

# **simpson**

## **OPERATOR'S MANUAL**

**MODEL 444  
DIGITAL MICRO-OHMMETER**



### **WARNING**

**READ AND UNDERSTAND THIS MANUAL BEFORE  
USING THE INSTRUMENT.**

**Failure to understand and comply with the WARNINGS  
and operating instructions can result in serious or fatal  
injuries and/or property damage.**

# **DIGITAL INSTRUMENT**

## **Warranty**

**SIMPSON ELECTRIC COMPANY warrants each digital instrument 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 any digital instrument 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 stations, 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 sale of its products.**

**This warranty shall not apply to any digital instrument which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, 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.**

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# **OPERATOR'S MANUAL**

## **MODEL 444 DIGITAL MICRO-OHMMETER**

**NOTE:** This Operator's Manual contains information essential to the operation of this Instrument. Therefore, it should be kept with the Instrument for reference as required.

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**WARNING**

**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.**

**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 milliamperes, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

**NOTE:** The proper measuring instrument for the measurement of leadage consists essentially of a network of a 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

## SAFETY SYMBOLS



This marking adjacent to another marking or a 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.



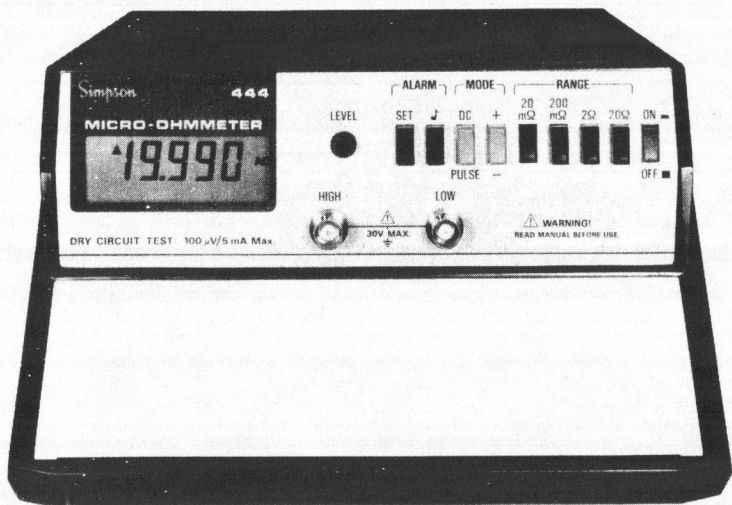
**CAUTION**

The CAUTION sign denotes a hazard. It calls attention to an operating 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.



**30 v max**

This marking advises the user that the terminal(s) so marked must not be connected to a circuit point at which the voltage, with respect to earth ground, exceeds (in this case) 30 volts, maximum.



**Figure 1-1. Model 444 Micro-Ohmmeter**

# **SECTION 1**

## **INTRODUCTION**

### **1.1 GENERAL**

**1.1.1** The Simpson 444 Micro-Ohmmeter measures resistances from 1 micro ohm to 20 ohms. It makes the measurement by using an extremely small test voltage (100 microvolt maximum) and a four wire measurement technique. The measured resistance is displayed on 4 1/2 digit LCD display. The 444 is designed to be run from the power line, but self-contained rechargeable Ni-Cad batteries are provided for field use.

**1.1.2** The Simpson 444 has two measurement modes, an automatic AC measurement mode and manual DC measurement mode. In the AC mode a 100 microvolt maximum square wave is used to test the resistance. Because of the AC nature of the square wave, all offset voltages and thermocouple effects are automatically canceled and the resistance can be directly read. In the DC mode, a 100 microvolt maximum DC test voltage is used and the user must manually cancel out any offsets and thermocouple effects.

### **1.2 ITEMS AND ACCESSORIES**

All items and accessories required for the operation of the 444 are furnished with each Instrument, and listed in the accompanying Table 1-2. (Available replacement parts are listed in Table 7-1.).

### **1.3 SAFETY CONSIDERATIONS**

This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and servicing conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and is defined at the front of this manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of this Instrument, these instructions must be adhered to.

# Introduction

## 1.4 TECHNICAL DATA SPECIFICATIONS

Table 1-1 lists the technical data for the 444 Digital Micro-Ohmmeter.

**Table 1-1. Technical Data**

The following specifications apply over an operating temperature range of 18° to 28°C at a relative humidity up to 80% unless otherwise specified.

