**OPERATOR'S MANUAL**

**SIMPSON 165/165U**

**VOLT-OHM-MILLIAMMETER**

**Simpson**

**INSTRUMENTS THAT STAY ACCURATE**

**Courtesy of:**

Simpson260.com
TABLE OF CONTENTS

SECTION I
Introduction ........................................ 1-1
  1.1 General ......................................... 1-1
  1.2 Supplies and Accessories ...................... 1-1
  1.3 Safety Considerations ......................... 1-2
  1.4 Technical Data .................................. 1-2

SECTION II
Installation ......................................... 2-1
  2.1 General ......................................... 2-1
  2.2 Unpacking and Inspection ...................... 2-2
  2.3 Warranty ........................................ 2-2
  2.4 Shipping ........................................ 3-1
  2.5 Installation .................................... 3-1

SECTION III
Controls, Connectors and Indicators .............. 3-1
  3.1 General ......................................... 3-1
  3.2 Panel Description .............................. 3-2
SAFETY SYMBOLS

This marking, adjacent to another marking, terminal, or operating device, indicates that the Operator must refer to an explanation in the operating instructions to avoid damage to the equipment and/or to avoid personal injury.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly performed or adhered to, could result in personal injury.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly adhered to could result in damage to or destruction of part or all of the Instrument.
SECTION I
INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 165/165U Volt-Ohm-Milli-ammeter (hereafter referred to as the 165 or the Instrument) is a compact, easy-to-operate instrument which may be used for measuring electrical characteristics of circuits and circuit components. It features a taut-band movement suspension with diode overload protection to provide long, trouble-free service. The 180 degree dial arc and knife edge pointer provide excellent readability.

1.1.2 A one-knob Function/Range selector simplifies operation of the Instrument. The internal batteries used to furnish the power required for resistance measurements and the fuse used to protect the ohms ranges are readily obtainable. Replacement is accomplished quite easily.

1.1.3 Most of the component parts are mounted on a printed circuit board conforming to the latest engineering developments. This ensures uniformity of performance, reduces maintenance and extends the useful life of the Instrument.

1.2 SUPPLIES AND ACCESSORIES

1.2.1 All supplies and accessories are furnished with each Instrument and listed in Table 1.2. (Available replacement parts are listed in Table 1.1.)
1.3 SAFETY CONSIDERATIONS
1.3.1 This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and service conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and is defined at the front of the manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of the instrument, these instructions must be adhered to.

1.4 TECHNICAL DATA
1.4.1 Table 1-1 lists the technical data for the 165.

<table>
<thead>
<tr>
<th>Table 1-1. Technical Data</th>
</tr>
</thead>
</table>

## 1. DC Volts:
- **Ranges:** 2.5, 10, 50, 250; and 1000 V on separate jacks
- **Sensitivity:** 20,000 ohms per volt
- **Rated Accuracy:** Within ±3% of full scale, all ranges

## 2. AC Volts:
- **Ranges:** 2.5, 10, 50, 250; and 1000 V on separate jacks
- **Sensitivity:** 5,000 ohms per volt
- **Rated Accuracy:** Within ±4% of full scale, all ranges
- **Indication:** Full-wave average-responding; calibrated in rms for sinusoidal waveforms
- **Frequency Response:** Rated accuracy to 100,000 Hz on all ranges through 50 V; to 20 kHz on 250 V range; to 1 kHz on 1000 V range

## 3. Direct Current:
- **Ranges:** .5, 5, 50, 500 mA
- **Rated Accuracy:** Within ±3% full scale, all ranges
- **Rated Circuit-To-Ground Voltage:** 1000 V AC/DC max.

*See typical Response Curves, Figure 1-2.

**Per ANSI C39.5 April 1974: “The maximum voltage with respect to ground, which may safely and continuously be applied to the circuit of any instrument.”**
4. DC Resistance:
- R x 1: 20 k ohms (200 ohm center)
- R x 10: 200 k ohms (2000 ohm center)
- R x 100: 2 megohms (20,000 ohm center)
- R x 1 k: 20 megohms (200,000 ohm center)

Accuracy: 1° arc

Max. Voltage or Current Delivered:
- R x 1: 7.5 mA short circuit
  1.5 V open circuit
- R x 10: 75 mA short circuit
  1.5 V open circuit

