



Simpson 270 Series 5 Volt-Ohm-Milliammeter INSTRUCTION MANUAL



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About this Manual

To the best of our knowledge and at the time written, the information contained in this document is technically correct and the procedures accurate and adequate to operate this instrument in compliance with its original advertised specifications.

Notes and Safety Information

This Operator's Manual contains warning symbols which alert the user to check for hazardous conditions. These appear throughout this manual where applicable, and are defined below. To ensure the safety of operating performance of this instrument, these instructions must be adhered to.



Warning, refer to accompanying documents.



Caution, risk of electric shock.

Technical Assistance

SIMPSON ELECTRIC COMPANY offers assistance Monday through Friday 8:00 am to 4:30 pm Central Time. To receive assistance contact Technical Support or Customer Service at (715) 588-3311.

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SIMPSON ELECTRIC COMPANY warrants each instrument and other articles manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory or other article of equipment which shall within one (1) year after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service centers, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sales of its products.

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6.3 Schematic Diagram

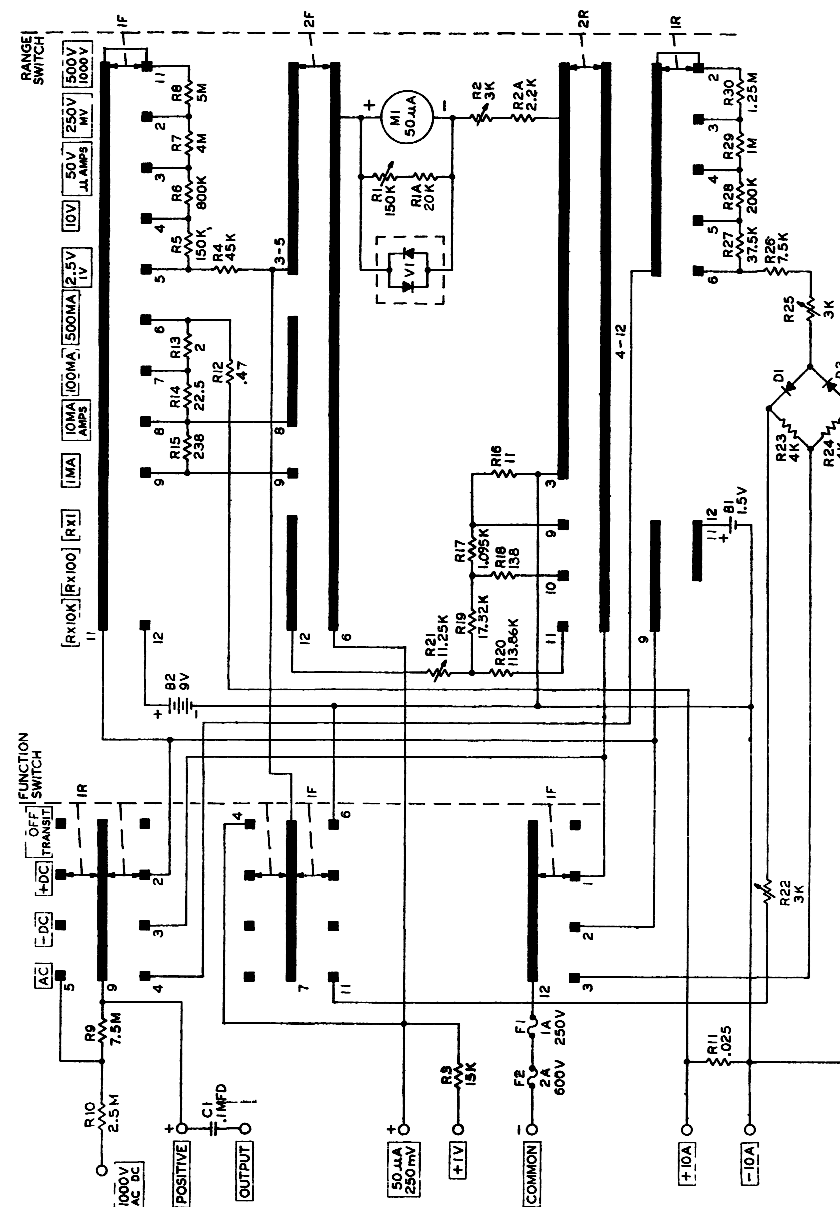


Figure 6-1. Schematic Diagram

Reference Symbol	Description	Part No.	Reference Symbol	Description
R16	Resistor, 11 Ω , 5W (Wire Wound)	6-111979		(Bussman Type BBS or Littlefuse Type BLS)
R17	Resistor, 1.095 k Ω	6-111639		For Function Switch
R18	Resistor, 138 Ω	6-111640		Knobs: For Zero Ohms
R19	Resistor, 17.320 k Ω	6-111638		Adjust
R20	Resistor, 113.860 k Ω	6-111637		For Range Switch
R21	Potentiometer			Case Assembly, Phenolic,
	11.25 k Ω	6-111446		Complete, including
R23, R24	Resistor, 4 k Ω	1-117140		Handleless Battery
R26	Resistor, 7.5 k Ω	1-117152		Compartment Front
R27	Resistor, 37.5k Ω	1-117145		Cover
R28	Resistor, 200 k Ω	1-117146		Cover Assembly
R29	Resistor, 1 M Ω	1-117150		Rubber Bumper Plug
R30	Resistor, 1.25 M Ω	5-110455		270-5 and 270-5RT
C1	Capacitor, 0.1 μ F, 400V	1-113733		Indicating Instrument
D1, D2	Diode, Germanium	1-115970		w/ Panel Assembly
V1	Diode 1N914 (2)	5-112004		Cover Assembly for
F1	Fuse, 1 Amp, 250V;3AG (1-1/4" x 1/4")			Indicating Instrument
	Quick acting			Probe Tip Leads,
	(Littlefuse Type 312001)	1-112507		one red and one black
				Label, Battery and
				Fuse Data
F2	Fuse, 2A, 600V			

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- d. Verify Instrument accuracy by performing operational checks using known, accurate, stable sources. If proper calibration equipment is not available, contact the nearest Authorized Service Center. If the Instrument has not been used for 30 days, check the batteries for leakage and replace if necessary.
- e. It is recommended that the Instrument be returned annually to the nearest Authorized Service Center, or to the factory, for an overall check, adjustment, and calibration.
- f. When not in use, store the Instrument in an environment free from temperature extremes, dust, corrosive fumes, and mechanical vibration or shock. If storage time is expected to exceed 30 days, remove batteries.