### 1. Ranges:

Range	Resolution	Max. Test Current
20 m $\Omega$	1 $\mu\Omega$	5mA
200 m $\Omega$	10 $\mu\Omega$	500 $\mu$ A
2 $\Omega$	100 $\mu\Omega$	50 $\mu$ A
20 $\Omega$	1 m $\Omega$	5 $\mu$ A

### 2. Accuracy:

AC MODE:  $\pm$  (0.05% of input + 15 counts)

DC MODE:  $\pm$  (0.05% of input  $\pm$  150 counts)

### 3. Maximum Test Voltage: 100 $\mu$ V (Peak)

### 4. Measurement Techniques:

Pulse (AC) 40 Hertz Square Wave  
DC Switchable Polarity

### 5. Alarm: Resistance below setpoint activates audible beeper and display annunciator. Resistance above setpoint activates display annunciator.

Setpoint Adjustment: Front Panel Knob

Accuracy:  $\pm$  (1% of input + 150 counts)

Hysteresis: 1% typical

Adjustment Range: 1 to 20,000 counts typical



## Introduction

6. **Display:** 19,999 count LCD with 0.5" digits and "AC", "DC" and "◆" annunciators  
Conversion rate: 2 readings per second
7. **Test Leads:** 1 meter RG-58 leads with BNC connector one end and Kelvin clip on the other end.
8. **Operating Voltage:** 120 VAC  $\pm$  10%, 240 VAC optional, 3 VA typical
9. **Operating Temperature Range:** 0° to 50°C
10. **Storage Temperature Range:** -40° to +60°C
11. **Relative Humidity:** 90% maximum up to 35°C, 70% maximum up to +50°C (non-condensing)
12. **Temperature Coefficient:** 0.1 times the applicable accuracy specification per °C (0° to 18°C and 28° to 50°C)
13. **Battery Voltage Effect:** Plus or Minus(0.15% of input), Fully charged to "B" annunciator displayed.
14. **Battery Life:** 8 hours typical
15. **Rated Circuit-to-Ground Voltage:** 30V (rms)
16. **Dimensions:** 2.7 x 8.4 x 9.0" (68.6 x 213.4 x 228.6 mm) nominal
17. **Weight:** Approx 3 lbs

# Introduction

**Table 1-2. Items and Accessories  
Furnished With This Instrument**

Quantity	Description	Number
1	Operator's Manual	6-114500
1	Power Cord	5-118916
2	KelvinTest Leads	6-114574

**Note:** Other optional Kelvin type test leads are available from Simpson Electric.

## **SECTION II**

### **INSTALLATION**

#### **2.1 GENERAL**

This section contains instructions for the installation and shipping of the 444. Included are unpacking and inspection procedures, warranty, shipping, power source requirements, and installation.

#### **2.2 UNPACKING AND INSPECTION**

Examine the shipping carton for obvious signs of damage. If damage is suspected open the carton and inspect the Instrument for possible damage. If damage is noted, notify the carrier and supplier prior to using the Instrument. If the Instrument appears to be in good condition, read this Operator's Manual in its entirety. Then run a series of familiarity tests as instructed in this manual. Also, check that all items are included with the Instrument (Table 1-2).

#### **2.3 WARRANTY**

The Simpson Electric Company warranty policy is printed on the inside 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, read the warranty printed on the inside cover of this manual, then contact the dealer or factory. Either will ask for date of purchase, the model and serial number of the unit and a brief description of the problem encountered. Based on the information given, the customer will be advised how to proceed in returning the Instrument for service.

#### **2.4 SHIPPING**

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

# **Installation**

## **2.5 POWER SOURCE REQUIREMENTS**

The Simpson 444 is a powerline operated instrument with built in rechargeable battery backup. The battery automatically charges when the instrument is plugged in. The battery may not be charged when the Instrument is shipped. An 18 hour charging period is recommended before using this Instrument.

## **2.6 INSTALLATION**

The Instrument may be operated in a horizontal position or in an inclined position using the handle as a support.

## SECTION III

### CONTROLS, CONNECTORS AND INDICATORS

#### 3.1 GENERAL

Before attempting any operation of the 444, become familiar with each control. A thorough understanding of how the Instrument operates will avoid undue mistakes and prolong the life of the Instrument.

#### 3.2 FRONT PANEL DESCRIPTION

Table 3-1 lists all front panel controls, connectors and indicators. (See Figure 3-1 for identification.)

