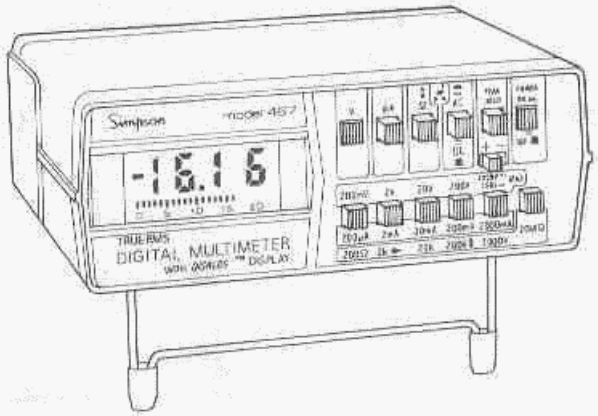
SERVICE MANUAL

Simpson Model 467
True RMS
Digital Multimeter

Part Number T00377

ADDENDUM



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Chapter 1. INTRODUCTION

1-1. SCOPE. This manual provides repair and test procedures for the Simpson model 467 digital multimeter which are not available in the separate Digital Multimeter, Current Shunt Adapter, and High Voltage Test Probe manuals. Included are procedures for battery, fuse, and circuit board replacement, as well as performance tests to verify proper equipment operation.

1-2. FURNISHED ITEMS. Refer to table 1-1 for items furnished with the Simpson 467 multimeter.

Table 1-1. Furnished Items List

Item	Simpson part no.
Current Shunt Adapter	10-864942
High Voltage Probe	10-830844
Carrying Case	10-864945
Test Lead Set	6-112092
Alligator Clip Set	10-864240
Digital Multimeter	10-864657
Manual, Current Shunt Adapter	6-112782
Manual, High Voltage Test Probe	6-112777
Manual, Simpson 467 Multimeter	6-112491

1-3. TOOLS AND TEST EQUIPMENT. No special tools are required for maintenance and adjustment of the digital multimeter. Test equipment required for performance verification and calibration is listed in table 1-2.

Table 1-2. Test Equipment List

Nomenclature	Part number
Digital Multimeter (DMM)	Simpson Model 467
DMM Calibrator	Rotek 610
Function Generator	Simpson Model 420

Chapter 2. MAINTENANCE INSTRUCTIONS

2-1. INTRODUCTION. Repair of the digital multimeter is limited to replacement of the battery, fuses, circuit board assemblies, and input range connector. Further disassembly of the digital multimeter is not authorized. Authorized service procedures are contained in the following paragraphs.

2-2. CASE AND REAR COVER. Remove the digital multimeter from the case in accordance with fig. 2-1 and the following procedure.

WARNING

To avoid electric shock, disconnect test leads before removing the rear cover.

a. Loosen two screws (1) and pull rear cover (2) from case (7).

b. Remove two spacers (3) and lock washers (4).

c. Carefully pull circuit board assemblies (5) from case (7).

d. Remove switch gasket (6) only if replacement of switch gasket or a circuit board is required.

e. If necessary for replacement, remove two E-rings (8) and screws (1) from rear cover (2).

f. Install circuit board assemblies in case by reversing steps a. thru e. above.

2-3. BATTERY. Replace the battery as follows:

CAUTION

When battery reaches the end of its useful life, replace it promptly. Failure to do so may result in corrosion at the battery contacts.

a. Push the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the digital multimeter input terminals.

WARNING

To avoid electric shock, disconnect test leads before removing the rear cover.

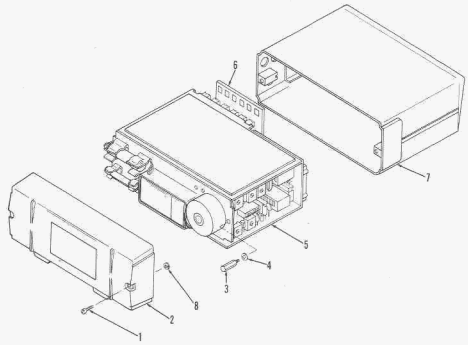
c. Loosen two screws (1, fig. 2-1) and remove rear cover (2) from case (7).

d. Pull battery (fig. 2-2) with connector from battery compartment.

e. Separate battery from connector.

f. Press connector onto terminals of replacement battery.

g. Slide replacement battery with installed connector into battery compartment.