6. SERVICING INSTRUCTIONS

This Instrument must be serviced by qualified personnel. To aid in troubleshooting, a schematic diagram is available on page 29. The replacement parts list (Table 6-1) describes the components and refers to Simpson part numbers. Reference Symbol numbers on the replacement parts list correlate with the components shown on the schematic diagram.

The following information is provided as an adjunct to the overall text contained in this manual and should be read and understood thoroughly before ordering replacement parts for the Instrument.

6.1 Removing the Instrument Case

To open the Instrument panel, first de-energize and disconnect the test leads, and remove the cover from the battery compartment. Remove the four case-fastening screws and lift the case from the panel.

When replacing the case, make certain that the wires leading to the battery compartment are seated in their respective slots within the compartment wall. This will prevent damage to the wire insulation.

6.2 Replacement Parts

To obtain replacement parts, address order to the nearest Authorized Service Center. Refer to paragraph 2.2 for ordering instructions.

Table 6-1. Replacement Parts

Reference Symbol	Description	Part No.	Reference Symbol	Description	
R1	Rheostat, 150 k Ω	6-111487	R10	Resistor, 2.5 M Ω	5-115080
R1A	Resistor, 20 k Ω	5-119705	R11	Resistor 0.025 Ω	
R2, R22, R25	Rheostat, 3 k Ω	6-111488		Shunt 10A	
R2A	Resistor, 2.2 k Ω	5-118606		(Calibrate in Instrument)	6-111575
R3	Resistor, 15 k Ω	5-115082	R12	Resistor, 0.47 Ω 5W	
R4	Resistor, 45 k Ω	1-117148		(Wire Wound)	6-111980
R5	Resistor, 150 k Ω	1-117149	R13	Resistor, 2 Ω 5W	
R6	Resistor, 800 k Ω	1-117147		(Wire Wound)	6-111810
R7	Resistor, 4 M Ω	1-117151	R14	Resistor, 22.5 Ω 3W	
R8	Resistor, 5 M Ω	1-118181		(Wire Wound)	6-111809
R9	Resistor, 7.5 M Ω	5-115081	R15	Resistor, 238 Ω	1-115079

- a. Two batteries are used to supply power for resistance measurements, a 1.5V D and a 9V battery. When it is no longer possible to adjust the pointer to zero for the R x 1 and R x 100 ranges (refer to ZERO OHMS ADJUSTMENT paragraph 4.17) replace the 1.5V battery. When it is no longer possible to adjust the pointer to zero on the R x 10,000 range, replace the 9V battery.
- b. Recommended replacement batteries are a 1.5V, D size, NEDA 13F and a 9V, NEDA 1604.
- c. To install or replace a battery, de-energize and disconnect test leads from the Instrument, then remove the cover to the externally accessible battery compartment by loosening the single captivated screw.
- d. Observe polarity when replacing the 1.5V D battery and connect as indicated. The D battery is held in place with spring clips which also act as battery contact clips. The 9V battery contacts and connector are polarized. To remove the 9V battery, first withdraw battery with mated connector from the compartment, then remove connector.

5.3 Fuse Replacement



The 1 and 2 Amp fuses (also the 1A spare) are located in the externally accessible battery and fuse compartment. Access compartment by de-energizing and disconnecting the test leads and loosening the single captivated screw on the compartment cover. To replace or check a fuse, apply pressure to the 1 amp fuse cup then rotate the plate to expose a selected fuse for removal from the panel's cavity.

Replace the 1 and 2 ampere fuse with the specified fuse type only. (See replacement parts list, Table 6-1, for proper fuse type.)

5.4 Test Lead Inspection

Periodic inspection of the test leads is recommended to detect cuts, burned areas, deterioration or other damage that could reduce the insulation strength of the leads.



Before returning the Instrument for service, check the performance and make sure that the electrical and mechanical configurations have been restored to their original ratings and condition.

5.5 Care

- a. Immediately clean all spilled materials from the Instrument and wipe dry. If the spillage is corrosive, use a suitable cleaner to neutralize the corrosive action, and remove the spillage.
- b. When the Instrument is not in use, rotate the function switch to the OFF/TRANSIT position.
- c. Avoid prolonged exposure or usage in areas subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic fields.

1. INTRODUCTION

1.1 General Description

The Simpson Volt-Ohm-Milliammeter 270 Series 5 is a rugged, accurate, compact and easy-to-use instrument that will make accurate measurements of AC and DC voltage, direct current, resistance, decibels, and output voltage. The output voltage function is used for measuring the AC component of a mixture of AC and DC voltage. This occurs primarily in amplifier circuits.

New Features for the 270 are:

New connectors between the Instrument and the test leads, eliminating a shock hazard if a connector is inadvertently pulled out of the Instrument jack.

An OFF/TRANSIT position, which is added to the function switch to protect the meter movement during transit. (This position shunts the meter movement and opens the internal connections to the COMMON and + jacks.)

A test lead set with molded elbow plugs at one end for connection to the front panel input terminals and test probes at the other end. The test probes have a non-slip grip surface and a barrier to maintain the spacing between the user's fingers and the probe tip. Threaded shoulders at the probe tip accept screw-on alligator clips (supplied) or an accessory AC or DC 5000 volt range extending probes.

1.2 Overload Protection

No single protective device nor even a combination of devices as found in the 270 can fully protect a multipurpose instrument under all overload conditions. Despite all the built-in-protection provided, however, severe overloads can damage the Instrument when the Instrument is misused. The fuse/varistor combination in the 270 has been designed to afford maximum instrument protection under foreseeable overload conditions which might occur within the measuring capabilities of the Instrument. However, the operator must use care to avoid severe overloads, particularly when working in high voltage circuits.

