	1502-170266	73445	C426ARF10	3	1	B
C207	Cap, Al, elect, 1250 uf -10/+50%, 4V	1502-166330	73445	C437ARB1250	2	1	
C208	Cap, Al, elect, 5 uf -10/+75%, 25V	1502-152009	56289	Same as C206	REF		A
	Cap, Al, elect, 10 uf -10/+50%, 25V	1502-170266	73445	Same as C206	REF		B
C209	Cap, plstc, .0047 uf ±20%, 200V	1507-106054	56289	192P47202	1		
C210	Cap, cer, 500 pf ±10%, 500V	1501-105692	56289	40C210	2		
C211	Cap, plstc, .022 uf ±20%, 100V	1507-106039	84411	663UW22301	1		
C212	Cap, plstc, .047 uf ±20%, 100V	1507-106096	84411	Same as C203	REF		
C213	Cap, Al, elect, 5 uf -10/+75%, 25V	1502-152009	56289	Same as C206	REF		A
	Cap, Al, elect, 10 uf -10/+50%, 25V	1502-170266	73445	Same as C206	REF		B
C214	Cap, Al, elect, 1250 uf -10/+50%, 4V	1502-166330	73445	Same as C207	REF		
C215	Cap, cer, 500 pf ±10%, 500V	1501-105692	56289	Same as C210	REF		
CR201	Diode, Si, Stabistor, 6 PIV, 0.15A (not illustrated)	4802-113308	07910	CD13161	1		A
DS201	Lamp, neon (coated with epoxy resin)	3902-162776	89536		1	1	
DS202	Lamp, neon (not illustrated)	3902-162602	89730	NE2U	1	1	
Q201	Tstr, field effect, P-channel, Si	4805-159210	17856	SU443	1	1	
Q202	Tstr, PNP, Si	4805-159491	04713	SM4144	1		H
	Tstr, PNP, Si	4805-195974	04713	2N3906			K
	Tstr, PNP, Si	4805-169375	65092	2N3638	4	1	M
Q203 thru Q205	Tstr, PNP, Ge	4805-148643	01295	2N1307	3		A
	Tstr, PNP, Si	4805-169375	65092	Same as Q202	REF		B

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
Q206, Q207	Tstr, NPN, Ge	4805-117127	01295	2N1304	2	1	
Q208	Tstr, NPN, Si	4805-150359	95303	Same as Q101	REF	1	
Q209	Tstr, PNP, Si	4805-159491	04713	Same as Q202	REF		A
	Tstr, PNP, Ge	4805-182709	01295	GA2877			K
	Tstr, PNP, Ge	4805-148619	01295	2N1303	1	1	L
R201	Res, comp, 270K ±10%, 2W	4704-110023	01121	HB2741	1		
R202	Res, comp, 470K ±10%, 1/2W	4704-108290	01121	EB4741	3		
R203	Res, met flm, 200Ω ±1%, 1/2W	4705-151480	75042	Type CEC-TO	1		
R204	Res, comp, 1.2M ±10%, 1/2W	4704-108407	01121	EB1251	1		
R205	Res, comp, 2.2M ±10%, 1/2W	4704-108225	01121	EB2251	1		
R206	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	1		
R207	Res, comp, 1.8K ±10%, 1/2W (not illustrated)	4704-108860	01121	EB1821	3		
R208	Res, met flm, 6.81K ±1%, 1/2W	4705-162552	75042	Type CEC-TO	1		
R209	Res, var, WW, 5K ±5%, 2W	4702-111609	71450	Type 115	1		
R210	Res, comp, 120K ±10%, 1/2W	4704-108779	01121	EB1241	5		
R211	Res, comp, 470K ±10%, 1/2W	4704-108290	01121	Same as R202	REF		
R212	Res, comp, 120K ±10%, 1/2W	4704-108779	01121	Same as R210	REF		
R213	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	Same as R113	REF		
R214	Res, comp, 5.6K ±10%, 1/2W	4704-108324	01121	Same as R115	REF		
R215	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	Same as R207	REF		
R216	Res, comp, 4.7Ω ±10%, 1/2W	4704-165746	01121	EB47G1	1		
R217	Res, comp, 470K ±10%, 1/2W	4704-108290	01121	Same as R202	REF		
R218, R219	Res, var, comp, 100K ±20%, 1-1/4W	4701-163873	71450	Type UPE200	3		
R220, R221	Res, comp, 120K ±10%, 1/2W	4704-108779	01121	Same as R210	REF		
R222	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	Same as R207	REF		
R223, R224	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	EB1531	3		
R225	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	Same as R113	REF		
R226	Res, comp, 120K ±10%, 1/2W	4704-108779	01121	Same as R210	REF		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R227	Res, var, comp, 100K ±20%, 1-1/4W	4701-163873	71450	Same as R218	REF		
R228	Res, comp, 47M ±10%, 1/2W	4704-146415	01121	EB4761	1		
R229	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	Same as R223	REF		
R230	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	EB3321	1		
R231	Res, var, WW, 100Ω ±20%, 1-1/4W	4702-112797	71450	Same as R121	REF		
R232	Res, met flm, 402Ω ±1%, 1/2W	4705-150839	75042	Type CEC-TO	1		
R233	Res, met flm, 17.8K ±1%, 1/2W	4705-162545	75042	Type CEC-TO	1		N
	Res, met flm, 18.2K ±1%, 1/2W	4705-217778			1		O
R234	Res, met flm, 14.7K ±1%, 1/2W	4705-162537	75042	Type CEC-TO	1		
R235	Res, met flm, 15.8K ±1%, 1/2W	4705-171983	75042	Type CEC-TO	1		N
	Res, met flm, 15.0K ±1%, 1/2W	4705-151498			1		O
R236, R237	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	Same as R112	REF		
R238	Res, comp, 5.6K ±10%, 1/2W	4704-108324	01121	Same as R115	REF		C
T201	Transformer	5602-167775	89536		1		
V201	Photoelectric cell	3700-200287	89536		1		
	Rod, optical (not illustrated)	3800-168047	89536		1		
	Polyethelene grommet, 3/8 x 1/4	2807-171876	89536		REF		