**Table 3-1 Front Panel Description**

##### 1. POWER SWITCH:

Push button switch used to apply power to the Instrument. This switch does not remove power from the battery charger circuit.

##### 2. RANGE SWITCHES:

These switches select the maximum resistance which will yield a full scale reading.

##### 3. MODE DC/PULSE:

This switch is used to select between the automatic averaging pulse measurement mode and the manual reading DC measurement mode.

##### 4. PLUS OR MINUS:

This switch is used in conjunction with the DC measurement mode to select the test voltage polarity.

##### 5. :

This switch is used to enable the audible continuity alarm.

##### 6. SET:

This switch is used to display the user adjustable resistance level which triggers the audible continuity alarm.

# Controls, Connectors and Indicators

## 7. LEVEL:

This control is used to set the resistance level which triggers the audible continuity alarm. To display this level, the SET switch must be depressed.

## 8. DISPLAY AREA:

The LCD display area is used to display the resistance measured, the measurement mode, continuity or lack of continuity and battery condition.

### **Numerical:**

The numerical display is used to indicate the resistance value of the resistor under test, or the user settable continuity level.

The up arrow and down arrow indicates whether the resistance under test is less than or greater than the settable continuity level.

### **Annunciators:**

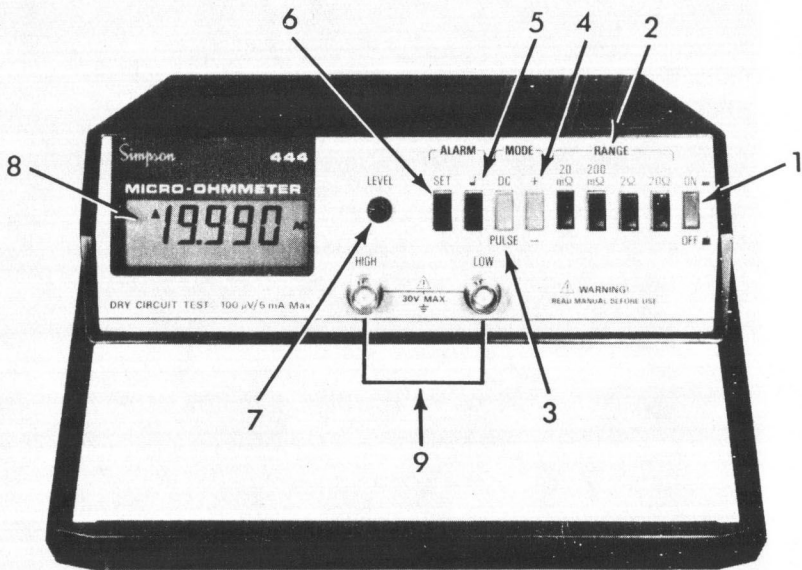
The "AC/DC" annunciators indicate whether the current measurement mode is PULSE (AC) OR DC.

The "B" annunciator appears when the battery is fully discharged.

## 9. HIGH/LOW:

These inputs are used to connect the four wire Kelvin probes to the Instrument. The HIGH/LOW designation refers to the probe polarity in the + DC operating mode.





**Figure 3-1. Front Panel Description**

## SECTION IV

### OPERATION

#### 4.1 GENERAL

This section of the manual contains all the information related to the operation of the Instrument. Special notes and instructions have been included for added safety.

#### 4.2 SAFETY PRECAUTIONS

##### WARNING

**This Instrument is not intended for use on live circuits. Use in circuits exceeding 30V will create a shock hazard which can result in a serious or fatal accident. In addition to being a shock hazard, an energized circuit can damage the Instrument. Before connecting the Instrument to any component in a circuit, the user must be absolutely certain the circuit is not energized, by disconnecting its power source and discharging any capacitors in the circuit.**

**4.2.1** The Model 444 Micro-Ohmmeter is intended for use only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury.

**4.2.2** Do not work alone when making measurements where a shock hazard can exist. Notify another person that you are, or intend to make, such measurements.

#### 4.2.3

Remember, voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured *before* making any connections or disconnections. The above precautions are wise even in the laboratory, and especially in field usage of the Instrument where many unusual or unknown safety hazards might prevail.

## Operation

**4.2.4** Locate all voltage sources and current accessibility paths prior to making any measurement or connections.

**4.2.5** For your own safety, inspect the test leads for cracks, breaks or crazes in the insulation prods and connectors before each use. If any defects are noted, replace the defective item(s) immediately.

