OPERATOR'S MANUAL
Model 160
Volt-Ohm-Milliammeter

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.

This instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

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.
Internet: **http://www.simpsonelectric.com**

Warranty and Returns

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.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service centers, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a

potential in excess of 30 volts RMS (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

1. INTRODUCTION 5
1.1 General 5
1.2 Suppliers & Accessories 5
1.3 Safety Consideration 5
1.4 Technical Data 5

2. INSTALLATION 7
2.1 Unpacking & Inspection 7
2.2 Warranty 7
2.3 Shipping 8
2.4 Operating Procedure 8

3. CONTROLS, CONNECTORS & INDICATORS 8
3.1 Panel Description 8

4. OPERATION 9

4.1 Safety Precaution 9
4.2 Zero Adjustment 10
4.3 Measuring DC Voltages, 250 Millivolt Range 10
4.4 Measuring DC Voltages, 1 V Range 11
4.5 Measuring DC Voltages, 2.5 Through 500 V Ranges 11
4.6 Measuring DC Voltages, 1,000 Volt Range Only 12
4.7 Measuring AC Voltages, 2.5 Through 500 Volt Range 12
4.8 Measuring AC Voltages, 1000 Volt Range Only 13
4.9 Measuring Decibels 13
4.10 Measuring Resistance 13
4.11 Direct Current Measurement 14
4.12 Measuring Direct Currents, 50 mA Range 14
4.13 Measuring Direct Current, 0-1 Through 0-500 mA Ranges 15

5. BATTERY REPLACEMENT 15

1. INTRODUCTION

1.1 General

The Simpson 160 Volt-Ohm-Milliammeter (hereafter referred to as the 160 or the Instrument) is a compact, easy-to-operate instrument used for measuring electrical characteristics of circuits and circuit components. The Instrument has a taut-band movement suspension with diode overload protection to provide long, trouble-free service. The 100 degree mirrored dial arc and knife edge pointer provide excellent readability and eliminate parallax errors.

A polarity-reversing switch and a one-knob Function/Range selector simplify operation of the Instrument. The internal batteries are easily obtained and replaced.

Most of the component parts are mounted on a printed circuit board. This helps ensure uniform performance, reduces maintenance and extends the useful life of the Instrument.

1.2 Supplies & Accessories

All supplies and accessories required for the operation of the 160 are furnished with each Instrument and listed in Table 1-2.

1.3 Safety Considerations

This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and service conditions. CAUTION or WARNING symbols are placed throughout this publication, where applicable, and are defined on the inside cover of the manual under the heading SAFETY SYMBOLS. Adherence to these instructions will help ensure safety of operating and servicing personnel and protect the instrument.

1.4 Technical Data

Table 1-1. Technical Data

DC Volts	
Ranges:	2.5, 10, 50, 250V; 0.25, 1.0 and 1000V on separate jacks.
Sensitivity:	20,000 per volt
Rated Accuracy:	Within 2% DC and 3% AC of full scale on all ranges.
	Ranges: 2.5, 20, 50, 250, 500V; 1,000V on separate jack.
Sensitivity:	5,000Ω per volt.
Indication:	Full-wave average-responding: calibrated in RMS for sinusoidal waveforms.
* Frequency Response:	Rated accuracy to 100,000 Hz on all ranges through 50V; to 20 kHz on 250V range. 2-A.
** **Rated Circuit-To-Ground Voltage:**	1,000V AC/DC max.

* See typical Response Curves, Figure 1-1.
** 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."

Direct Current:

Ranges:	1, 10, 100, 250, 500 mA; 50 µA on separate jack.
Rated Accuracy:	Within ±2% full scale, all ranges