5. dB Ranges:
- -20 dB to +10 dB on 2.5 VAC range
- -8 dB to +22 dB on 10 VAC range
- +6 dB to +36 dB on 50 VAC range
- +20 dB to +50 dB on 250 VAC range

Zero dB referenced to 1 milliwatt at 600 ohms (0.775 volt)

6. Movement:
Taut-Band 100° arc, 50μA full scale

7. Dial Arcs:
One arc for ohms, one arc for DC,
two arcs for AC, one arc for dB

8. Scale Length: 3.0 inches
Table 1-2. Items Supplied With This Instrument

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe tip test leads</td>
<td>02055</td>
</tr>
<tr>
<td>Operator's manual</td>
<td>6-112660</td>
</tr>
<tr>
<td>Carrying case 16U (Only)</td>
<td>02935</td>
</tr>
</tbody>
</table>

Table 1-3. Additional Accessories

<table>
<thead>
<tr>
<th>Description</th>
<th>Catalog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl carrying case</td>
<td>02935</td>
</tr>
<tr>
<td>Leatherette carrying case</td>
<td>02225</td>
</tr>
<tr>
<td>Molded hard case</td>
<td>02929</td>
</tr>
<tr>
<td>Simpson 150-2 AC Amp-Clamp adapter</td>
<td>00541</td>
</tr>
<tr>
<td>Adapter pins for Amp-Clamp</td>
<td>02056</td>
</tr>
<tr>
<td>Alligator clip leads</td>
<td>01927</td>
</tr>
</tbody>
</table>

SECTION II
INSTALLATION

2.1 GENERAL

2.1.1 This section contains instructions for the installation and shipping of the 165. Included are unpacking and inspection procedures, warranty, shipping and installation.
2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for signs of damage prior to unpacking. Then unpack and inspect the instrument for possible damage in shipment. Notify the carrier and supplier before using the instrument. Also, check that all furnished items and accessories are included (Table 2).

2.2.2 Save all shipping materials for future use.

2.3 WARRANTY

2.3.1 The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the instrument under warranty, contact the nearest Authorized Service Center for instruction (listed on the last pages of this manual). If it is necessary to contact the factory directly, give full details of the difficulty and include the instrument model number and date of purchase. Service data or shipping instructions will be mailed promptly. If an estimate of charges for non-warranty or other service work is required, a maximum charge estimate will be quoted. This charge will not be exceeded without prior approval.

2.4 SHIPPING

2.4.1 Pack the instrument carefully and ship it prepaid and insured to the proper destination.

2.5 INSTALLATION

2.5.1 The instrument may be operated in a horizontal or vertical position. It can also be set at an angle by positioning a stand (not supplied) under the instrument.

SECTION III
CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

3.1.1 All operating and adjustment controls, connectors and indicators are described in this section along with a list (Table 3-1) describing their function. Become familiar with each item prior to operating the instrument.
3.2  PANEL DESCRIPTION

3.2.1  Table 3-1 lists all Controls, Connectors and Indicators.

Table 3-1. Controls, Connectors and Indicators

1. Function and Range Switch:
   This control is located in the lower center of the panel. This switch combines the operations of selecting the desired range and function. The switch may be turned in either direction to any of its 16 positions.

2. Zero Ohms Adjust Control:
   This control is located at the lower left on the front panel and is used to obtain a "0" indication on the ohms scale when the test leads are shorted together. During operation, the zero indication is checked each time the ohmmeter is to be used. This permits compensation for aging internal batteries, and allows them to be used for a longer period of time.

3. Input Jacks:
   There are four input jacks: Two of these are on the right side of the panel and two directly below the zero adjustment screw. The two jacks on the right are identified COM – and + Ω. The COM – and + Ω

Figure 3-1. Front Panel Description
Controls, Connectors and Indicators

Jacks are used for all ranges and functions with the exception of the 1000 VDC and 1000 VAC ranges. The two jacks on the instrument are identified 1000 VDC and 1000 VAC and are used to extend the 250 VDC and the 250 VAC ranges.

SECTION IV
OPERATION

WARNING
Before proceeding with the operation of the 165, review the SHOCK HAZARD definition printed at the front of this manual.

4.1 SAFETY PRECAUTIONS

4.1.1 Instruments of this type are intended for use only in low-power, consumer product type applications, such as TV or radio. Their use is not recommended in high-power circuits, such as power plants, substations or high power transmitter circuits, where the likelihood of corona, together with sufficient energy to sustain flash-over arcs, is a serious hazard.