1. Screws (2)
2. Rear cover
3. Spacers (2)
4. Lock washers (2)
5. Circuit board assemblies
6. Switch gasket
7. Case
8. E-rings (2)

Figure 2-1. Case and Rear Cover Removal

h. Position rear cover (2, fig. 2-1) on case (7) and secure by tightening two screws (1).

2-4. FUSES. Replace the fuses as follows:

a. Push the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the digital multimeter input terminals.

WARNING

To avoid electric shock, disconnect test leads before removing the rear cover.

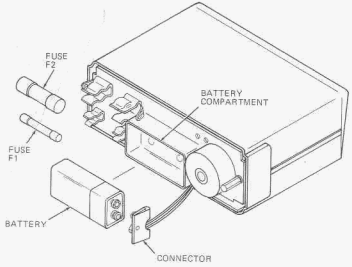


Figure 2-2. Battery and Fuses Replacement

c. Loosen two screws (1, fig. 2-1) and remove rear cover (2) from case (7).

d. Using a pointed tool such as a probe tip, pry fuse F1 or F2 (fig. 2-2) from fuse clips.

WARNING

For continued fire protection, replace fuses with the same types and ratings. Using incorrect fuses can endanger the operator when working in high voltage, high power circuits.

e. Press ends of replacement fuse F1 into bottom fuse clips. Use a 2A, 250V, type 3AG fuse only.

f. Press ends of replacement fuse F2 into top fuse clips. Use a 3A, 600V, type BBS fuse only.

g. Position rear cover (2, fig. 2-1) on case (7) and secure by tightening two screws (1).

2-5. CIRCUIT BOARDS. Replace and repair the circuit boards in accordance with the following procedures.

a. Removal. Remove the circuit boards in accordance with fig. 2-3 and the following procedures:

CAUTION

Be careful not to scratch viewing surface of display circuit board in the following steps.

NOTE

High impedance areas of circuit boards can be contaminated by oils and salt from skin. This may degrade operation in high humidity conditions; therefore, handle circuit boards by the edges only, and remove shields (step 5 below) only if necessary for replacement or repair.

(1) Gently pull peak-hold circuit board (1) until it clears switches.

(2) Grasp edges of function circuit board (2) and pull upward to disengage from connector pins at top of display and rear circuit boards (5 and 9).

(3) Tilt function circuit board (2) as required for access to component side; then pull connectors (3 and 4) from pins on component side of function circuit board (2). Remove function and peak-hold circuit boards (2 and 1) as an assembly.

(4) Grasp edges of display circuit board (5) and pull upward from connector at front of range circuit board (6).

(5) If necessary, remove shields (7 and 8) by grasping at edges near the two pins and gently pulling away from circuit board.

(6) Set aside range and rear circuit boards (6 and 9) as an assembly.

b. Disassembly. Circuit board disassembly is limited to removal of the input connector assembly as follows:

NOTE

In the following steps, unsolder and disconnect leads only from the assembly (range circuit board or input connector) that requires replacement. Tag or otherwise identify leads before unsoldering, and record lead routing to facilitate reassembly.

(1) Unsolder and disconnect violet wire (fig. 2-4) from lug of top, inner fuse clip on rear circuit board.

(2) Pull free end of violet wire through fuse clip eyelet.

(3) Unsolder leads of resistors R100 and R101 at range circuit board (do not disconnect leads at this time).

(4) Unsolder the single lug of input connector assembly at range circuit board; then lift input connector assembly with attached parts from component side of range circuit board.

(5) Unsolder and remove the violet wire and resistors R100 and R101 from top lugs of input connector assembly.