**4.2.6** Do not make measurements near a circuit where corona is present. Corona can be identified by a pale-blue color emanating from sharp metal points in the circuit, or by a buzzing sound, or by the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates the presence of high voltage, and probably an electrical malfunction.

**4.2.7** Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or the Instrument.

**4.2.8** For maximum safety, do not touch test leads, circuit, or Instrument while power is applied to the circuit being measured.

**4.2.9** Do not use test leads of lesser safety than those originally furnished with the Instrument.

### **4.3 OPERATING INSTRUCTIONS**

#### **4.3.1 AC MEASUREMENT MODE**

The AC measurement mode will provide accurate results on resistances having negligible inductances. To measure resistance using the AC measurement mode:

- (1) The ALARM SET button and the MODE DC/PULSE buttons must be in the out position.
- (2) Select the desired resistance range.
- (3) Connect the Kelvin probes to the resistance to be tested and turn on the Instrument.

## Operation

- (4) The display will read the resistance directly. If more resolution is desired, press the range switch which will give the desired resolution.

### 4.3.2 DC MEASUREMENT MODE

The DC measurement mode is used to measure resistances where the inductance is not negligible (Such as transformer windings, coils of wire and other inductive items). To measure resistance in this mode:

- (1) Press the MODE DC/PULSE switch in.
- (2) Select the desired resistance range.
- (3) Connect the Kelvin probes to the resistance to be tested and turn the Instrument on.
- (4) Record the reading shown on the display including the polarity.
- (5) Then press the MODE PLUS OR MINUS switch and record the reading shown on the display including the polarity.
- (6) To calculate the measured resistance, subtract the reading made with the MODE PLUS OR MINUS switch in the - position from the reading made with the switch in the + position.

**EXAMPLE 1:** + Reading and - reading both positive.

$$+ \text{ reading} = 135.6 \text{ m } \Omega$$

$$- \text{ reading} = 83.2 \text{ m } \Omega$$

$$135.6 - 83.2 = 52.4 \text{ m } \Omega$$

**EXAMPLE 2:** + Reading positive and - reading negative.

$$+ \text{ reading} = 83.2 \text{ m } \Omega$$

$$- \text{ reading} = - 52.4 \text{ m } \Omega$$

## Operation

To subtract a negative – reading from a positive + reading add the value of the two readings, i.e.:

$$83.2 + 52.4 = 135.6 \text{ m } \Omega .$$

**EXAMPLE 3:** + Reading and – reading both negative.

$$+ \text{ reading} = - 83.2 \text{ m } \Omega$$

$$- \text{ reading} = - 135.6 \text{ m } \Omega$$

To subtract a negative - reading from a negative + reading, subtract the value of the + reading from the value of the – reading, i.e.:


$$135.6 - 83.2 = 52.4 \text{ m } \Omega .$$

### 4.3.3 USER SETTABLE CONTINUITY

To set the continuity level:

1. Select the desired resistance range.
2. Connect Kelvin test leads to a resistance within the selected range.
3. Depress the ALARM SET switch.
4. Adjust the level control to the desired continuity level as read on the display.

### 4.3.4 AUDIBLE CONTINUITY ANNUNCIATOR

The audible continuity annunciator is enabled by pressing the ALARM "  " switch. The alarm will sound when the resistance level drops below the user settable continuity level.

# **SECTION V**

## **THEORY OF OPERATION**

### **5.1 General**

**5.1.1** Conventional resistance measurement is performed by passing a fixed known current through a resistor and measuring the voltage which results from that current. This technique is relatively simple and accurate for most resistance measurements. However, it is less accurate when taking resistance measurements below 20 ohms because of the large currents required to generate the necessary voltages for full scale readings. Additional problems arise when the resistance to be measured is sensitive to the heat generated by the measurement current, or when the resistance can be altered by the voltage created by the test current. A different approach must be used to measure low resistances where such constraints apply.

**5.1.2** The Simpson Model 444 is a precision instrument designed to measure resistances down to several micro ohms without resorting to high test currents used by other micro-ohmmeters. The Model 444 is designed to test these resistances without applying more than 100 Micro Volts to the resistance under test. This feature allows the Model 444 to measure low resistances without the possibility of punch through or heating in the resistance to be tested. It also makes it possible to use the Model 444 as a self-contained portable micro-ohmmeter suitable for field use.