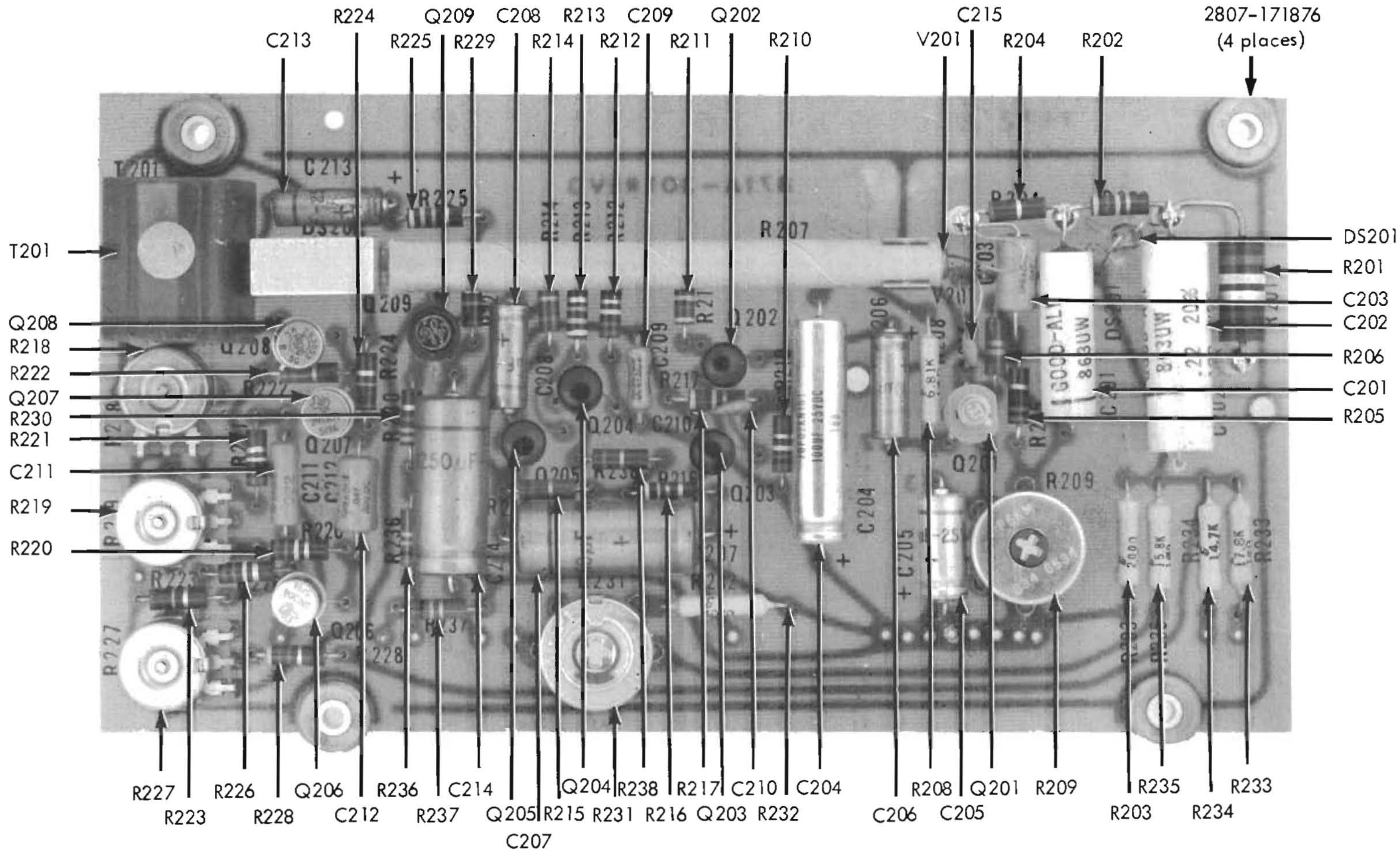


Figure 5-5. NULL DETECTOR ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Kelvin-Varley Resistor Assembly	3158-167668	89536				
R301	Res, var, WW, 2.5K ±.5%, Dial "D"	4711-163154	89536		1		
R302	Res, WW, 476.2Ω ±.05%, 1/4W (not illustrated)	4707-163956	89536		1		
R303 thru R313	Res, WW, 200Ω ±.06%, 1/4W	▷1	89536		11		
R314 thru R324	Res, WW, 1K ±.05%, 1/4W	▷1	89536		11		
R325 thru R336	Res, WW, 5K ±.05%, 1/4W	▷1	89536		12		
S301	Switch, rotary, Dial "A", 2 poles, 11 positions	5105-162644	89536		1		
S302, S303	Switch, rotary, Dials "B" and "C", 2 poles, 10 positions	5105-162651	89536		2		

▷1 These resistors are factory matched for each instrument. When ordering, include all information stamped on old resistor, or an adjacent resistor.