4.1.2 The small size of this instrument might tempt the user to hold it in his hand while making measurements. Avoid this practice when working in circuits that might contain a shock hazard.

4.1.3 Inspect the test leads, probes, connectors and insulating boots for damage or deterioration before each use. If any defects are found, replace the leads immediately with leads designed for this instrument. Do not use test leads inferior to those furnished with the instrument.

4.1.4 Never disconnect the COMMON lead from an active circuit while the other lead is connected to an energized circuit. The COMMON lead becomes unexpectedly “hot” in such a case and can be a shock hazard to the user. Develop safe habits by always turning off power to the measured circuit and discharging any capacitors before handling the test leads.

4.1.5 Become familiar with the circuit to be measured and locate any shock hazards before attempting measurements. Keep in mind that high voltages might appear where not expected in a faulty circuit.

4.1.6 Electrical measurements in the presence of humidity or moisture are particularly hazardous. Hands, shoes, floor and workbench must be dry.
4.1.7 Avoid making measurements in circuits where composite voltages can exceed the Instrument's safe limits. When measuring DC voltages, the Instrument will not respond to (and thereby not indicate) the presence of AC components.

4.1.8 Be alert for the presence of corona in the measured circuit. Its presence indicates high voltage; and unexpected or unknown paths might lead to a flash-over. A buzzing sound, odor of ozone and a pale blue emanation are indications of its presence.

4.1.9 Do not work alone when making measurements where a shock hazard can exist. Notify a nearby person of your intentions.

4.2 MECHANICAL ZERO ADJUSTMENT

4.2.1 Before making any measurements, check to see that the pointer indicates zero when the Instrument is in the operating position. If the pointer is off zero, make the required correction by turning the screw located directly below the “Simpson 165” legend.

4.3 MEASURING DC VOLTAGES, 2.5 THROUGH 250 VOLT RANGES:

a. Connect the black test lead into the COM - jack and the red test lead into the + jack.

b. Set the range switch for the DC voltage range desired. When in doubt as to which range to use, always start with the highest voltage range as a protection to the Instrument.

c. Turn on power in the circuit to be measured.

d. Touch the black test prod to the negative side of the circuit and the red prod to the positive side.

**NOTE:** If the pointer moves to the left of zero, circuit polarity is reverse of that anticipated. Transpose the test prods for proper indication.

e. Read the voltage on the black arc marked DC which is second from the top of the dial. If the voltage is within a lower range, the switch may be set for a lower range to obtain a more accurate reading.

2.5 VDC range: Use the 0-250 scale and divide the value by 100.

10 and 50 VDC ranges: Read the corresponding scale directly.

250 VDC range: Use the 0-250 scale and read the value directly.
4.4 MEASURING DC VOLTAGES, 1000 VOLT RANGE ONLY:

**WARNING**

Use extreme care when working in high voltage circuits. Even though the instrument and its test leads are well insulated for the measuring ranges available, avoid touching the instrument and test leads except for the prod handles. Keep fingers behind the prod barrier rings.

a. Set the range switch to the 250 VDC position.

b. Connect the black test lead to the COM - jack and the red test lead to the 1000 VDC jack.

c. Turn on power in the circuit to be measured.

d. Connect the black test lead to the negative (−) side of the circuit and the red test lead to the positive (+) side.

e. If the pointer deflects to the left side of zero, refer to Paragraph 4.3, step d.

f. Read the voltage, using the 0-10 scale on the black arc marked DC and multiply the reading by 100.

4.5 MEASURING AC VOLTAGES

2.5 THROUGH 250 VOLT RANGES:

4.5.1 The 165 rectifier circuit responds to the full wave rectified average value of the AC voltage being applied. The instrument dial, however, is calibrated in terms of r.m.s. voltage, which will be correct for all sinusoidal waveforms.