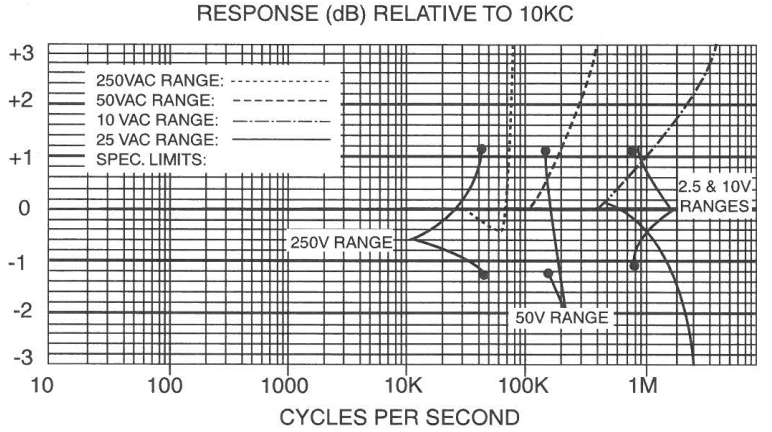

Figure 1-1. Typical Frequency Response Curve

DC Resistance

Ranges:	
R x 1	0-3,000Ω (30Ω center)
R x 10	0-30,000Ω (300Ω center)
R x 100	0-300,000Ω (3 KΩ center)
R x 1K	0-3 MΩ (30 KΩ center)
R x 10K	30 MΩ (300 KΩ center)
Accuracy:	3° arc
Max. Voltage or Current Delivered:	
R x 1	50 mA short circuit, 1.5V open circuit
R x 10	5 mA short circuit, 1.5V open circuit
R x 100	0.5 mA short circuit, 1.5V open circuit
R x 1K	0.75 mA short circuit, 22.5V open circuit
R x 10K	0.075 mA short circuit, 22.5V open circuit
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 600Ω
Movement:	Taut-Band 100° arc, 50 µA full scale
Dial Arcs:	One arc for ohms, one arc for DC, two arcs for AC, one arc for dB.
Scale Length:	3.0 inches

Lead Reversal:	Polarity Reverse Switch; on DC and ohms 10.
Operating Position:	Horizontal or vertical; rubber feet prevent slipping on moderate slopes.
Batteries:	1.5 V AA penlight and AA 3.6V.
Movement & Indicator Protection:	Silicon double diode across movement terminals.
Test Leads:	Custom molded elbow terminals; 3 ft. flexible probe tips.
Operating Temperature:	75 °F for rated accuracy; less than 4% additional
Range:	error over the range of +25 °F to +130 °F.
Size:	4-9/16 x 3-5/16 x 1-3/4 (inches)
Weight:	Approx. 12 oz., complete

Table 1-2. Items and Accessories Supplied with This Instrument

Description	Cat. Number
Probe Tip Test Leads	02055
Operator's Manual	05-111658

Table 1-3. Additional Accessories

Description	Cat. Number
Padded Nylon Case	00836
Alligator Clip Leads	01927

2. INSTALLATION

This section contains instructions for the installation and shipping of the 160. Included are unpacking and inspection procedures, warranty, shipping, and operating procedure.

2.1 Unpacking & Inspection

Examine the shipping carton for signs of damage before unpacking. Unpack and inspect the Instrument for possible damage in shipment. If damaged, notify the carrier and supplier before using the Instrument. Check that all furnished items and accessories are included (Table 1-2). Save all shipping materials for future use.

2.2 Warranty

The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully before requesting a warranty repair. For all assistance, contact the nearest Authorized Service Center for instructions. If necessary, 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 nonwarranty or other service work is required, a maximum charge estimate

will be quoted. This charge will not be exceeded without prior approval.

2.3 Shipping

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

2.4 Operating Procedure

The Instrument may be operated in a horizontal or vertical position.

3. CONTROLS, CONNECTORS & INDICATORS

All operating and adjustment controls, connectors, and indicators are described in this section along with a list (Table 3-1) describing their functions. Become familiar with each item before operating the Instrument.