- a. Fuses: Basic overload protection is provided by a small, inexpensive and easily obtainable 3 AG type, 1 ampere, quick-blow fuse. This fuse is rated to interrupt circuit voltages up to 250 volts. A supplemental high energy fuse is provided for additional protection from severe overloads. This fuse is the Bussman Type BBS 2A 600 V and has an interruption capacity of 10,000 amps AC. The Littlefuse Type BLS 2A 600 V with an interrupt capacity of 100,000 amps AC may also be used.
- b. For maximum protection replace the 1A fuse with a Littlefuse Type 312001 only. This will allow the combination 1A and 2A fuse to give maximum protection to the unit and user under overload conditions which may occur within the measuring capability of the VOM.
- c. If the Instrument fails to indicate, the 1 Amp or the 2 Amp fuse may be burned out. (Refer to paragraph 5.3 for fuse replacement.) A 1 Amp spare fuse is furnished with each Instrument. Fuses are located in the battery and fuse compartment.

NOTE: The 0-10A range is **not** fused. The shunt connects directly to the -10A and +10A jacks.

- d. Two diodes connected across the meter movement afford protection to the movement by circumventing excessive current around the movement in the event of an overload.

1.3 Internal Batteries

There are two batteries in the ohmmeter circuits, a NEDA 13F size D cell that furnishes 1.5-volts for the R x 1 and R x 100 ranges and a NEDA 1604 battery that furnishes 9-volts for the R x 10,000 range.

1.4 Printed Circuit

Most of the component parts are mounted on a printed circuit board which simplifies assembly and maintenance, thus extending the useful life of the Instrument.

1.5 Phenolic Case

The Phenolic case is designed with heavy reinforced walls for maximum durability and provides excellent protection for the circuit components. The case also has an externally accessible battery and fuse compartment. Access to the batteries and fuses is obtained by unscrewing a single captivated screw at the bottom of the case and sliding out the compartment cover.

1.6 Adjust-A-Vue Handle

A carrying handle is attached to the Instrument case. The handle may be used to support the Instrument in a convenient sloping position for easy viewing. The case can also be placed either vertically or horizontally. The horizontal position is preferable for greater accuracy since the Instrument is calibrated in this position.

1.7 Test Leads

Each Instrument is furnished with one pair (Catalog Number 00043) of probe type test leads (one red and one black, each 48 inches long) for all applications of the Instrument. These test leads have elbow prods on one end to connect the leads to the recessed jacks on the Instrument front panel. The probe tips at the opposite end have threaded shoulders to accept the screw-on insulated alligator clips (furnished with the test leads) or the 5000 volt test probe(s) to extend the Instrument AC or DC voltage range. The test leads and the insulated alligator clips are rated for the voltage and current ranges available on the 270. Maximum ratings are 1000 V AC or DC or 10 DC amperes. These ratings for the test leads must not be exceeded in any application.

1.8 Technical Data

Table 1-1. Technical Data

1. DC VOLTS:	
Ranges:	0-1-2.5-10-50-250-500-1000V
Sensitivity:	20,000V per volt
2. DC MILLIVOLTS:	
Range:	0-250mV
Sensitivity:	20,000V per volt
3. AC VOLTS:	
Ranges:	0-2.5-10-50-250-500-1000V
Sensitivity:	5,000Ω per volt

5. OPERATOR SERVICING

The following paragraphs describe the battery replacement, fuse replacement, test lead inspection and care for the 270-5.

5.1 Inspection

The user is protected from electrical shock by the insulation of the 270 and its test leads. Frequently examine the 270 and its test leads for insulation damage. Check for cracks, cuts, chips, burns or deterioration that expose internal metal parts or reduce the spacing between such metal parts and hand contact.

Make certain that the battery compartment cover is securely fastened in place before the Instrument is used.

Do not permit an Instrument with a broken glass meter cover to be used.

Whenever the battery compartment cover is removed for any reason, check that the proper fuses are being used.

Severe overloads may have damaged the Instrument's circuitry despite the protection afforded by the fuse. When a fuse is replaced, all ranges should be routinely checked (calibrated) against the specifications in this manual before the Instrument is returned to service.

5.2 Battery Replacement

Batteries should be replaced before their useful life has expired. Failure to do so may result in battery leakage and corrosion.

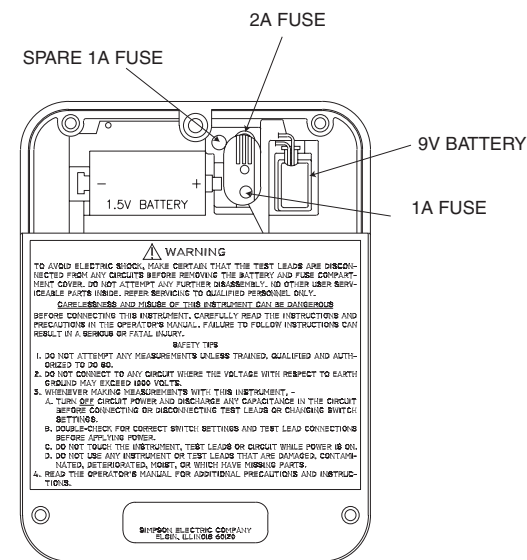


Figure 5-1. Battery and Fuse Compartment

Note: The OHMS scale reads from right to left for increasing values of resistance.

- e. To determine the actual resistance value, multiply the reading by the factor at the switch position. (K on the OHMS scale equals one thousand.)

4.19 Resistance Measurement of Semiconductors



Make sure that the OHMS range being used will not damage any of the semiconductors (refer to Table 1-1, item 8, Section 1).

If there is a "forward" and "backward" resistance such as in diodes, the resistance should be relatively low in one direction (for forward polarity) and higher in the opposite direction.

Rotate the function switch between the two DC positions to reverse polarity. This will determine if there is a difference between the resistance in the two directions. To check a semiconductor in or out of a circuit (forward and reverse bias resistance measurements) consider the following before making the measurement:

- a. The polarity of the internal ohmmeter battery voltage at the (+) positive jack is identical to the function switch, polarity setting, and opposite to the (-) common jack.