### **5.2 Theory of Measurement**

**5.2.1** When using extremely low voltages to measure resistance, several physical phenomena become significant enough to affect the accuracy of the voltage readings used to calculate the resistance. These effects are:

- 1) Voltage drop in the test leads caused by the test current in those leads.
- 2) Drift and offset in the semiconductor devices used to measure the resistance.



## Theory of Operation

### 3) Thermocouple effects in wire connections.

**5.2.2** Four wire resistance measurement is a common technique used to eliminate the voltage drop caused by current in a test lead. This method uses two pairs of wires to measure resistance. One pair carries the test current while the other pair is used to transmit the voltage across the resistor back to the ohmmeter. Since no current flows in the voltage measurement leads, no errors can be introduced in the measurement. The test probes used for this type measurement are frequently called Kelvin Probes and come in many variations and sizes.

**5.2.3** Drift and offset in semiconductors and thermocouple effects are a much more difficult problem to solve since these effects can contribute to measurement errors ranging from a few percent to several times the actual resistance. These errors occur when the drift/offset and thermocouple effects appear in the voltage measurement circuit causing the measured voltage to be different than the actual voltage. While these effects are not constant, they are not affected by the resistance being tested or by the voltage generated across the resistor nor do they change quickly. Because of these characteristics, it is possible to make two measurements and mathematically cancel the errors out.

**5.2.4** By measuring the voltage across a resistor with current flowing in one direction we obtain a reading. This reading consists of the errors mentioned in the last paragraph plus the voltage across the resistor being tested. A second measurement is then made with the test current reversed. Since the voltmeter leads were not reversed, this second measurement contains the same errors as the last measurement but this time the voltage across the resistor has been subtracted from the measurement. If we take the difference of the two readings we are left with a voltage that is exactly twice the voltage across the resistor. Ohm's law can now be used to calculate resistance once the voltage is divided in half.

## Theory of Operation

**5.2.5** The PULSE measurement mode in the Model 444 has automated this method of testing allowing the user to directly read the resistance without performing any math. In this mode, the test current provided by the Model 444 is automatically switched from one direction to the other 40 times each second. The voltage measurement circuit then feeds the resulting voltages created by this alternating current to a switching network and a sample and hold amplifier which cancels the errors and provides a corrected resistance reading to the analog to digital converter. The analog to digital converter turns this reading to a digital form which is displayed on a liquid crystal display.

**5.2.6** Because this method uses an AC test current, it cannot be used to make measurements where inductance is present. For this reason the Model 444 offers a DC measurement mode. In this mode the current is no longer reversed on a regular basis. Instead, a constant current is fed to the resistor and a measurement is made that contains the errors. A second reading is taken in which the test current is shut off and the voltage measurement contains only the errors generated by the measurement system. To arrive at the correct resistance, the operator must subtract the error reading from the actual reading.

**5.2.7** In the DC mode, measurement errors are not canceled 40 times each second. As a result the drift error present in the sources is passed on to the final reading. This drift will cause the reading to change considerably more than in the PULSE mode. Simpson Electric suggests that the DC mode not be used unless absolutely necessary, since the DC mode readings may be less certain.

## SECTION VI

### OPERATOR MAINTENANCE

#### 6.1 GENERAL

##### WARNING

**Improper repairs can be dangerous to the operator of the Instrument. Servicing other than as described in this section should be performed only by qualified personnel. Refer to Authorized Service Centers or factory should Instrument require repair or calibration.**

#### 6.2 COVER REMOVAL

The bottom cover can be removed for maintenance purposes by the following procedures.

##### WARNING

**Remove all power and connections to the Instrument before removing the case cover. Do not operate the Instrument with the bottom cover removed.**

- (1) Set the POWER switch to the OFF position.
- (2) Disconnect the line cord from the power source and all connections from the Instrument.
- (3) Pull out the knobs on the sides of the Instrument and raise the handle towards the rear of the Instrument.
- (4) Turn the Instrument over and remove the four screws within the rubber feet.
- (5) Lift bottom cover and remove handle.
- (6) Reverse this procedure when replacing the cover.

# Operator Maintenance

## 6.3 BATTERY REPLACEMENT

For maximum performance and battery life, use only the proper replacement Nickel-Cadmium rechargeable battery as supplied with the Instrument. If battery replacement is required, return the Instrument to the factory or the nearest Factory Authorized Service Center.