3.1 Panel Description

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

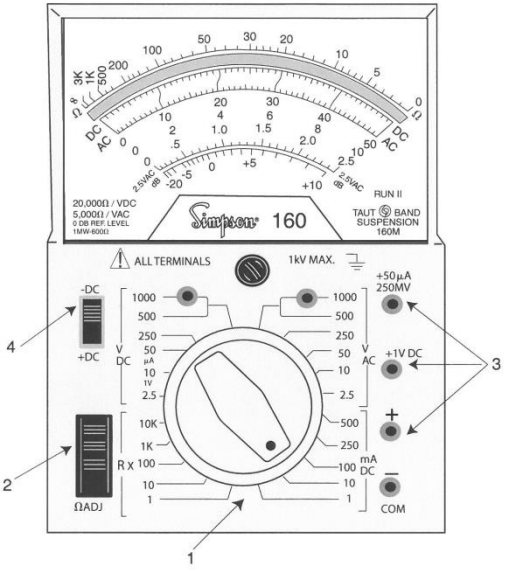

Figure 3-1. Front Panel

Table 3-1. Controls, Connectors, and Indicators

1. **Function and Range Switch:** This switch, located in the lower center of the panel, is used to select the desired current, voltage, or resistance function and appropriate range.

2. **Zero Ohms Adjust Control:** This control, located at the lower left on the front panel, 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 six input jacks: Four of these are on the right side of the panel and two directly below the zero adjustment screw. The four jacks on the right are identified COM –, +, +1V, and +50Ω / +250 mV. The COM + jack is used for all ranges and functions with the exception of the 1V, 50ΩA, 250 mV, 1,000 VDC and 1,000 VAC ranges. The two jacks below the Instrument are identified 1,000 VDC and 1,000 VAC and are used to extend the 500 VDC and 500 VAC ranges

4. **Polarity Reversing Switch:** This switch, located above the ΩADJ control, allows simple lead polarity reversal when making DC or resistance measurements on any range except the 50 µA, 250 mV, or 1V positions. For normal operation, set this switch to +DC position, using the COM – as the reference. Conversely, negative polarity signals can be measured without interchanging leads by setting the switch to the – DC position. When the VOM is set on any resistance range, this switch reverses the polarity of the measuring potential in the same manner.

NOTE: When making measurements of the 50 µA, 250 mV, 1V ranges, the reversing switch must be set to the +DC position to obtain readings.

4. OPERATION

Before operating the 160, review the SHOCK HAZARD definition printed on the inside front cover of this manual.

4.1 Safety Precautions

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.

1. Do not hold the instrument when working in circuits that might contain a shock hazard.
2. Inspect the test leads, probes, connectors, and insulating boots for damage or deterioration before each use. If defects are found, replace the leads immediately with leads designed for the Instrument. Do not use test leads inferior to those furnished with the Instrument.
3. 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. Develop safe habits by always turning off power to the measured circuit and discharging any capacitors before handling the test leads.
4. Become familiar with the circuit to be measured and locate any shock hazards before attempting measurements. Remember that high voltages might appear unexpectedly in a faulty circuit.
5. Measuring electricity is particularly hazardous in the presence of humidity or moisture. Hands, shoes, floor and workbench must be dry.
6. Avoid measuring 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.
7. Be alert for corona in the measured circuit. Signs of corona include a buzzing sound, ozone odor and a pale blue emanation. Its presence indicates high voltage; an unexpected or unknown path might lead to a flash-over.
8. Do not work alone when measuring where a shock hazard can exist. Notify someone nearby of your intentions.
9. Do not connect the Instrument to an electrically energized circuit in a hazardous area. Do not use the Instrument to check electrical "blasting" circuits.
10. 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 Zero Adjustment

Before measuring, 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 160" legend.

4.3 Measuring DC Voltages, 250 Millivolt Range

Use care when making measurements with the 160 on the 250 mV range. An excessive voltage applied when in this range can damage the Instrument.

1. Connect the black test lead into the COM (–) jack and the red test lead into the +50 µA +250 mV jack.
2. Set polarity switch to the + DC position.
3. Set the Range Selector Switch to the 50 µA position (common to the 50 VDC position).
4. Connect the black test lead to the negative (–) side of the circuit to be measured and the red test lead to the positive (+) side of the circuit.
5. Read the voltage on the black arc marked DC. Use the figures marked 0-2.5 and multiply reading by 100 for the millivolt reading. If the pointer moves to the left of zero, reverse the test lead connections, as the reversing switch must be kept in the + DC position for this range.