Make sure that the OHMS range being used will not damage any of the semiconductors (refer to Table 1-1, item 8, Section 1).

- b. If the semiconductor is a silicon diode or conventional silicon transistor, precautions are not normally required.
- c. If the semiconductor material is germanium, check the ratings of the device and refer to Table 1-1, item 8.

NOTE: The resistance of diodes will measure differently from one resistance range to another on the same VOM with the function switch in a given position. For example, a diode which measures 80 ohms on the R x 1 range may measure 300 ohms on the R x 100 range. The difference in values is a result of the diode characteristics and is not indicative of any fault in the VOM.

4. OUTPUT VOLTAGE (AC):
Ranges: 0-2.5-10-50-250 (limited to 350 VDC)
5. DC MICROAMPERES:
Range: 0-50μA
Voltage Drop: 250 mV
6. DC MILLIAMPERES:
Ranges: 0-1-10-100-500 mA
Voltage Drop (Approx.): 250 mV, 255 mV, 300 mV, 500 mV
7. DC AMPERES:
Range: 0-10A
Voltage Drop (Approx.): 255 mV

NOTE: The 10A range is **not** internally fused.

RESISTANCE	R X 1	R X 100	R X 10,000
Range:	0-2000Ω	0-200,000Ω	0-20 MΩ
Center Reading:	12Ω	1200Ω	120,000Ω
Nominal Open Circuit Voltage	1.5V	1.5V	9V
Nominal Short Circuit Current	125mA	1.25mA	75μA

9. *ACCURACY: 77°F 67°-87°F
DC Voltage Ranges: 1.25% of F.S. 1.75% of F.S.
DC Current
0-50μA Range: .75% F.S. 1.25% of F.S.
Other Ranges: 1.25% of F.S. 1.75% of F.S.
**AC Voltage Ranges: 2% of F.S. 3% of F.S.
Frequency Response: Referenced to 100 Hz (Figures 4-2 and 4-4)
Resistance Ranges:
R x 1: 1.5% of Arc 1.75° of Arc
R x 100: 1° of Arc 1.25° of Arc
R x 10,000: 1° of Arc 1.25° of Arc
10. DECIBELS:
Ranges: -20 to +10 dB, -8 +22dB, +6 to +36 dB, +20 to +50 dB
Reference Level: W/zero power level equal to 1 mW across a 600Ω line.
11. BATTERIES: 1.5V, D Size, NEDA 13F 9V, NEDA 1604
12. FUSES: F1: 1A, 250V, type 3AG, quick-acting Littlefuse Type 312001, F2: 2A, 600V (Bussman Type BBS or Littlefuse Type BLS)
13. TEST LEADS: 1 red, 1 black, 48" long.
14. SIZE: 5-1/2" x 7" x 3 1/8" (13.34 x 17.78 x 7.94 cm)
15. WEIGHT: 3 lbs. (1.359 kg)
16. ***RATED CIRCUIT-TO-GROUND VOLTAGE: 1000V AC/DC Max.

*Accuracies specified are for the 270 in a horizontal position.

**Responds to the average value of an AC current, and is calibrated to indicate the RMS value of a pure sine wave.

***Per ANSI C39.5 April 1974: "The maximum voltage, with respect to Ground, which may safely and continuously be applied to the circuit of an Instrument."

1.9 Definition of Accuracy

The voltage and current accuracy of this Instrument is commonly expressed as a percent of full scale. This should not be confused with accuracy of reading (indication). For example, +2% of full scale on the 10 volt range allows an error of $\pm 0.20V$ at any point on the dial. This means that at full scale, the accuracy of reading would be $\pm 2\%$, but at half scale it would be $\pm 4\%$. Therefore, it is advantageous to select a range which gives an indication as near as possible to full scale.

1.10 Safety Considerations

This Operator's Manual contains special caution and warning symbols which alert the user to hazardous operating and servicing conditions. These symbols appear throughout this publication, where applicable, and are defined on the inside front cover of this manual under NOTES AND SAFETY INFORMATION. These instructions must be adhered to in order to ensure the safety of operating and servicing personnel and to retain the operating conditions of the Instrument.

Table 1-2. Items and Accessories Furnished with this Instrument

Quantity	Description	Number
1	Test Lead Set, one red and one black (48" long) each with combination probe tip and removable rubber-sleeved alligator clip.	00043
*1	1.5 volt, D cell, NEDA 13 F	
*1	9.0 volt Cell, NEDA 1604	
2	1 Amp, 250 V Fuse, Littlefuse Type #312001	
1	2 Amp Fuse, 600 V (Bussman Type BBS or Littlefuse Type BLS)	
1	Operator's Manual	6-111642

*Batteries are standard items replaceable from local retail stores.

Table 1-3. Additional Accessories

Description	Catalog Number
Deluxe Case	00812
Leatherette Ever-Redy Hard Case, Drop Front	00805
Low-Power Ohm Probe	00414
Model 150-2 Amp-Clamp	00545

4.17 Zero Ohms Adjustment

When resistance is measured, the INTERNAL batteries B1 and B2 furnish power for the circuit. Since batteries are subject to variation in voltage and internal resistance the Instrument must be adjusted to zero before measuring a resistance, as follows:

- Turn range switch to desired ohms range.
- Plug the black test lead into the - COMMON jack and the red test lead into the + jack.
- Connect ends of test leads together to short the VOM resistance circuit.
- Rotate the ZERO OHMS control until pointer indicates zero ohms. If pointer cannot be adjusted to zero, one or both of the batteries must be replaced. (For battery replacement refer to Section 5.)
- Disconnect shorted ends of test leads.

4.18 Measuring Resistance



Voltage applied to a resistance range will cause reading errors if low and damage the Instrument if high. When making in-circuit measurements, make certain that the circuit is completely de-energized before making connections to it.

When making in-circuit measurements, circuit paths in parallel with the resistance being measured may cause reading errors. Check circuit diagrams for the presence of such components before assuming that the reading obtained is correct.