**NOTE:** Since the 165 will respond to DC voltage when set on any AC volt range, an external blocking capacitor must be employed where measurements of AC superimposed on DC are encountered.

a. Connect the black test lead to the COM - jack and the red test lead to the + jack.

b. Set the range switch for the VAC range desired. When in doubt as to which range to use, always start with the highest voltage range as a protection to the Instrument.

c. Turn on power in the circuit to be tested.

d. Touch the test prods to the circuit points between which voltage is to be measured (either polarity).

e. Read the voltage on the red arc marked AC as follows:

- **0-2.5 VAC range:** Read the value directly on the special arc marked 2.5 VAC.
- **10 VAC and 50 VAC ranges:** Read the red arc marked AC, and use the corresponding black numbers immediately above the arc.
- **250 VAC range:** Read the red arc marked AC and use the 0-250 figures directly.
4.6 MEASURING AC VOLTAGES, 1000 VOLT RANGE ONLY:

**WARNING**

Use extreme care when working in high voltage circuits. Even though the instrument and its test leads are well insulated for the measuring ranges available, avoid touching the instrument and test leads except for the prod handles. Keep fingers behind the prod barrier rings.

a. Set the range switch at 250 VAC position.
b. Connect the black test lead in the COM jack, and the red test lead in the 1000 VAC jack.
c. Turn on power in the circuit being measured.
d. Touch the test prods to the circuit points between which voltage is to be measured (either polarity).
e. Read the voltage on the red arc marked AC using the 0-10 figures and multiply the reading by 100.

4.7 MEASURING DECIBELS

4.7.1 For some applications, power loss or gain measurements in terms of dB are required. The dB is defined as:

\[
\text{dB} = 10 \log \frac{\text{Power}_1}{\text{Power}_2} \quad \text{or} \quad 20 \log \frac{E_1}{E_2} \quad \text{when} \quad R_1 = R_2
\]

The 165 is calibrated with 0 dB referenced to 1 milliwatt at 600 Ω, i.e., dB reading corresponds to:

\[
20 \log \frac{E}{\text{reading}}
\]

0.775 V (measured across 600 Ω)

The decibel scale at the bottom of the dial is numbered from –20 through 0 to +10. To measure decibels, proceed according to instructions for AC voltages, and read the dB arc. The dB scale is calibrated for direct reading on the 2.5 V range. Scale factors for other ranges and dB reference at 0.006 watts into 500 ohms are given in the table below.

<table>
<thead>
<tr>
<th>dB Scale Factor (add to reading)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 dB Reference</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Range</th>
<th>1 mW @ 600</th>
<th>6 mW @ 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 V</td>
<td>direct</td>
<td>-7</td>
</tr>
<tr>
<td>10 V</td>
<td>+12</td>
<td>+5</td>
</tr>
<tr>
<td>50 V</td>
<td>+26</td>
<td>+19</td>
</tr>
<tr>
<td>250 V</td>
<td>+40</td>
<td>+33</td>
</tr>
</tbody>
</table>
Operation

4.8 MEASURING RESISTANCES

4.8.1 When DC resistances are measured, the internal batteries of the 165 furnish power for the measuring circuit. Correction for battery deterioration over long periods of time is provided by means of the Zero Adjust control which is part of the ohmmeter circuit.

a. Set the range switch at the desired resistance range position.
b. Connect the black test lead to the COM – jack, and the red test lead to the 1 Ω jack.
c. Connect the contact ends of the test leads together.
d. Observe the Instrument indication. Look for a reading of “0” on the OHMS arc, which is at the top of the dial.
e. If the pointer does not read “0”, rotate the ZERO OHMS knob at the lower left on the front panel until it does. If the pointer cannot be adjusted to zero, one or both batteries may be exhausted or their connections corroded. The 1.5 V battery powers the R x 1, R x 10 and R x 100 ranges and the 15 V battery powers the R x 1 k range. Refer to Section VI for battery replacement instructions.
f. If the pointer does not move when adjusting for zero in any of the resistance ranges, the fuse may need to be replaced. See Section VI for fuse replacement instructions.

g. Connect the test leads across the resistance which is to be measured. If there is a “forward” and “backward” resistance, such as with diodes, observe polarity in the lead connections to control each direction of test.
h. Read the indication on the OHMS arc at the top of the dial. Note that the arc reads from right to left for increasing values.
i. Multiply the reading by the multiplier factor indicated at the switch position; the result is the resistance value in ohms. “K” on the dial and panel stands for “times one thousand.”