1. Peak-hold PCB
2. Function PCB
3. Connector (black wire)
4. Connector (red wire)
5. Display PCB
6. Range PCB
7. Range shield
8. Function shield
9. Rear PCB

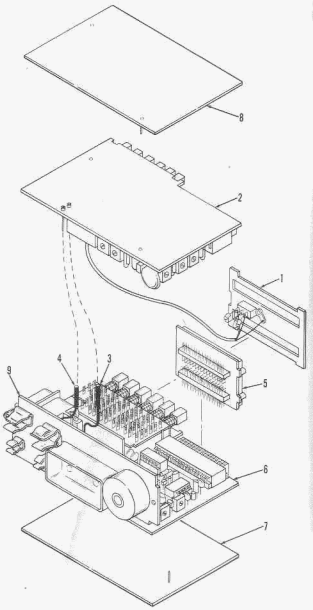


Figure 2-3. Printed Circuit Boards Removal

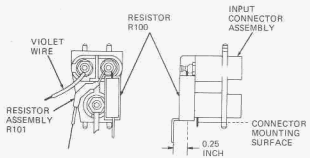


Figure 2-4. Input Connector Assembly Removal

c. Cleaning. Remove contaminants from the range and function circuit boards with demineralized water and a soft brush (remove the display circuit board before cleaning, and avoid getting excessive amounts of water on the switches). Dry with clean, dry air at low pressure (15 psi maximum); then bake at 100 to 125 degrees F for 24 hours.

d. Reassembly. Reassemble and install the input connector assembly as follows:

NOTE

Make all electrical solder connections with SN60 solder conforming to Federal Specification QQ-S-571 unless otherwise specified.

(1) Connect one lead of resistor assembly R101 to input connector lug shown in fig. 2-4.

(2) Form a 0.25 inch offset in one lead of resistor R100; then connect the other lead to indicated input connector lug. Be sure the 0.25 inch portion of R100 lead does not extend below connector mounting surface. Solder resistor leads to input connector lug.

(3) Connect and solder one end of violet wire to remaining top lug of input connector.

(4) Pass free leads of resistors R100 and R101 through respective holes in component side of range circuit board; then press lugs of input connector assembly into mounting holes in range circuit board.

(5) Solder leads of resistors R100 and R101, and single metallic lug of input connector assembly, to range circuit board.

(6) Pass free end of violet wire through eyelet of top, inner fuse clip on rear circuit board. Then connect and solder the violet wire to the fuse clip lug.

e. Installation. Install the circuit boards in accordance with fig. 2-3 and the following procedures:

CAUTION

Be careful not to scratch viewing surface of display circuit board in the following steps.

NOTE

High impedance areas of circuit boards can be contaminated by oils and salt from skin. This may degrade operation in high humidity conditions; therefore, handle circuit boards by the edges only.

(1) Install shields (7 and 8) by guiding pins on shields into respective circuit board connectors; then press shields against circuit boards fully.

(2) Locate the "F" and "R" marks on the viewing side of the display circuit board (5). Grasp edges of display circuit board and position over mating connector at front of range circuit board (6) with "F" and "R" marks at front, right of range circuit board. Then press pins of display circuit board into mating connector.

(3) Locate the pins marked "RED" and "BLACK" on the component side of the function circuit board (2). Press connector (3) of black wire onto pin marked "BLACK", and connector (4) of red wire onto pin marked "RED".

(4) Align connectors on function circuit board (2) with connector pins at top of display and rear circuit boards (5 and 9); then press function circuit board (2) onto connector pins.

(5) Guide peak-hold circuit board (1) over switches and push tabs into slots at front of function and range circuit boards (2 and 6). Be sure bare leads of components on peak-hold circuit board (1) are centered between terminals of switches on function and range circuit boards (2 and 6).

Chapter 3. PERFORMANCE VERIFICATION

3-1. INTRODUCTION. This chapter contains procedures used to verify digital multimeter performance specifications. Necessary calibration adjustment procedures are included.

3-2. PERFORMANCE TESTS. The performance tests are used to compare digital multimeter performance with the list of specifications given in Section I of the separate Operator's Manual. Performance tests are recommended for incoming inspection, periodic maintenance, and to verify specifications prior to critical use. If the digital multimeter fails any test, calibration adjustment and/or repair will be required. The digital multimeter being tested will be referred to as the UUT (unit under test).

a. Initial Procedure. Each of the following performance tests assume that the following conditions exist:

(1) The UUT has been allowed to stabilize and will be tested at an ambient temperature of 64 to 82 degrees F (18 to 28 degrees C), with less than 90% relative humidity.