- Before measuring resistance in the circuit make sure the power is off in the circuit being tested and all capacitors discharged.
- Disconnect the shunted component from the circuit before measuring its resistance. Then set the range switch to one of the resistance range positions as follows (Figure 4-8):
 - Use R x 1 for resistance readings from 0 to 200 Ω .
 - Use R x 100 for resistance readings from 200 to 20,000 Ω .
 - Use R x 10,000 for resistance readings above 20,000 Ω .
- Set the function switch at either - DC or + DC position. Operation is the same in either position except if semiconductors are in the circuit. (See paragraph 4.19) Adjust ZERO OHMS control for each resistance range.
- Observe the reading on the OHMS scale at the top of the dial.

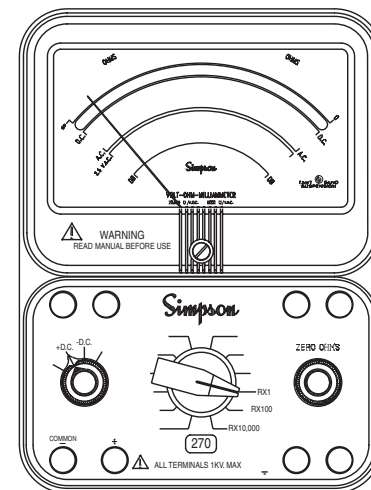


Figure 4-8. Jacks and Switch Positions for Measuring Resistance

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- The image shows the Simpson 270 Multi-Range Voltmeter. The top section is the scale, which is a semi-circular arc. It has two sets of markings: one for AC voltage (VAC) and one for DC voltage (VDC). The AC scale ranges from 0.005 to 500, with major markings at 0.005, 0.05, 0.5, 5, 50, and 500. The DC scale ranges from 10 to 10000, with major markings at 10, 100, 1000, and 10000. The bottom section is the control panel. It features a large needle and a scale with markings for 10A, 100MA, 10MA, 1000MA, 50V, and 500V. A large needle is shown pointing to the 270 mark on the 500V scale. The panel also includes a 'WARNING READ MANUAL BEFORE USE' label, a 'Simpson' logo, and various range selector knobs for 10A, 100MA, 10MA, 1000MA, 50V, and 500V. A large needle is shown pointing to the 270 mark on the 500V scale.

3. CONTROLS, JACKS AND INDICATORS

All operating and adjustment controls, jacks and indicators for the Simpson 270-5 are described in this section. Become familiar with each item before operating the Instrument.

3.1 Front Panel Description

The front panel controls, jacks and indicators are described in Table 3-1 and illustrated in Figure 3-1.

Table 3-1. Controls, Jacks and Indicators

1. Front Panel:

The 270-5 Volt-Ohm-Milliammeter is a large, easy-to-read 4-1/4" indicating Instrument. Switch positions and circuit jacks are marked in white characters for easy reading.
2. Range Switch:

The range switch may be rotated in either direction to select the desired voltage, current, or resistance range position.
3. Function Switch:

The function switch has four positions: Off/Transit, +DC, -DC and AC. To measure DC current or voltage, set the function switch at the -DC or +DC position, depending on polarity of the signal applied across test leads. To measure AC voltage set the function switch to the AC position. For resistance measurement, the switch may be set in either the +DC or -DC position. The polarity of the internal ohmmeter battery voltage at the (+) positive jack is identical to the function switch polarity setting and opposite at the (-) common jack.

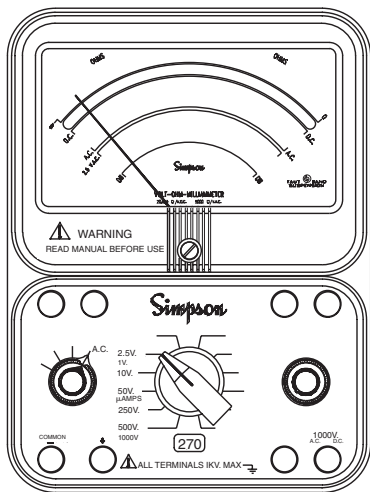


Figure 3-1. Controls, Indicators and Connector

VOLTAGE RANGE	dB RANGE	READING
0-2.5V	-20 to +10	Read directly
0-10V	-8 to +22	Add +12 dB to reading
0-50V	+6 to +36	Add +26 dB to reading
0-250V	+20 to +50	Add +40 dB to reading

NOTE: The maximum voltage ratio that can be measured is +50 dB on the 0-250V range.

- e. If dB measurement is being made to a 0.0006 watt into 500 ohm reference level, subtract +7 dB from the reading obtained on the 270-5.

4.13 Direct Current Measurement



- a. Do not change the setting of the range or change the function switches while circuit under measurement is energized.
- b. Never disconnect test leads from circuit under measurement while the circuit is energized.
- c. Always turn the circuit power off and discharge all the capacitors before setting the switches or disconnecting the leads.
- d. Never exceed the circuit-to-ground voltage of the instrument (1000V MAX., Table 1-1, Item 16).
- e. Always connect the Instrument in series with the ground side of the circuit.

4.14 Direct Current Measurement 0-50 μ A Range

- a. Set the function switch at + DC.
- b. Plug the black test lead into the - COMMON jack and the red test lead into the +50 μ A/250mV jack.
- c. Set the range switch at 50 μ A (dual position with 50V).
- d. Turn OFF power. Then discharge any capacitors in the circuit.
- e. Open the ground side of the circuit in which the current is being measured. Connect the VOM in series with the circuit. Connect the red test lead to the positive side and the black test lead to the negative side.
- f. Turn ON power.
- g. Read the current on the black DC scale. Use the 0-50 figures to read directly in microamperes.
- h. Turn power OFF and restore circuit to original condition.

NOTE: For polarity reversing see paragraph 4.2.

4.15 Direct Current Measurement 0-1mA through 0-500mA Range

- a. Set the function switch at + DC (Figure 4-7).
- b. Plug the black test lead into the - COMMON jack and the red test lead into the + jack.