NOTE: The resistance of nonlinear components will measure as different values on different ranges of the 165. For example, a diode could measure 80 ohms on the R x 1 range, and 300 ohms on the R x 10 range. This is normal and is the result of the diode characteristic. The difference in readings does not indicate faulty operation of the ohmmeter circuit.
4.9 DIRECT CURRENT MEASUREMENT

**WARNING**

- Never exceed the instrument's rated circuit-to-ground voltage (1000 V max: Table 1-1, 2-A).
- In all current measurements, turn power off in the circuit to be measured and discharge all capacitors, if any, in DC circuits before touching the circuit.
- Avoid disconnecting a test lead or changing the instrument's range setting while the circuit is energized.
- Whenever possible, connect the current measuring 165 in series with the grounded or nearest-to-ground side of the circuit to minimize the circuit-to-ground voltage.

4.10 MEASURING DIRECT CURRENT: 0-0.5 THROUGH 0-500 MILLIAMPERE RANGES:

a. Connect the black test lead to the COM – jack, and the red test lead to the + jack.

b. Set the range switch to the mA direct current range desired. When in doubt as to which range to use, always start with the highest ranges as a protection to the instrument.

c. When the circuit power is turned off, open the circuit at the point where current is to be measured. Connect the Instrument in series with the circuit, observing proper polarities.

d. Apply power to the circuit being measured. If the pointer deflects to the left of zero, the polarity is reversed. Turn off the power. Transpose the test prods and then re-apply the power.

e. Read the current on the black scale marked DC, which is second from the top of the dial.

<table>
<thead>
<tr>
<th>mA Range</th>
<th>Use Scale</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0-50</td>
<td>Divide by 100</td>
</tr>
<tr>
<td>5</td>
<td>0-50</td>
<td>Divide by 10</td>
</tr>
<tr>
<td>50</td>
<td>0-50</td>
<td>Read direct</td>
</tr>
<tr>
<td>500</td>
<td>0-50</td>
<td>Multiply reading by 10</td>
</tr>
</tbody>
</table>

f. Turn off power to the circuit. Remove the test leads and restore circuit continuity.
SECTION V
THEORY OF OPERATION

5.1 GENERAL
5.1.1 The taut-band indicating instrument used in the 165 responds linearly to direct current and requires less than 50 microamperes to cause full-scale deflection. The indicating instrument and its associated calibration network, R1 and R2, are adjusted accurately to an equivalent circuit resistance of 5000 ohms. The resulting basic metering circuit, after calibration, requires precisely 50 microamps at 0.25 volts for full-scale deflection. The varistor, D1 shown in the schematic diagram (Figure 5-1), provides an effective shorting path for metering signals appreciably in excess of full scale. The network can bypass excessive currents as high as several hundred milliampere continuously, thereby affording considerable protection to the indicating instrument.

5.2 DC VOLTOMETER CIRCUIT
5.2.1 The basic circuit configuration employed for DC voltage measurements is shown in simplified form in Figure 5-1. The metering circuit (M) in this diagram includes the calibrating network as described above. The precision voltage ranging resistors, R14, R15, R16, R17 and R28, provide the necessary voltage drop to yield full-scale deflection for each corresponding range as shown in Figure 5-1. Note that the 1000 V ranges utilize separate jacks.

Figure 5-1. Simplified Circuit-DC Volts
5.3 DC MILLIAMMETER CIRCUIT

5.3.1 The basic circuit configuration utilized for direct current measurements is shown in simplified form in Figure 5-2. Resistors R5, R6, R7 and R8 in the arrangement shown form a shunt. The values of these resistances can be computed as:

\[ R_{SH} = \frac{R_{M} \times I_{M}}{I_{SH}} \]

where \( R_{SH} \) is defined as the total value of the shunt between the input terminals.

5.4 AC VOLTMETER CIRCUIT

5.4.1 The simplified circuit for the AC voltage ranges of the 165 is given in Figure 5-3. The modified full-wave bridge comprising D2, D3, R26 and R27 provides direct current to the metering circuit (M) proportional to the average rectified value of the AC voltage being measured. With the range switch set at 2.5 volts, and calibration resistors R3 and R4 properly adjusted, an effective input resistance of 12,500 ohms is attained. This corresponds to a sensitivity of:

\[ \frac{12,500 \Omega}{2.5 \text{ V}} = 5,000 \Omega/\text{V} \]

Values of the range resistors R18, R19, R20 and R29 are calculated on the basis of this sensitivity.

Figure 5-2. Simplified Circuit-DC mA
5.5 OHMMETER CIRCUIT

5.5.1 A simplified circuit for the 165 ohmmeter ranges is given in Figure 5.4. Note for the R x 1 ohms measurements, the equivalent meter resistance is approximately 200 ohms. A 1.5 volt battery supplies the power for measurements on the R x 1, R x 10 and R x 100 ranges.