(2) The fuses and battery have been checked and, if necessary, replaced.

(3) Set the UUT switches to the following positions:

POWER	- ON
PEAK HOLD	- off
Slide switch	- "+"
All other switches	- out

b. Display Test. Use the following procedure to verify the proper operation of all UUT display indications except "B" (battery).

(1) Select the UUT ohms function and connect a short between the COM input terminal and the V-ohms input terminal. Then for each step in table 3-1, select the UUT range indicated and verify that the corresponding decimal point position and digit display in the table and the UUT display are the same.

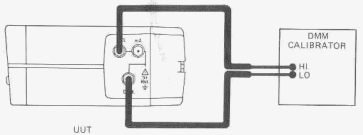


Figure 3-1. Voltage and Resistance Test Setup

Table 3-1. Display Test

Step	UUT range	UUT display
1	200 ohms	00.0*
2	2k	.000
3	20k	0.00
4	200k	00.0
5	2000k	000
6	20M	0.00

*One or two digits may appear if a test lead is used to connect the two terminals.

(2) Select the 200-ohms range on the UUT.

(3) With input terminals still shorted, verify that the down arrow appears in the UUT display.

(4) Disconnect short from UUT input terminals and verify that the up arrow appears in the UUT display.

(5) Select the DC V function, 2V range on the UUT.

(6) Connect the equipment as shown in fig. 3-1.

(7) Program the DMM calibrator for a UUT input of -1.0 Vdc and verify that the minus (-) sign appears in the UUT display.

(8) Verify that the UUT bargraph segments 0, 5, 10, 15, 20, and the first segment above the 0 are visible.

(9) Program the DMM calibrator for a UUT display of 1.888 and verify that all segments of each digit appear in the liquid crystal display.

(10) Program the DMM calibrator so that each possible number appears in each digit of the UUT display (3-1/2 digit).

(11) Select the ohms function on the UUT and verify that all the bargraph segments are off.

c. DC Voltage Test. Use the following procedure to verify the proper operation of the DC V measurement functions:

(1) Select the DC V function on the UUT.

(2) Connect the equipment as shown in fig. 3-1.

(3) For each step in table 3-2 select the listed UUT range, program the DMM calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the limits listed.

Table 3-2. DC Voltage Test

Step	UUT range	UUT input level	Display limits	Bargraph segments
1	200mV	Short	-00.1 to 00.1	0±1
2		+170.0mV	169.7 to 170.3	17±2
3		-170.0mV	-169.7 to -170.3	17±2
4		+250.0mV	Overrange	All 22 segments on
5	2V	Short	-.001 to .001	0±1
6		+1.700V	1.697 to 1.703	17±2
7	20V	Short	-0.01 to 0.01	0±1
8		-17.00V	-16.97 to -17.03	17±2
9	200V	Short	-00.1 to 00.1	0±1
10		+190.0V	189.7 to 190.3	19±2
11	1000V	Short	-001 to 001	0±1
12		-900V	-898 to -902	9±2

d. AC Voltage Test. Use the following procedure to verify the proper operation of the AC V measurement functions:

(1) Select the AC V function on the UUT.

(2) Connect a short between the COM and V-ohms input terminals on the UUT.

(3) Select each AC V range while observing UUT display. For each range, the indication shall be 000 (with appropriate decimal point) within 2 counts for the UUT digital and bargraph displays.

(4) Remove the short from UUT input terminals and connect the equipment as shown in fig. 3-1.

(5) For each step in table 3-3 select the listed UUT range, program the DMM calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the limits listed.