4.4 Measuring DC Voltages, 1 V Range

1. Connect the black test lead to the COM (–) jack and the red test lead to the + jack.
2. Set the polarity switch to the + DC position.
3. Set the range switch to the 1 VDC position (common to the 10 VDC position).
4. Connect the black test lead to the negative (–) side of the circuit to be measured and the red test lead to the positive (+) side.
5. Read the voltage on the black arc marked DC. Use the figures 0-10 and divide the reading by 10 to obtain voltage reading. If the pointer moves to the left of zero, reversing switch must be kept in the +DC position for this range.

4.5 Measuring DC Voltages, 2.5 Through 500 V Ranges

1. Connect the black test lead to the COM (–) jack and the red test lead to the + jack.
2. Set the range switch for any of the five DC volts range positions desired. These are marked 2.5, 10, 250, and 500 VDC. When in doubt as to which range to use, always start with the higher voltage range as a protection to the Instrument.
3. Connect the black lead to the negative (–) side of the circuit to be measured and the red test lead to the positive (+) side of the circuit.
4. Set the polarity switch to the + DC position. Turn the power on in the circuit to be tested. If the pointer deflects to the left of zero, the actual circuit polarity is the reverse of that anticipated. In this case, turn off power in the circuit to be tested, set the polarity switch to the – DC position and turn power on again.
5. 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 0-2.5 scale and read the value directly.
10 and 50 VDC ranges:	Read the corresponding scale directly.
250 VDC range:	Use the 0-2.5 scale and multiply reading by 100.
500 VDC range:	Use the 0-50 scale and multiply by 10.

4.6 Measuring DC Voltages, 1,000 Volt Range Only


Use extreme care when working in high voltage circuits. Even though the Instrument and test leads are well insulated for this voltage, do not handle when power is on in the circuit.

1. Set the range switch to the 1,000 VDC position (common with the 500 VDC position).
2. Connect the black test lead to the COM (–) jack and the red test lead to the 1,000 VDC jack.
3. Set the polarity switch to the + DC position.
4. Connect the black test lead to the negative (–) side of the circuit and the red test lead to the positive (+) side.
5. If the pointer deflects to the left side of zero, the actual circuit polarity is the reverse of that anticipated. (In this case see Paragraph 4.5, step d.)
6. Read the voltage, using the 0-10 scale on the black arc marked DC and multiply the reading by 100.

4.7 Measuring AC Voltages, 2.5 Through 500 Volt Range

The 160 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 RMS voltage, which will be correct for all sinusoidal waveforms.

NOTE: Since the 160 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.

1. Connect the black test lead to the COM – jack and the red test leads to the + jack.
2. Set the range switch for any of the five VAC range positions desired. These are marked 2.5 VAC, 10 VAC, 50 VAC, 250 VAC, and 500 VAC. When in doubt as to which range to use, always start with the highest voltage range as a protection to the Instrument.
3. Turn the power on in the circuit to be tested. Read the voltage on the red arc marked AC.

0-2.5 VAC range:	Read the value directly on the special arc marked 2.5 VAC.
10 and 50 VAC ranges:	Read the red arc marked AC, and use the corresponding black numbers immediately below the arc.
250 VAC range:	Read the red arc marked AC using the 0-2.5 figures and multiply the reading by 100.
500 VAC range:	Read the red arc marked AC using the 0-50 figures and multiply the reading by 10. If the voltage is within a lower range, the switch may be set for the lower range to obtain a more accurate reading.

4.8 Measuring AC Voltages, 1000 Volt Range Only


Use extreme care when working in high voltage circuits. Even though the Instrument and test leads are well insulated for this voltage, do not handle when power is on in the circuit.

1. Set the range switch at 1,000 VAC position (common with the 500 VAC position).
2. Turn off power in the circuit being measured.
3. Connect the black test lead to the COM (–) jack, and the red test lead to the 1,000 VAC jack.
4. Turn on power in the circuit being measured.
5. Read the voltage on the red arc marked AC using the 0-10 figures and multiply the reading by 100.

4.9 Measuring Decibels

The decibel scale at the bottom of the dial is numbered from –20 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 2.5V range. Scale factors for other ranges and dB reference at 0.006 watts into 500 ohms are given in the table below.