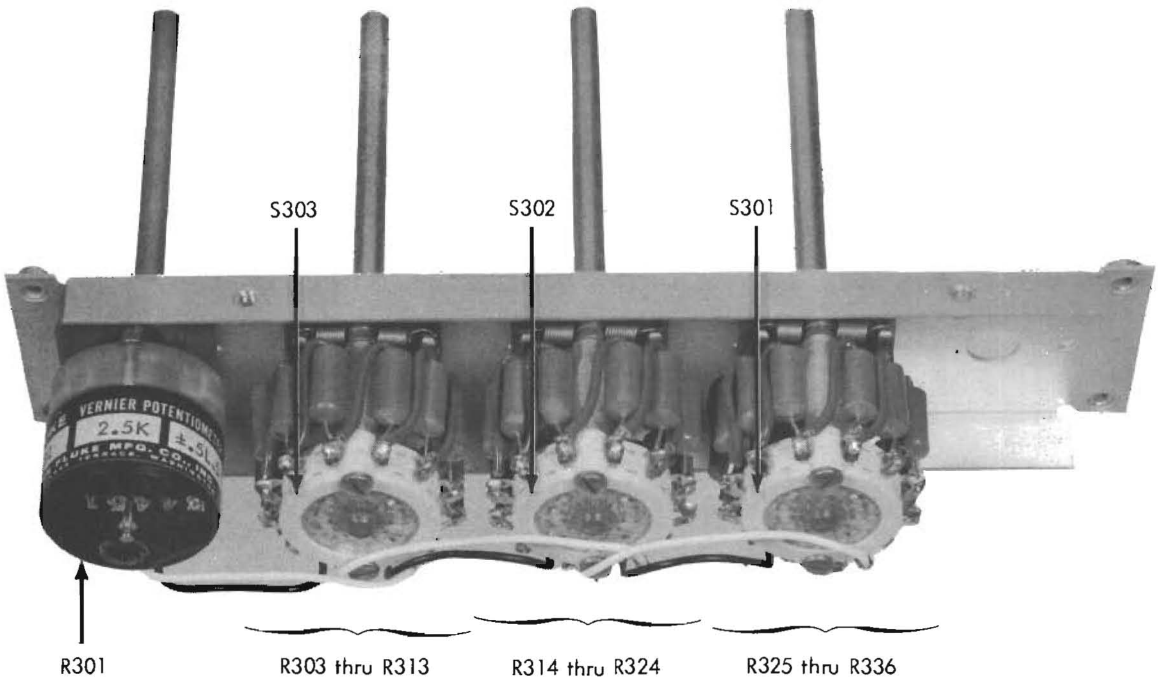


Figure 5-6. KELVIN-VARLEY RESISTOR ASSEMBLY

5-8. USE CODE EFFECTIVITY

5-9. The following list of use codes is intended to aid the customer in determining the effectivity of all replaceable parts. All parts having 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 871A and 871AB serial number 123 and on
A	Model 871A and 871AB serial number 123 thru 181
B	Model 871A and 871AB serial number 182 and on
C	Model 871A and 871AB serial number 182, 203 and on
D	Model 871A and 871AB serial number 123 thru 160
E	Model 871A and 871AB serial number 161 and on
F	Model 871A and 871AB serial number 123 thru 227
G	Model 871A and 871AB serial number 228 and on
H	Model 871A and 871AB serial number 123 thru 181, and 183 thru 202
I	Model 871A and 871AB serial number 276 and on
J	Model 871A and 871AB serial number 161 thru 275
K	Model 871A serial number 353 and on
L	Model 871A serial number 182 thru 351
M	Model 871A serial number 182, 203 thru 351
N	Model 871A serial number 123 thru 447 Model 871AB serial number 123 thru 432
O	Model 871A serial number 448 and on Model 871AB serial number 433 and on

SECTION VI

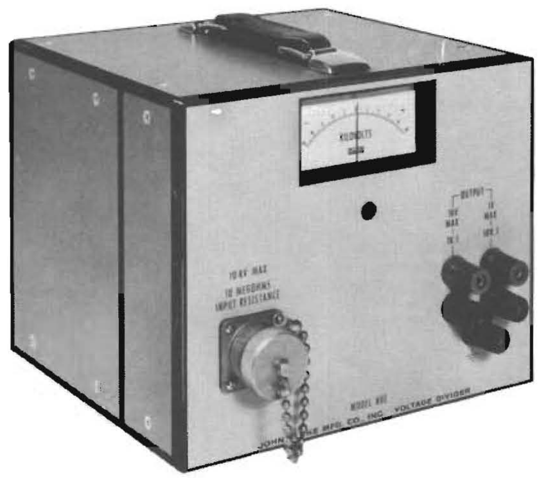
ACCESSORIES

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 80A-2	1 KV 2 KV	1 M 2 M	1 ma 1 ma	2:1 4:1	—— ——	—— ——	±0.015% ±0.015%	—— ——
80E-5 80E-10	5 KV 10 KV	5 M 10 M	1 ma 1 ma	— —	500:1 1000:1	5,000:1 10,000:1	±0.01% ±0.01%	±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.

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name. Suppliers not listed in the Federal Supply Code for Manufacturers have been assigned an alphabetical code by FLUKE.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Company Milwaukee, Wisconsin
01281	Pacific Semiconductors Inc. Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas
01730	Circle Mfg. Co. Inc. Little Falls, New Jersey
01884	Dearborn Electronic Labs Inc. Orlando, Florida
01963	Cherry Electrical Products Corp. Highland Park, Illinois
02660	Amphenol-Borg Elect. Corp. Chicago, Illinois
02606	Fenwal Laboratories Inc. Framington, Massachusetts
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Bussmann Mfg. Div. of McGraw-Edison Co. Los Angeles, California
03615	Ohmite Mfg. Co. Los Angeles, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Elmenco Products Company New York, New York
04202	Winchester Electronics Co. New Milford, Connecticut