Table 3-3. AC Voltage Test

Step	UUT range	UUT input level	Input freq.	Display limits*
1	200mV	170.0mV	40 Hz	168.6 to 171.4
2			1 kHz	168.6 to 171.4
3			5 kHz	161.0 to 179.0
4	2V	1.700V	40 Hz	1.686 to 1.714
5			1 kHz	1.686 to 1.714
6			5 kHz	1.610 to 1.790
7	20V	17.00V	40 Hz	16.86 to 17.14
8			1 kHz	16.86 to 17.14
9			5 kHz	16.10 to 17.90
10	200V	190.0V	40 Hz	188.5 to 191.5
11		170.0V	400 Hz	168.6 to 171.4
12		190.0V	1 kHz	188.5 to 191.5
13		190.0V	5 kHz	180.0 to 199.9
14	750V	750.0V	40 Hz	742 to 758
15			400 Hz	742 to 758

*The bargraph display shall correspond to the digital display within ±1 segment (±2 segments between 1 kHz and 5 kHz).

e. Resistance Test. Use the following procedure to verify the proper operation of the resistance measurement function:

(1) Select the ohms function on the UUT.

(2) Connect the equipment as shown in fig. 3-1.

(3) For each step in table 3-4 select the listed UUT range, program the DMM calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the limits listed.

Table 3-4. Resistance Test

Step	UUT range	UUT input (ohms)	Display limits
1	200 ohms*	Short	00.0 to 00.1
2	200 ohms*	100.0	99.6 to 100.4
3	2k	1.000k	.996 to 1.004
4	20k	10.00k	9.96 to 10.04
5	200k	100.0k	99.6 to 100.4
6	2000k	1.000M	996 to 1004
7	20M	10.00M	9.89 to 10.11

*Subtract lead resistance on this range.

f. DC Current Test. Use the following procedure to verify the proper operation of the DC mA measurement functions:

(1) Select the DC mA function on the UUT.

(2) Connect the equipment as shown in fig. 3-2.

(3) For each step in table 3-5 select the listed UUT range, program the DMM calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the limits listed.

Table 3-5. DC Current Test

Step	UUT range	UUT input level	Display limits*
1	200uA	Short	-00.1 to 00.1
2	200uA	+170.0uA	169.0 to 171.0
3	2mA	-1.700mA	-1.690 to -1.710
4	20mA	+17.00mA	16.90 to 17.10
5	200mA	-170.0mA	-168.6 to -171.4
6	2000mA	+1.000A	991 to 1009

*The bargraph display shall correspond to the digital display within ±1 segment.

g. AC Current Test. Use the following procedure to verify the proper operation of the AC mA measurement functions:

(1) Select the AC mA function on the UUT.

(2) Connect the equipment as shown in fig. 3-2.

(3) For each step in table 3-6 select the listed UUT range, program the DMM calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the limits listed.

Table 3-6. AC Current Test

Step	UUT range	UUT input level (at 400 Hz)	Display limits*
1	200uA	Short	00.0 to 00.5
2	200uA	170.0uA	166.9 to 173.1
3	2mA	1.700mA	1.669 to 1.731
4	20mA	17.00mA	16.69 to 17.31
5	200mA	170.0mA	166.9 to 173.1
6	2000mA	1.000A	980 to 1020

*The bargraph display shall correspond to the digital display within ±1 segment.

h. Continuity Test. Use the following procedure to verify the proper operation of the continuity function:

(1) Select the ohms function and 2k range on the UUT.

(2) Connect the test leads to the COM and V-ohms terminals on the UUT.

(3) With test leads open circuited, the UUT up arrow shall be displayed.

(4) Short the test leads together. The UUT up arrow shall disappear and the down arrow shall be displayed.

(5) Depress the AC/DC function switch to activate the audible tone function.

(6) Momentarily short the test leads together and observe that the tone sounds coincident with the UUT down arrow. The UUT up arrow may or may not be displayed (the UUT responds to continuity of 50 microseconds or longer duration).

i. Peak Hold Test. Use the following procedure to verify proper operation of the peak hold function:

(1) Set UUT controls as follows:

```
Function switches - V DC
Range switch      - 20V
PEAK HOLD switch  - off (out)
Slide switch      - "-"
POWER switch      - ON
```

(2) Set function generator controls as follows:

```
FREQUENCY dial       - "1"
AMPLITUDE pushbutton - 0 dB
WAVEFORM switch      - squarewave
RANGE control        - X .1
AMPLITUDE control    - MAX (clockwise)
DC OFFSET control    - OFF
POWER switch         - ON
```

(3) Connect test leads from V-ohms and COM terminals of UUT to 600-ohm output terminals of function generator.