## 6.4 FUSE REPLACEMENT

The line fuse (F1) and battery fuse (F2) are mounted inside fuse holders on the main P.C. Board. Use the following procedure to replace a fuse.

### WARNING

**Remove all power and input connections to the Instrument before removing bottom cover.**

- (1) Remove bottom cover as described in paragraph 6.2.

### CAUTION

**DO NOT replace a blown fuse with a fuse which has a larger rating or slower time lag characteristic than those specified.**

- (2) Carefully lift the defective fuse from the holder and replace with an appropriate fuse. (Table 7-1)
- (3) Replace bottom cover.
- (4) If the fuse was found to have been blown and replacing it did not restore operation, circuit damage is indicated. Return the Instrument to the factory or nearest Authorized Factory Service Center for repair.

# Operator Maintenance

## 6.5 PREVENTIVE MAINTENANCE

### WARNING

**Do not attempt to clean this Instrument with the test leads connected to a power source or when it is connected to the AC power line.**

**6.5.1** Immediately clean all spilled materials from the Instrument and wipe dry. If necessary, moisten a cloth with soap and water to clean plastic surfaces.

**6.5.2** Whenever possible, avoid exposure or usage in areas which are subject to temperature and humidity extremes, vibration, mechanical shock, dust, corrosive fumes, or strong electrical or electromagnetic interferences.

**6.5.3** Verify Instrument calibration by performing operational checks using known value sources. If the need for calibration is indicated, contact the nearest Authorized Service Center.

**6.5.4** When the Instrument is not in use, store it in a location free from temperature extremes, dust and corrosive fumes, and mechanical vibration or shock.

## SECTION VII

### SERVICING INSTRUCTIONS

#### 7.1 REPLACEMENT PARTS AND SCHEMATIC DIAGRAM

**NOTE:** This instrument must be serviced by qualified personnel. To aid in troubleshooting a schematic diagram is enclosed. The accompanied parts list (Table 7-1) describes the components and refers to Simpson part numbers. Reference Symbol numbers correlate the components shown on the schematic diagram with the parts list.

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

**7.1.2** To obtain replacement parts, address order to the nearest Authorized Service Center.

**Table 7-1. Replacement Parts**

Reference Symbol	Description	Part No.
AT1	Transducer Assembly	10-864659
B1	Battery and Connector Assembly	10-865029
C4, C5	Capacitor, $1\mu\text{F}$ , 10%, 50V, MP	6-113700
C6, C8,	Capacitor, $.01\mu\text{F}$ , +80/-20%, 100V, MC	5-113883
C9-11	Capacitor, $1\mu\text{F}$ , 10%, 50V, MP	6-113700
C12	Capacitor, $.1\mu\text{F}$ , +80/-20%, 50V, CD	5-119660
C13	Capacitor, $.1\mu\text{F}$ , 20%, 160V, MPP	6-112831
C14	Capacitor, $.1\mu\text{F}$ , +80/-20%, 50V, CD	5-119660
C15	Capacitor, $1\mu\text{F}$ , 10%, 50V, MP	6-113700
C16	Capacitor, 10pF, $\pm .5\text{pF}$ , 1KV, CD	5-116863
C17	Capacitor, 5pF, $\pm .5\text{pF}$ , 50V, CD	6-113252
C20, C21	Capacitor, 680pF, 10%, 100V, CD	5-118667