04221	Telex-Aemco Division of Telex Corp. Mankato, Minnesota
04645	Kurz-Kasch, Inc. Chicago, Illinois
04713	Motorola Inc. Semiconductor Products Division Phoenix, Arizona
05082	Tung-Sol Electric Inc. Melrose Park, Illinois
05278	Penn-East Engrg. Corp. Kutztown, Pennsylvania
05397	Union Carbide Corp. Linde Division Kemet Dept. Cleveland, Ohio
05571	Sprague Electric Company Culver City, California
05704	Alac, Inc. Glendale, California
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Ward Leonard Electric Co. Los Angeles, California
06473	Amphenol Space and Missile Sys Chatsworth, California
06555	Beede Electrical Inst. Co. Penacook, New Hampshire
06751	Nuclear Corporation of America, Inc. U. S. Semcor Div. Phoenix, Arizona
06860	Gould National Batteries Inc. La Puente, California
07115	Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania
07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08863	Nylomatic Corp. Morrisville, Pennsylvania
08988	Skottie Electronics Inc. Peckville, Pennsylvania
11237	Chicago Telephone of Calif Inc. South Pasadena, California
11503	Keystone Mfg. Co. Warren, Michigan
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12400	International Resistance Co. Control Components Division Philadelphia, Pennsylvania
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components Inc. Conshohocken, Pennsylvania
14752	Electro Cude Inc. South Pasadena, California
15818	Amelco Inc. Mountain View, California
15909	Daven Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey
16332	Milwaukee Relays Inc. Cedarburg, Wisconsin
16473	Cambridge Scientific Industries Inc. Cambridge, Maryland
17069	Circuit Structures Lab Santa Ana, California
17856	Siliconix Inc. Sunnyvale, California
17910	Continental Device Corp. Hawthorne, California
18083	Clevite Corp. Transistor Division Palo Alto, California
19429	Montronics, Inc. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
24655	General Radio Co. West Concord, Mass.
28520	Heyman Mfg. Co. Kenilworth, New Jersey
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	P. R. Mallory and Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Division Manchester, New Hampshire
42498	National Company, Inc. Malden, Massachusetts
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	USHCO Mfg. Co., Inc. Buffalo, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Co. Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois

71400 Bussman Manufacturing
Division of McGraw Edison Co.
St. Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71468 Cannon Electric Company
Los Angeles, California

71482 Clare, C. P. and Company
Chicago, Illinois

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

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

71744 Chicago Miniature Lamp
Works
Chicago, Illinois

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

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

72092 Eitel-McCullough, Inc.
San Bruno, California

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72354 Fast, John E. Co.
Div. of Victoreen Instr. Co.
Chicago, Illinois

72559 Essex Electronics Inc.
Berkeley Heights, New Jersey

72619 Dialight Corp.
Brooklyn, New York

72665 Mallory Battery Company
Cleveland, Ohio

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Helipot Division of
Beckman Instruments Inc.
Fullerton, California

73293 Hughes Products Div. of
Hughes Aircraft Co.
Newport Beach, California

73445 Amperex Electronic Co.
Div. of North American
Philips Co., Inc.
Hicksville, New York

73559 Carling Electric Inc.
Hartford, Connecticut

73586 Circle F Mfg. Co.
Trenton, New Jersey

73899 JFD Electronics Corp.
Brooklyn, New York

73949 Guardian Electric Mfg. Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74306 Piezo Crystal Company
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

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

75042 International Resistance Co.
Philadelphia, Pennsylvania

75915 Littelfuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 American Machine
and Foundry Company
Potter & Brumfield Div.
Princeton, Indiana

77969 Rubbercraft Corp. of
California Ltd.
Torrance, California

78277 Sigma Instruments, Inc.
South Braintree, Mass.

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

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

80294 Bourns Laboratories, Inc.
Riverside, California

80583 Hammarlund Company, Inc.
New York, New York

80640 Stevens, Arnold Co., Inc.
Boston, Massachusetts

81073 Grayhill Company
La Grange, Illinois

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Astron Division
Renwell Industries Inc.
East Newark, New Jersey

82389 Switchcraft Inc.
Chicago, Illinois

82872 Roanwell Corp.
Brooklyn, New York

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

82879 Royal Electric Corp.
Pawtucket, Rhode Island

83003 Varo Mfg. Co., Inc.
Garland, Texas

83298 Bendix Corp.
Red Bank Division
Red Bank, Eatontown,
New Jersey

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

83478 Rubbercraft Corp. of Am.
New Haven, Connecticut

84411 Good All Electric Mfg. Co.
Ogallala, Nebraska

86689 R.M.B. Corp.
Los Angeles, California

88419 Cornell-Dubilier Elec. Corp.
Electro-Mechanical Div.
Fuquay Springs,
North Carolina

88690 Essex Wire Corp.
R.B.M. Division
Detroit, Michigan

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

89730 General Electric Company
Newark Lamp Works of
Lamp Division of Consumer
Products Group
GECO
Newark, New Jersey

90205 Best Stamp and Mfg. Co.
Kansas City, Missouri

90211 Square D Company
Chicago, Illinois

90303 Mallory Battery Company
North Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Superior Electric Company
Oak Park, Illinois

91662 Elco Corp.
Willow Grove, Penn.

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

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91929 Minneapolis Honeywell
Regulator Company
Micro Switch Division
Freeport, Illinois