Range	1 mW @ 600	6 mW @ 500
2.5V	direct	–7
10 V	+12	+5
50 V	+26	+19
250 V	+40	+33

4.10 Measuring Resistance

When resistances are measured, the internal batteries of the 160 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.

1. Set the range switch at the desired resistance range position.
2. Connect the black test lead to the COM (–) jack, and the red test lead to the + jack.
3. Connect the contact ends of the test leads together.
4. Observe the Instrument indication. Look for a reading of “0” on the OHMS arc, which is at the top of the dial.
5. 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 brought up to the “0” mark, replace the appropriate battery.

NOTE: Disconnect power from any resistor or circuit to be measured before measuring resistance. Do not apply any power until the measurements are completed and test leads are disconnected.

6. 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. With the polarity switch in the + DC position, the + jack will provide a positive potential referred to COM – jack. Setting the switch to the – DC position will reserve this measuring potential.
7. 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.
8. 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 160. For example, a diode could measure 80 Ω the R x 1 range, and 300 Ω 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.

4.11 Direct Current Measurement

1. Do not switch the range setting of the Range or Polarity Switches while the circuit under measurement is energized.
2. Never disconnect the test leads from the circuit under measurement while the circuit is energized.
3. Always turn the power off and discharge all the capacitors before the setting of the switches is changed, or the leads disconnected.
4. Never exceed the Circuit-To-Ground voltage of the Instrument (1,000 V max: Table 1-1, Rated Circuit-Ground Voltage).
5. Always connect the Instrument in series with the ground side of the circuit.
6. In all direct current measurements make certain the power to the circuit being tested has been turned off before connecting and disconnecting test leads or restoring circuit continuity.

4.12 Measuring Direct Currents, 50 µA Range

Never connect the test leads directly across any source of voltage when the 160 is used for current measurements. This will damage the Instrument.

1. Connect the black test lead to the COM – jack, and the red test lead to the + 50 mA jack.
2. Set the range switch at 50 mA (common with 50 VDC).
3. With the circuit power 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 when making connection.
4. Turn on power to the circuit being measured. If the pointer is deflected to the left of zero, the polarity is opposite to that anticipated. Turn power off

and reverse the leads. The polarity switch must be kept in the + DC position on this range.

5. Read the current directly on the black arc marked DC, using the 0-50 scale. The current value is shown in microamperes.
6. Turn off power to the circuit. Remove the test leads and restore the circuit continuity.

4.13 Measuring Direct Current, 0-1 Through 0-500 mA Ranges

1. Connect the black test lead to the COM (–) jack and the red test leads to the + jack. Set the polarity switch to the + DC position.
2. Set the range switch to any of the five mA direct current range positions, as desired. The switch positions are marked 1 mA, 10 mA, 100 mA, 250 mA, and 500 mA. When in doubt as to which range to use, always start with the highest ranges as a protection to the Instrument.
3. 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.
4. Apply power to the circuit being measured. If the pointer deflects to the left of zero, the polarity is reversed. Turn off the power. Set the polarity switch to the –DC position and then reapply the power.
5. Read the current on the black scale marked DC, which is second from the top of the dial.

mA Range	Use Scale	Reading
1.0	0-10	Divide by 10
10	0-10	Read direct value
100	0-10	Multiply reading by 10
250	0-2.5	Multiply reading by 100
500	0-50	Multiply reading by 10

6. Turn off power to the circuit. Remove the test leads and restore circuit continuity.

5. BATTERY REPLACEMENT

When the Ohms Adjust control cannot be adjusted for zero ohms (with shorted test leads), it is generally an indication that the battery must be replaced. Failure to do so promptly can result in damage to the 160 due to chemical leakage from the battery.

To replace the battery, remove the screw holding the back cover to front panel and separate the back cover from the front panel. Loosen the screw securing the battery contact plate located at the top of the 160 panel assembly, then rotate the contact plate enough to allow removal of the batteries. When installing new batteries, note battery placement and polarity as indicated on the contact plate.

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Printed in U.S.A. Part No. 05-111658 Edition 17, 10/15
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