- d. Turn OFF power.
- e. Connect the test leads across the circuit being measured with the black test lead to the ground side.
- f. Turn on power in the test circuit. Read the output voltage on the appropriate AC voltage scale. For the 0-2.5V range, read the value directly on the scale marked 2.5 VAC. For the 10V, 50V, or 250V ranges, use the red scale marked AC and read the black figures immediately above the scale.

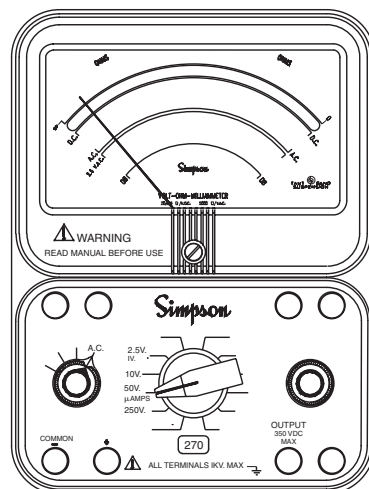


Figure 4-5. Jacks and Switch for Output Measurement

4.12 Decibel Measurement (-20 to +50 dB)

Some industries measure in terms of voltage or current ratios (decibels) based on a specific reference level. The dB scale on the 270 serves this purpose and is calibrated to a reference level (zero dB) or 0.001 watt into 600 ohms. The scale calibration of -20 to +10 dB is for the 0-2.5V range (zero dB = 0.775V). Higher ranges may be used by adding an appropriate dB value to the reading in accordance with chart on the following page.

- a. Review the safety precautions in paragraph 4.1.
- b. Set the functions switch at AC (figure 4-6).
- c. Plug the black test lead into the - COMMON jack and the red test lead into the + jack.
- c. Use operating instructions for AC VOLTAGE MEASUREMENT, 0-2.5/10/50/250/500V RANGES (paragraph 4.9).

Do not use the 500V range for decibel readings.

- d. Read decibels on the bottom scale marked dB. For the 10/50/250V ranges, add the appropriate factor from the following chart.

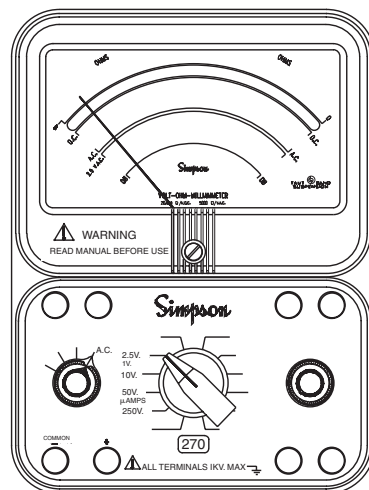


Figure 4-6. Jacks and Switch Positions for Measuring Decibels

4. **Zero Ohms:**
5. **Circuit Jacks:**
6. **Pointer Adjust: for Zero:**

Off/Transit Position: This function switch position opens the 270 common and + jack inputs to avoid accidental instrument overload or internal battery drain. It also shunts the sensitive instrument during transit to provide damping during non-use periods.

This control is used to compensate for variation in the voltage of internal batteries.

There are eight jacks on the front panel marked with the functions they represent (Fig. 3-1). These jacks provide electrical connections to the test leads. The COMMON (-) jack is used (in conjunction with black test lead) as the reference point for measurement of all the functions with the exception of the 10A range. (Refer to Section 5, Operator Servicing.)

With the Volt-Ohm-Milliammeter in an operating position, check that the pointer indicates zero at the left end of the scale when there is no input. If pointer is off zero, adjust the screw located in cover below the center of the dial. Use a small screwdriver to adjust the screw until the pointer rests freely over the zero mark at the left end of the scale. This procedure will avoid disturbances to the zero setting by subsequent changes in temperature, humidity, vibration, and other environmental conditions.

4. OPERATION

This section contains information required to operate the 270-5 safely and properly.



Multifunction Instruments, (VOM's), such as the 270-5 are intended as general purpose measuring instruments for use in low power circuitry such as found in consumer appliances, TV and radio receivers, and in general laboratory applications. Their use is not recommended in high voltage, high power circuitry where operator errors and inadequate personal protective measures could result in serious injury from arcing or explosion. Such circuitry is found in industrial or commercial applications such as induction (r-f) heaters and broadcast transmitters, power substations and distribution centers, x-ray equipment, large motor controls, etc. Working in the high voltage section of such equipment requires single-function, often specially designed, instruments operated by specially trained personnel who use appropriate protective equipment and procedures.

4.1 Safety Precautions

The following precautions are commonly recognized safe practices to adopt and specific hazards to avoid, and are not implied to be sufficient to safeguard untrained personnel in all circumstances. Neither is this manual a substitute for technical manuals covering the equipment in which measurements are to be made. Always refer to the equipment manual and its specific warnings and instructions and observe them as well as those contained herein.

- a. The 270 should only be used by personnel qualified to recognize shock hazards and who are trained in the safety precautions required to avoid possible injury.
- b. Do not connect any terminal of this Instrument to a circuit point at which a voltage exceeding 1000 volts AC or DC may exist with respect to earth ground. (Refer to Table 1-1, item 16.)
- c. Turn off power and discharge any capacitors in the circuit to be measured before connecting to or disconnecting from the circuit.
- d. Before using this Instrument, check accessories (if any) and test leads for missing, damaged, deteriorated or otherwise faulty insulating parts. Do not use, or permit the use of, equipment with faulty insulation until it has been properly repaired.