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

93332 Sylvania Electric Products Inc.
Semiconductor Products Division
Woburn, Massachusetts

94145 Raytheon Company
Semiconductor Division
California Street Plant
Newton, Massachusetts

95146 Alco Electronics Mfg. Co.
Lawrence, Massachusetts

95264 Lerco Electronics Inc.
Burbank, California

95303 Radio Corp. of America
Comm. Receiving Tube &
Semiconductor Division
Cincinnati, Ohio

95354 Methode Mfg. Co.
Chicago, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

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

96881 Thomson Industries, Inc.
New Hyde Park
Long Island, New York

97945 S. S. White Dental Mfg. Co.
Plastics Division
New York, New York

97966 CBS Electronics Div. of
Columbia Broadcasting
System, Inc.
Danvers, Massachusetts

98094 Penta Laboratories, Inc.
Santa Barbara, California

98388 Accurate Sales Company
Culver City, California

98743 James Vibrapower Corp.
Chicago, Illinois

98925 Semiconductor Division
of Clevite Corp.
Waltham, Massachusetts

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Electron Prod. Div.
Pasadena, California

Revised May 15, 1966
Using H4-2 Dated March 1963

WARRANTY

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

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

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

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

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

Sales and Service Representatives

ALABAMA

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BCS Associates, Inc.
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Tel. (205) 534-1648

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Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington
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Barnhill Associates
4900 E. Indian School Road
Tel. (602) 959-2115

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2870 Los Feliz Place
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940 N. Fern Creek Ave.
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44 Kirk Drive
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P.O. Box 7371
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1046 Massachusetts Avenue
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10534 Natural Bridge Road
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Union, New Jersey
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NEW MEXICO

ALBUQUERQUE
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SBM Associates, Inc.
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Pleasantville, New York
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Plainview, Long Island
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Tel. (716) 381-8330