## Reference

Symbol	Description	Part No.
C22	Capacitor, 220 $\mu$ F, 20%, 16V, Lytic	6-114126
C23	Capacitor, 1000 $\mu$ F, 20%, 16V, Lytic	6-113984
C24, C26	Capacitor, .1 $\mu$ F, +80/-20%, 50V, CD	5-119660
C25	Capacitor, 120pF, 20%, 500V, CD	5-111432
C27	Capacitor, 100 $\mu$ F, +50/-10%, 25V, Lytic	5-117737
C28	Capacitor, .1 $\mu$ F, +80/-20%, 50V, CD	5-119660
C29	Capacitor, 120pF, 20%, 500V, CD	5-111432
C30	Capacitor, .22 $\mu$ F, 10%, 100V, MP	6-113067
C31, C32	Capacitor, .1 $\mu$ F, 10%, 63V, MP	6-114132
C33	Capacitor, 100 $\mu$ F, +50/-10%, 25V, Lytic	5-117737
C34	Capacitor, .047 $\mu$ F, 20%, 630V, MP	6-111599
C35	Capacitor, .047 $\mu$ F, 10%, 630V, MP	6-113517
C36, C37	Capacitor, 0.1 $\mu$ F, 80-20%, 100V, MC	5-113883
C38, C39	Capacitor, .001 $\mu$ F, GMV, 1KV, CD	5-111119
C40	Capacitor, .047 $\mu$ F, 20%, 630V, MP	6-111599
C42, C43	Capacitor, .001 $\mu$ F, GMV, 1KV	5-111119
D1-3	Diode, Sil, 1N4002	5-113201
D4, D5		
D7	Diode, Sil, 1N914	5-112004
D8	Diode, Sil, 1N4002	5-113201
D9	Diode, Sil, 1N6263	6-113231
D10	Diode, Sil, 1N914	5-112004
D11	Diode, Sil, 1N4002	5-113201
D12-19	Diode, Sil, 1N914	5-112004
F1	Fuse, 1/4 AMP (120V Model)	1-113835
F1	Fuse, 1/8 AMP (220V Model)	6-110301
IC1-3	IC, Op-Amp, LT1001	6-114391
IC4	IC, Op-Amp, LTC 1052	6-114493
IC5	IC, Dual Op-Amp, LF412A	6-114273
IC6	IC, A/D Converter, ICL7129	6-113034
IC7	IC, Dual Op-Amp, LF412A	6-114273

**Reference**

<b>Symbol</b>	<b>Description</b>	<b>Part No.</b>
IC8	IC, Quad Nand, 4011	6-114490
IC9	IC, Quad Switch, 4066	6-110627
IC10	IC, Multi/DeMultiplexer, 4053	6-112215
IC11	IC, Volt Comparator, LM311	6-114395
IC12	IC, Dual Flip-Flop, 4027	6-114491
IC13	IC, Counter/Divider, 4024	5-118504
IC15	IC, Multi/DeMultiplexr, 4053	6-112215
IC18	IC, Dual Op-Amp, 1458	5-117432
J2	Connector, AC, Power, 3 Pins	6-114085
J3	Connector, 30 Pins	6-114084
J4	Cable and Connector Assy., 5 Pins	6-114573
J5	Connector, 2 X 2, 4 Pin	6-114609
J6	Connector, Header, Male, 2 Pins	6-113017
L1, L2	Coil, Choke, 120 $\mu$ H	6-114494
Q1	Transistor, NPN, 2N4124	5-118128
Q2 - Q5	Transistor, N-FET, 2N7000	6-114290
Q6	Transistor, NPN, 2N4124	5-118128
Q7, Q8	Transistor, PNP, 2N4126	5-116458
Q9, Q10	Transistor, NPN, 2N4401	6-114323
Q11	Transistor, NPN, 2N4124	5-118128
Q12	Transistor, N-FET, 2N7000	6-114290
R1	Potentiometer, 1M $\Omega$	5-118765
R2	Potentiometer, 100K $\Omega$	5-118899
R3	Potentiometer, 10K $\Omega$	5-118081
R4	Potentiometer, 1K $\Omega$	5-118079
R6	Res., 200K $\Omega$ , 0.01%, PMF	6-114613
R7	Res., 20K $\Omega$ , 0.01, PMF	6-114612
R8	Res., 2.0K $\Omega$ , 0.01%, PMF	6-114611
R9	Res., 200 $\Omega$ , 0.01%, PMF	6-114610
R10, R11	Res., 1K $\Omega$ , 5%, 1/4W, CF	5-118155
R12	Res., 4.7K $\Omega$ , 5%, 1/4W, CF	5-118160
R13	Res., 536 $\Omega$ , 1%, 1/4W, MF	5-118924
R14, R15	Res., 29.4K $\Omega$ , 0.5%, 1/4W, MF	6-113593