5.5.2 For the R x 1 k range, a 15 volt battery is employed to obtain the required full-scale meter current. The Ohms Adjust resistor (R12) is adjusted manually by the operator to allow full-scale deflection (zero ohms) with the test leads shorted. A slight readjustment of R12 might be required when switching from the lower ohms scales to the higher because of the difference in condition of the two batteries.

Figure 5.3. Simplified Circuit-AC Volts
SECTION VI
OPERATOR MAINTENANCE

6.1 REMOVAL FROM THE CASE

6.1.1 The Instrument has been designed to provide easy access for all necessary adjustments and replacement of parts. It is only necessary to remove one screw from the back of the Instrument (center of the case) to gain access to the battery and fuse compartments.

6.1.2 After removing this screw, the front panel, including the indicating instrument, printed circuit board, fuse and batteries, can then be removed as a unit. Press lightly against the threaded brass insert, using a pencil or similar device, to facilitate separation of the Instrument from its case.

6.2 BATTERY REPLACEMENT

NOTE: When the Ohms Adjust control cannot be adjusted for zero ohms (with shorted test leads), it is generally an indication that a battery has reached the end of its useful life. Consequently the defective battery must be replaced. Failure to do so promptly can result in damage to the 165 due to chemical leakage from the battery.
Operator Maintenance

6.2.1 After removal of the case, loosen and remove the screw securing the battery contact plate to the panel assembly. The contact plate is marked showing location and polarity of the two batteries used in the instrument. When installing new batteries, note battery placement and polarity as indicated on contact plate.

6.2.2 Line up notch in contact plate with round boss on panel assembly and press contact plate down. While holding contact plate down, insert screw back into its hole and thread into nut located in panel assembly. Continue to thread screw until contact plate is firmly secured to panel assembly.

6.3 FUSE REPLACEMENT

6.3.1 After removal of the case, loosen and remove the screw securing the battery and fuse contact plate to the panel assembly. The contact plate is marked showing location of the fuse.

---

WARNING

The following servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

---

6.3.2 Replace the fuse with a 3AG type, 1/8 A, 250 V, normal time lag fuse (refer to Table 7-1).

6.3.3 Replace the contact plate in accordance with 6.2.2.

6.4 TEST LEAD INSPECTION

6.4.1 Periodic inspection of the test leads is recommended to detect cuts, burns or other damage that could reduce the insulation strength of the leads. New leads may be purchased from the nearest Authorized Service Center.
SECTION VII
SERVICING INSTRUCTIONS

7.1 REPLACEMENT PARTS AND SCHEMATIC DIAGRAM

7.1.1 This section contains information for ordering replacement parts. Table 7-1 lists parts in alphanumerical order of their reference designators and indicates the description. (Refer to Table 1-2 for Items and Accessories Furnished with This Instrument.)

7.1.2 To obtain replacement parts, address order to the nearest Authorized Service Center (listed on the last page of this manual). Refer to paragraphs 2, 3, 4 for ordering instructions.

NOTE: If it is necessary to replace components, do not apply heat directly to the circuit board. Cut leads close to component body and solder new component to the leads. Refer to an Authorized Service Center or the Simpson Electric Company for recalibration or servicing of the printed circuit board.