- e. **Always wear safety glasses when working in electrical circuitry.**
- f. **Do not work alone on high voltage circuits. Make certain that someone capable of giving aid is nearby and alert to potential problems.**
- g. **Do not handle the instrument, test leads, or circuitry while high voltage is being applied.**
- h. Hands, shoes, floor, and workbench must be dry. Avoid measuring under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or Instrument.
- i. Do not change switch settings or test lead connections while the circuit is energized. A mistake could damage the Instrument or cause personal injury.
- j. Locate all voltage sources and accessible current paths before making connections to circuitry. Voltage may appear unexpectedly or in unexpected locations in faulty equipment. An open bleeder resistor, for example, may result in a capacitor retaining a dangerous charge.
- k. Make certain that the equipment being worked on is properly grounded and fuses are of the proper type and rating.
- l. Double check switch positions and jack connections before applying power to the Instrument.
- m. Remain alert for low voltage circuits which may be floating at high voltage with respect to earth ground and for composite voltages (AC + DC) such as are found in r-f amplifiers. The floating voltage or composite voltage must not exceed the Instrument's rated maximum circuit-to-ground voltage.
- n. Do not measure where the air may contain explosive concentrations of gas or dust such as in mines, grain elevators, gasoline stations or in the presence of charging batteries until determined to be safe by qualified personnel. Note that even metallic dusts can be explosive.
- o. No general purpose VOM is to be used to make electrical measurements on blasting circuits or blasting caps. Use VOMs designed for this purpose only.

4.2 Polarity Reversing

The function switch provides a convenient means to reverse polarity of the internal battery to facilitate testing semiconductor devices. The +DC and -DC positions transpose internal connections to the COMMON and + jacks and therefore can also be used to reverse polarity of external voltages and currents connected to these jacks (only). Because polarity reversing momentarily interrupts the circuit, it should not be done while measuring current without first turning off the



Turn off power to the circuit and wait until the meter indicates zero before disconnecting the test leads.

4.11 Output Voltage Measurement

Measuring the AC component of an Output Voltage where both AC and DC voltage levels exist is sometimes necessary. This occurs primarily in amplifier circuits. The 270 has a 0.1 mfd, 400 volt capacitor in series with the OUTPUT jack. The capacitor blocks the DC component of the current in the test circuit, but allows the AC or desired component to pass on to the indicating instrument circuit. The blocking capacitor may alter the AC response at low frequencies but is usually ignored at audio frequencies (Figure 4-4).

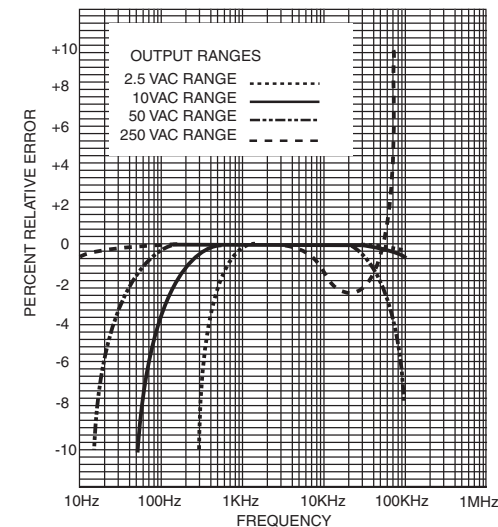


Figure 4-4. Frequency Response Output Ranges



Do not connect the OUTPUT jack to a circuit in which the DC voltage component exceeds 350V.

Before proceeding with the following steps, review the Safety Precautions in Paragraph 4.1.

- a. Set the function switch at AC (Figure 4-5).
- b. Plug the black test lead into the - COMMON jack and the red test lead into the OUTPUT jack.
- c. Set the range switch at one of the range positions marked 2.5V, 10V, 50V, or 250V.

- e. Connect the test leads across the circuit voltage to be measured with the black lead to the grounded side.
- f. Turn on power.
- g. For the 2.5V range, read the value directly on the scale marked 2.5 VAC. For the 10V, 50V, and 250V ranges, read the red scale marked AC and use the black figure immediately above the scale. For the 500V range, read the red scale marked AC and use the 0-50 figures. Multiply the reading by 10.



Turn off power to the circuit and wait until the meter indicates zero before disconnecting the test leads.

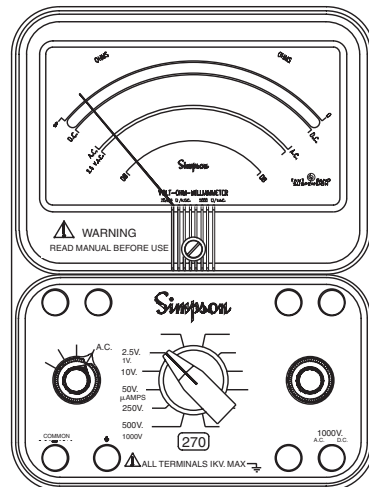


Figure 4-3. Jacks and Switch Positions for measuring AC Voltages

4.10 AC Voltage Measurement 0-1000V Range



Use extreme care when working in high voltage circuits. Do not handle the Instrument or test leads while the circuit being measured is energized. OBSERVE ALL SAFETY PRECAUTIONS in paragraph 4.1 and in the instruction manual for the equipment being tested.

Do not attempt any circuit-to-ground voltage measurement which may exceed 1000 volts.

Be sure that the range switch is set to the 500V/1000V range, function switch to AC position, and test leads connected to common and 1000V jack.

Do not touch the Instrument or test leads while the power is on in the circuit being measured.

- a. Set the function switch at AC (Figure 4-3).
- b. Set the range switch at 500/1000V position.
- c. Plug the black test lead into the - COMMON jack and the red test lead in the 1000V jack.
- d. Check that the power is off in the circuit being measured and that all its capacitors have been discharged.
- e. Connect the test leads across the circuit voltage to be measured with the black lead to the grounded side, if any.
- f. Turn on the power in the circuit being measured.
- g. Read the voltage on the red scale marked AC. Use the 0-10 figures and multiply by 100.

circuit power. When making measurements on the 50 μ A/250mV, 1 volt, or 10 amp range, polarity can be corrected only by interchanging the test lead connector to the current.

4.3 Measurement Of Unknown Voltage Or Current

If the approximate voltage or current to be measured is known then the correct range may easily be selected. However, particularly when working on faulty equipment, the voltage or current is sometimes unknown or much higher than normal and anticipated. When working on unfamiliar or unknown equipment, always begin a measurement using the highest range available on the Instrument. Once it is determined that the voltage is within the limits of a lower range, change to the lower range.

4.4 Test Leads

Test leads are provided with accessory screw-on alligator clips which may be attached to the probe tips. Eliminating the need to hand-hold test prods to a circuit for extended periods, the test clips also reduce hand proximity to a high voltage circuit while energized. Circuit power must, of course, be turned off and any charged capacitors discharged before connecting or disconnecting clips to or from the circuit.