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3118 Germantown Pike
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114 Spring Grove Road
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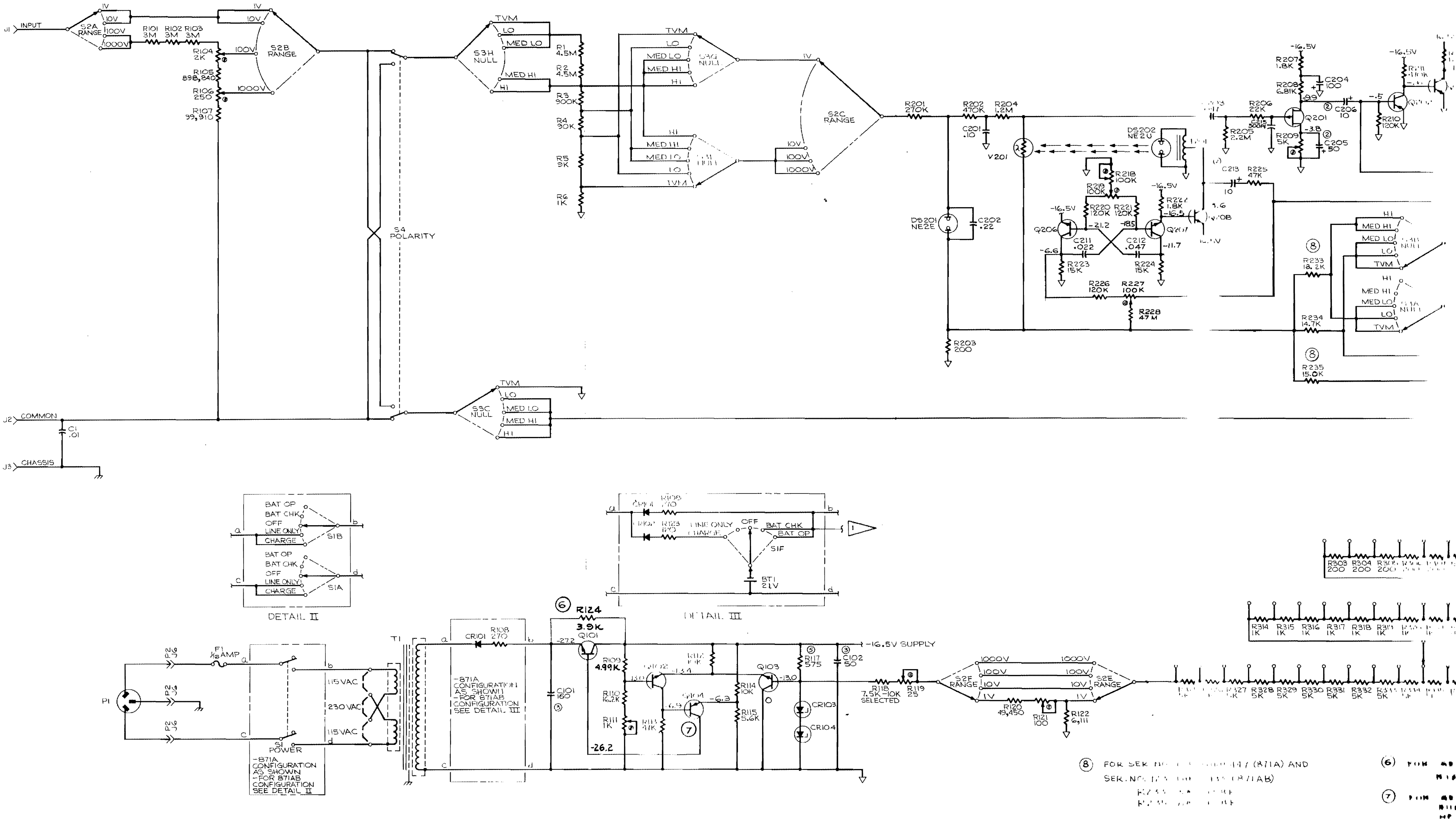
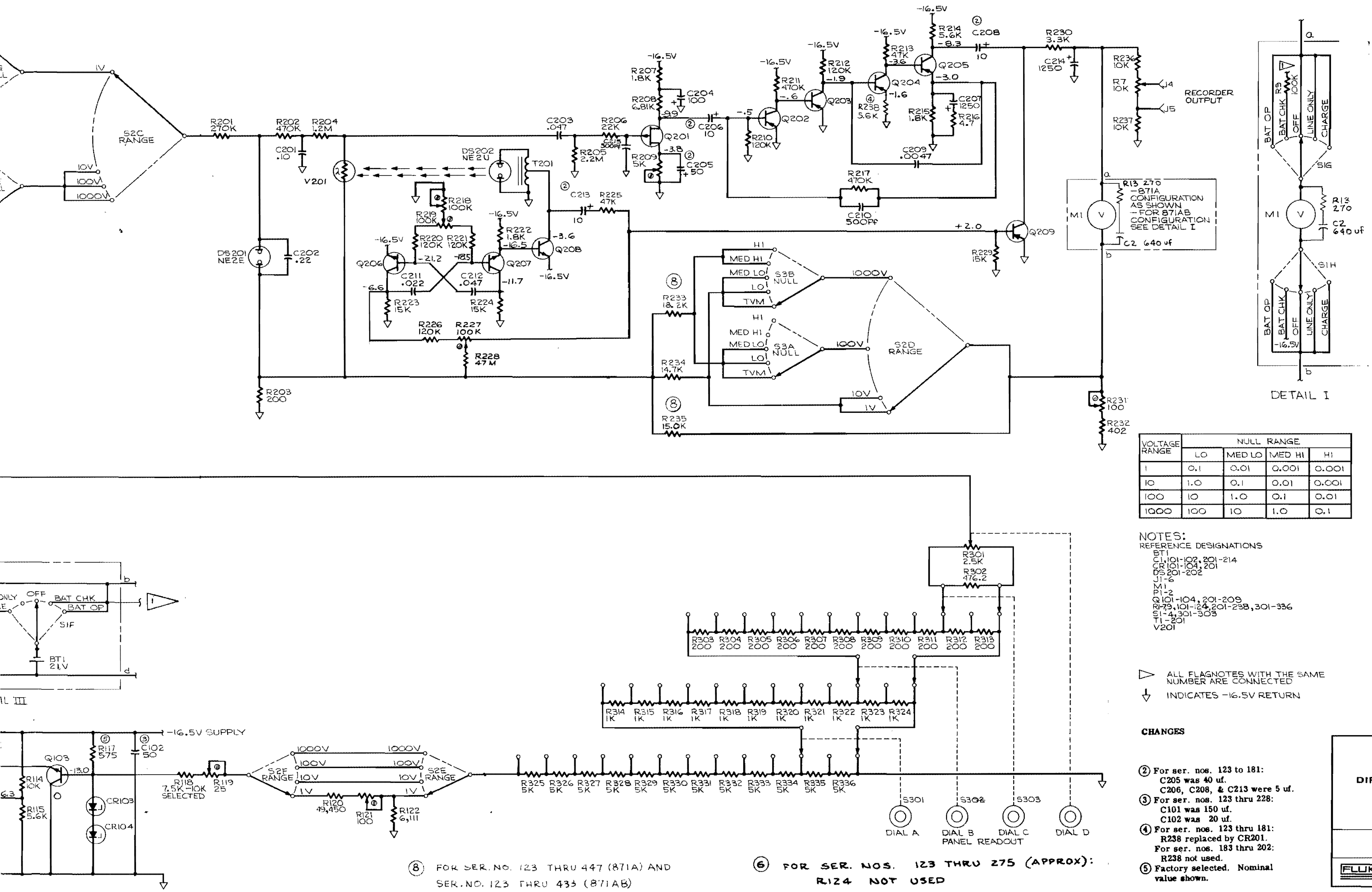
In Europe contact FLUKE NEDERLAND, N. V., Post Office Box 5053, Tilburg, The Netherlands