Reference Symbol	Description	Part No.
R16, 17	Res., 332 $\Omega$ , 0.1%, 1/4W, MF	6-114607
R18, R19	Res., 10K $\Omega$ , 0.1%, 1/4W, MF	6-112821
R20, R21	Res., 100K $\Omega$ , 1%, 1/4W, MF	5-115506
R22, R23	Res., 1.0M $\Omega$ , 0.1%, 1/4W, MF	6-112947
R24	Res., 2.0M $\Omega$ , 0.1%, 1/4W, MF	6-114608
R25	Res., 680 $\Omega$ , 5%, 1/4W, CF	5-119634
R26	Res., 2.0M $\Omega$ , 0.1%, 1/4W, MF	6-114608
R27, R28	Potentiometer, 5K $\Omega$	5-118080
R29	Res., 100K $\Omega$ , 5%, 1/4W, CF	5-118168
R30	Res., 2.2M $\Omega$ , 5%, 1/4W, CF	5-118308
R31	Res., 2K $\Omega$ , 5%, 1/4W, CF	6-110093
R32	Res., Potentiometer, 2K $\Omega$	6-110606
R33, R34,		
R35	Res., 100K $\Omega$ , 1%, 1/4W, MF	5-115506
R36	Res., 1.2K $\Omega$ , 5%, 1/4W, CF	5-118156
R37	Res., 150K $\Omega$ , 5%, 1/4W, CF	6-113474
R38	Res., 39K $\Omega$ , 5%, 1/4W, CF	5-118166
R39	Potentiometer, 20K $\Omega$	5-118082
R40	Res., 18K $\Omega$ , 5%, 1/4W, CF	5-119644
R41	Res., 330K $\Omega$ , 5%, 1/4W, CF	5-115965
R42	Res., 2.2M $\Omega$ , 5%, 1/4W, CF	5-118308
R43	Res., 47K $\Omega$ , 5%, 1/4W, CF	5-114980
R44	Res., 100K $\Omega$ , 5%, 1/4W, CF	5-118168
R45	Res., 47K $\Omega$ , 5%, 1/4W, CF	5-114980
R46, R47	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R48	Potentiometer, 500 $\Omega$	6-113309
R49	Res., 100K $\Omega$ , 5%, 1/4W, CF	5-118168
R50 - R53	Res., 10K $\Omega$ , 1%, 1/4W, MF	6-110497
R54, R55	Res., 1K $\Omega$ , 5%, 1/4W, CF	5-118155
R56	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R57	Res., 110 $\Omega$ , 5%, 1/4W, CF	5-118854
R58, R59	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R61	Res., 43 $\Omega$ , 10%, 5W, WW	5-116583

**Reference**

<b>Symbol</b>	<b>Description</b>	<b>Part No.</b>
R62	Res., 4.7K $\Omega$ , 5%, 1/4W, CF	5-118160
R63, R64	Res., 47K $\Omega$ , 5%, 1/4W, CF	5-114980
R65, R66	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R67, R68	Res., 47K $\Omega$ , 5%, 1/4W, CF	5-114980
R70	Res., 4.7K $\Omega$ , 5%, 1/4W, CF	5-118160
R71	Res., 180 $\Omega$ , 5%, 1/4W, CR	5-118153
R72, R73	Res., 100 $\Omega$ , 5%, 1/4W, CF	5-118152
R74	Res., 470K $\Omega$ , 5%, 1/4W, CF	5-119633
R75	Res., 1.5K $\Omega$ , 5%, 1/4W, CF	5-119637
R76, R77	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R78	Res., 20K $\Omega$ , 5%, 1/4W, CF	5-117283
R79	Res., 20K $\Omega$ , 5%, 1/4W, CF	5-117283
R80	Res., 1M $\Omega$ , 5%, 1/4W, CF	5-118305
R82	Res., 1K $\Omega$ , 5%, 1/4W, CF	5-118155
R83	Res., 220K $\Omega$ , 5%, 1/4W, CF	5-119707
R85	Res., 1K $\Omega$ , 5%, 1/4W, CF	5-118155
R86	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R87	Potentiometer, 1k $\Omega$	5-118079
R88	Res., 10K $\Omega$ , 5%, 1/4W, CF	5-118161
R89	Potentiometer, 5K $\Omega$	5-118080
R90	Res., 4.7K, 5%, 1/4W, CF	5-118160
R91	Res., 6.8K, 5%, 1/4W, CF	5-118256
R93	Res., 68K $\Omega$ , 5%, 1/4W, CF	5-115962
R94	Res., 1.5K $\Omega$ , 5%, 1/4W, CF	5-118162
R95	Res., 27K $\Omega$ , 5%, 1/4W, CF	5-118164
R96	Res., 100K $\Omega$ , 5%, 1/4W, CF	5-118168
T1	Xfmr., Power	6-114127
T2	Xfmr., DC/DC Converter	6-114324
VR2	Diode, Zener, 6.2V, 1N7435	5-113898
Y1	Crystal, 100KHz	6-113155





Quality is the indispensable component  
of every Simpson instrument . . . . .