Figure 7.1. Schematic Diagram
### Table 7.1. Replacement Parts

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R4</td>
<td>Potentiometer 6 kΩ</td>
<td>5-110716</td>
</tr>
<tr>
<td>R2</td>
<td>Potentiometer 150 kΩ</td>
<td>5-111672</td>
</tr>
<tr>
<td>R3</td>
<td>Potentiometer 20 kΩ</td>
<td>5-110850</td>
</tr>
<tr>
<td>R5</td>
<td>Resistor 48 Ω</td>
<td>6-112665</td>
</tr>
<tr>
<td>R6</td>
<td>Resistor 4.96 Ω</td>
<td>6-112669</td>
</tr>
<tr>
<td>R7</td>
<td>Resistor 50.5 Ω</td>
<td>6-112682</td>
</tr>
<tr>
<td>R8</td>
<td>Resistor 555 Ω</td>
<td>6-112662</td>
</tr>
<tr>
<td>R9</td>
<td>Resistor 140 Ω</td>
<td>6-112672</td>
</tr>
<tr>
<td>R10</td>
<td>Resistor 13.3 kΩ</td>
<td>6-112670</td>
</tr>
<tr>
<td>R11</td>
<td>Resistor 193 kΩ</td>
<td>5-114350</td>
</tr>
<tr>
<td>R12</td>
<td>Potentiometer 5 kΩ</td>
<td>6-112146</td>
</tr>
<tr>
<td>R13</td>
<td>Resistor 3 kΩ</td>
<td>5-116862</td>
</tr>
<tr>
<td>R14</td>
<td>Resistor 45 kΩ</td>
<td>1-114192</td>
</tr>
<tr>
<td>R15</td>
<td>Resistor 150 kΩ</td>
<td>1-113366</td>
</tr>
<tr>
<td>R16</td>
<td>Resistor 800 kΩ</td>
<td>1-113363</td>
</tr>
<tr>
<td>R17</td>
<td>Resistor 4 megΩ</td>
<td>1-113362</td>
</tr>
<tr>
<td>R18</td>
<td>Resistor 1 megΩ</td>
<td>1-113392</td>
</tr>
<tr>
<td>R19</td>
<td>Resistor 200 kΩ</td>
<td>1-113365</td>
</tr>
<tr>
<td>R20</td>
<td>Resistor 37.5 kΩ</td>
<td>1-113393</td>
</tr>
<tr>
<td>R21</td>
<td>Resistor 198 Ω</td>
<td>6-112664</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>R22</td>
<td>Resistor 1.8 kΩ</td>
<td>6-112668</td>
</tr>
<tr>
<td>R23</td>
<td>Resistor 18 kΩ</td>
<td>6-112671</td>
</tr>
<tr>
<td>R24, R25</td>
<td>Resistor 7.5 kΩ</td>
<td>5-111320</td>
</tr>
<tr>
<td>R26, R27</td>
<td>Resistor 5 kΩ</td>
<td>1-113425</td>
</tr>
<tr>
<td>R28</td>
<td>Resistor 15 megΩ</td>
<td>1-115763</td>
</tr>
<tr>
<td>R29</td>
<td>Resistor 3.75 megΩ</td>
<td>1-115765</td>
</tr>
<tr>
<td>D1</td>
<td>Diode, Varistor</td>
<td>1-110670</td>
</tr>
<tr>
<td>D2, D3</td>
<td>Diode, Germanium, IN 100</td>
<td>1-115970</td>
</tr>
<tr>
<td></td>
<td>Molded Case Assembly — 165U</td>
<td>10-864872</td>
</tr>
<tr>
<td></td>
<td>Molded Case Assembly — 165</td>
<td>10-864906</td>
</tr>
<tr>
<td></td>
<td>Case Mounting Screw, Nylon</td>
<td>5-111655</td>
</tr>
<tr>
<td></td>
<td>Range Knob</td>
<td>3-260548</td>
</tr>
<tr>
<td></td>
<td>Meter Cover Assembly</td>
<td>10-560318</td>
</tr>
<tr>
<td></td>
<td>Rubber Feet, Case</td>
<td>5-111660</td>
</tr>
<tr>
<td>B2</td>
<td>Battery, 15 V NEDA #220</td>
<td>1-115329</td>
</tr>
<tr>
<td></td>
<td>Eveready type 504 (or equivalent)</td>
<td>1-11802</td>
</tr>
<tr>
<td>B1</td>
<td>Battery, 1.5 V size AA NEDA 15F</td>
<td>1-11802</td>
</tr>
<tr>
<td></td>
<td>Eveready 915 (or equivalent)</td>
<td>3-812065</td>
</tr>
<tr>
<td></td>
<td>Battery and Fuse Contact</td>
<td>1-116104</td>
</tr>
<tr>
<td></td>
<td>Fuse, 1/8 A, 250 volt, 3AG type</td>
<td>02055</td>
</tr>
<tr>
<td></td>
<td>Test Leads, 1 set</td>
<td>02935</td>
</tr>
<tr>
<td></td>
<td>Carrying Case</td>
<td>02935</td>
</tr>
</tbody>
</table>
## Notes

**FOR THE RECORD**

<table>
<thead>
<tr>
<th>Date Purchased:</th>
<th>Purchased From:</th>
<th>Identification Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date</strong></td>
<td><strong>Type of Service</strong></td>
<td><strong>Serviced By</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>