FLUKE



J1 INPUT
S2A RANGE
1V
10V
100V
1000V
R101 3M
R102 3M
R103 3M
R104 2K
R105 898,840
R106 250
R107 99,910
S2B RANGE
S3H NULL
TVM
LO
MED LO
MED HI
HI
R1 4.5M
R2 4.5M
R3 900K
R4 90K
R5 9K
R6 1K
S3G NULL
S4 POLARITY
S2C RANGE
R201 270K
R202 470K
R204 1.2M
C201 .10
V201
DS201 NE2E
C202 .22
R203 200
DS202 NE2U
R218 100K
R219 100K
R220 120K
R221 120K
R222 1.8K
Q206
Q207
Q208
C211 .022
C212 .047
R223 15K
R224 15K
R226 120K
R227 100K
R228 47M
C213 10
R225 47K
R205 2.2M
R206 22K
R207 1.8K
R208 6.81K
R209 5K
C204 100
C205 50
C206 10
Q201
R210 120K
R233 18.2K
R234 14.7K
R235 15.0K
-16.5V
J2 COMMON
C1 .01
J3 CHASSIS
S3C NULL
BAT OP
BAT CHK
OFF
LINE ONLY
CHARGE
S1B
S1A
DETAIL II
CR101
R108 270
CR102
R123 270
S1F
BT1 21V
DETAIL III
R124 3.9K
Q101
R109 4.99K
R110 16.2K
R111 1K
R113 47K
Q102
Q104
Q103
R112 10K
R114 10K
R115 5.6K
R117 575
C102 50
CR103
CR104
-16.5V SUPPLY
C101 160
-26.2
-27.2
P1
F1 1/8 AMP
S1 POWER
115VAC
230VAC
T1
-871A CONFIGURATION AS SHOWN -FOR 871AB CONFIGURATION SEE DETAIL II
-871A CONFIGURATION AS SHOWN -FOR 871AB CONFIGURATION SEE DETAIL III
R118 7.5K-10K SELECTED
R119 25
S2F RANGE
S2E RANGE
R120 49,450
R121 100
R122 6,111
R303 200
R304 200
R314 1K
R315 1K
R316 1K
R317 1K
R318 1K
R327 5K
R328 5K
R329 5K
R330 5K
R331 5K
R332 5K



VOLTAGE RANGE	NULL RANGE			
	LO	MED LO	MED HI	HI
1	0.1	0.01	0.001	0.001
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
- C1,101-102,201-214
- CR101-104,201
- DS201-202
- J1-6
- M1
- P1-2
- Q101-104,201-209
- R1-79,101-124,201-238,301-336
- S1-4,301-303
- T1-201
- V201

▷ ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED

↓ INDICATES -16.5V RETURN

⑧ FOR SER. NO. 123 THRU 447 (871A) AND SER. NO. 123 THRU 433 (871AB)
R233 WAS 17.8K
R235 WAS 15.8K

⑥ FOR SER. NOS. 123 THRU 275 (APPROX):
R124 NOT USED

⑦ FOR SER. NOS. 123 TO 160:
R116 (1M) WAS CONNECTED FROM COLLECTOR OF Q104 TO -16.5V COMMON

FOR SER. NOS. 161 THRU 275 (APPROX):
R116 WAS 680K, CONNECTED AS ABOVE

CHANGES

② **For ser. nos. 123 to 181:**
C205 was 40 uf.
C206, C208, & C213 were 5 uf.

③ **For ser. nos. 123 thru 228:**
C101 was 150 uf.
C102 was 20 uf.

④ **For ser. nos. 123 thru 181:**
R238 replaced by CR201.
For ser. nos. 183 thru 202:
R238 not used.

⑤ **Factory selected. Nominal value shown.**

FUNCTIONAL SCHEMATIC

DIFFERENTIAL VOLTMETER

MODELS 871A and 871AB

871A	**SER. NO.**	**123 & ON**
871AB	**SER. NO.**	**123 & ON**

FLUKE **JOHN FLUKE MFG. CO. INC.**
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