4.5 DC Voltage Measurement 0-250 mV Range

NOTE: For polarity reversing see paragraph 4.2.



Before measuring voltage review the SAFETY PRECAUTIONS listed in paragraph 4.1. Also, when using the 270 as a millivoltmeter, care must be taken to prevent damage to the indicating instrument from excessive voltage. Before using the 250 millivolt range, use the 1.0-volt DC range to determine that the voltage measured is not greater than 250 millivolts (or .25 volt DC).

- a. Set the function switch at +DC (Figure 4-1).
- b. Plug the black test lead in the - COMMON jack and the red test lead into the +50 μ A/250mV jack.
- c. Set the range switch at 50 μ A COMMON position with 50V.
- d. Connect the black test lead to the negative side of the circuit being measured and the red test lead to the positive side of the circuit.
- e. Read the voltage on the black scale marked DC and use the figures marked 0-250. Read directly in millivolts.

4.6 DC Voltage Measurement 0-1V Range

- a. Set the function switch at + DC (Figure 4-1).
- b. Plug the black test lead into the - COMMON jack and the red test lead into the + 1V jack.
- c. Set the range switch at 1V (COMMON position with 2.5V).
- d. Connect the black test lead to the negative side of the circuit being measured and the red test lead to the positive side of the circuit.
- e. Read the voltage on the black scale marked DC and use the figures marked

0-10. Then divide the reading by 10.

4.7 DC Voltage Measurement 0-2.5 Through 0-500V Range.

- Set the function switch at + DC (Figure 4-1).
- Plug the black test lead into the - COMMON jack and the red test lead into the + jack.
- Set the range switch at one of the five voltage range positions marked 2.5V, 10V, 50V, 250V or 500V.



When in doubt as to the voltage present, always use the highest voltage range as a protection to the Instrument. If the voltage is within a lower range, the switch may be set for the lower range to obtain a more accurate reading.

IMPORTANT: Be sure power is off in the circuit being measured and all capacitors discharged.

- Connect the black test lead to the negative side of the circuit being measured and the red test lead to the positive side of the circuit.
- Turn on the power in the circuit being measured.
- Read the voltage on the black scale marked DC. For the 2.5V range, use the 0-250 figures and divide by 100. For the 10V, 50V, and 250V ranges, read the figures directly. For the 500V range, use the 0-50 figures and multiply by 10.



Turn off power to the circuit and wait until the meter indicates zero before disconnecting the test leads.

4.8 DC Voltage Measurement 0-1000V Range



Use extreme care when working with high voltage circuits. Do not touch the Instrument or test leads while power is on in the circuit being measured.

Before proceeding with the following steps, review Safety Precautions in Paragraph 4.1.

- Set the function switch at + DC (Figure 4-1).
- Set the range switch at 1000V (dual position with 500V).
- Plug the black test lead into the - COMMON jack and the red test lead into the 1000V jack.
- Be sure power is off in the circuit being measured and all capacitors dis-

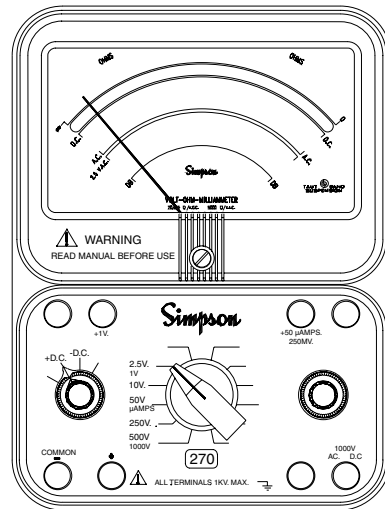


Figure 4-1. Jacks and Switch Positions for Measuring DC Voltages

- charged.
- Connect the black test lead to the negative side of the circuit being measured and the red test lead to the positive side of the circuit.
- Turn on power in circuit being measured.
- Read the voltage using the 0-10 figures on the black scale marked DC. Multiply the reading by 100.



Turn off power to the circuit and wait until the meter indicates zero before disconnecting the test leads.

4.9 AC Voltage Measurement 0-2.5 Through 0-500V Range



Branch and distribution circuits (120/240/480V etc.) can deliver dangerous explosive power momentarily into a short circuit before the fuse/breaker opens the circuit. Make sure that the Instrument switches are set correctly, jacks are properly connected, and that the circuit power is turned off before making connections to such circuits.

The 270 responds to the average value of an AC waveform. The Dial is calibrated in terms of the RMS value of a pure sine wave. If the waveform is non-sinusoidal, and depending upon its waveform, the reading may be either higher or lower than the true RMS value of the measured voltage. Thus an error may be introduced if the 270 is used to measure a non-sinusoidal waveform. Also, accuracy is lessened at higher input frequencies (Figure 4-2).

Before proceeding with the following steps, review the Safety Precautions in Paragraph 4.1.

- Set the function switch at AC (Figure 4-3).
- Set the range switch at one of the five voltage range positions marked 2.5V, 10V, 50V, 250V or 500V.
- Plug the black test lead into the - COMMON jack and the red test lead into the + jack.
- Turn off power to the circuit to be measured and discharge any capacitors.

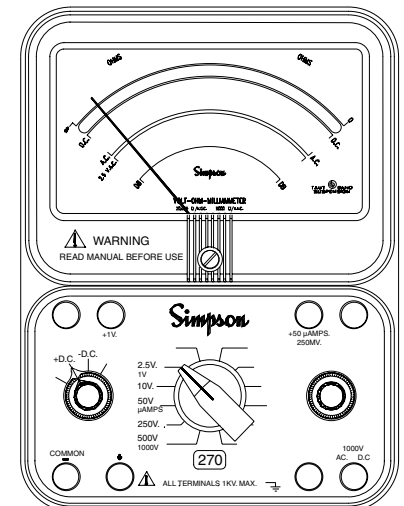


Figure 4-2. Frequency Response, AC Voltage Ranges