(4) Observe UUT digital display. The display shall alternately indicate a positive reading (V_p) and a negative reading (V_n) of approximately 10-volts. Note and record the display for V_p and V_n.

(5) Set function generator RANGE control to the X 100 position.

(6) Depress PEAK HOLD switch on UUT.

(7) Observe UUT digital display. Digital display shall indicate the value V_n from step (4) above within ±1% of (V_n + 10) counts.

(8) Set slide switch on UUT to the "+" position.

(9) Observe UUT digital display. Digital display shall indicate the value V_p from step (4) above within ±1% of (V_p + 10) counts.

(10) Set function generator AMPLITUDE control to MIN (counterclockwise) position.

(11) Observe UUT digital display for 10 seconds after performing step (10) above. Digital display shall not change by more than 10 counts in 10 seconds.

j. Pulse Detector Test. Use the following procedure to verify proper operation of the pulse detector function:

(1) Set UUT controls as follows:

```
Function switches - Ohms DC
Range switch      - 200k
PEAK HOLD switch  - off (out)
POWER switch      - ON
```

(2) Set function generator controls as follows:

FREQUENCY dial	- "5"
AMPLITUDE pushbutton	- 0 dB
WAVEFORM switch	- squarewave
RANGE control	- X 1k
AMPLITUDE control	- MAX (clockwise)
DC OFFSET control	- OFF
POWER switch	- ON

(3) Connect test leads from V-ohms and COM terminals of UUT to 600-ohm output terminals of function generator.

(4) Observe UUT display (disregard digital display indications). Up arrow and down arrow shall both be visible.

(5) Select AC function on UUT.

(6) UUT buzzer shall be on (audible).

(7) Disconnect either test lead from UUT input terminals.

(8) The UUT buzzer shall be off, and the down arrow on the display shall disappear.

(9) Set function generator POWER switch to OFF, then disconnect test leads from function generator.

k. Battery Indicator Test. Perform the following procedure to verify that the "B" indicator appears on the UUT display at the correct battery level:

(1) Remove battery from UUT (paragraph 2-3).

(2) Connect the equipment as shown in fig. 3-3.

(3) Set POWER switch of UUT to ON.

(4) Set DMM controls as follows:

Function switches	- V DC
Range switch	- 20V
PEAK HOLD switch	- off (out)
POWER switch	- ON

(5) Set output of DMM calibrator for 6.25 display on DMM.

(6) Observe UUT display. The "B" symbol shall be visible.

(7) Set output of DMM calibrator for 7.50 display on DMM.

(8) Observe UUT display. The "B" symbol shall not be visible.

(9) Set all POWER switches to OFF.

(10) Disconnect UUT from test setup.

(11) Install UUT battery (paragraph 2-3).

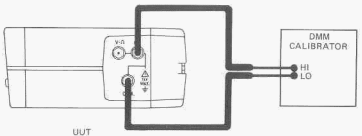


Figure 3-2. Current Test Setup

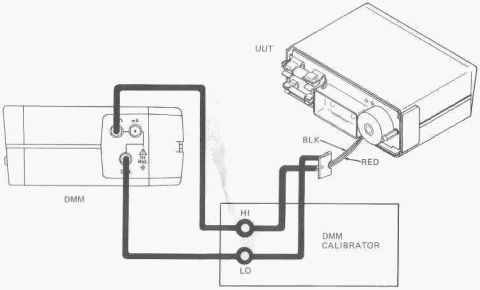


Figure 3-3. Battery Indicator Test Setup

3-3. CALIBRATION. Perform calibration adjustments after circuit board replacement, and immediately after a digital multimeter fails any part of the performance tests in paragraph 3-2. Local using agencies may also require calibration prior to critical use and/or on a periodic schedule. If a digital multimeter fails any portion of the calibration procedure, discontinue calibration until digital multimeter repair has been completed.

a. Initial Procedure. Each of the following calibration adjustments assume that the following conditions exist:

CAUTION

Place the digital multimeter on an insulated surface whenever it is out of the case and turned on; otherwise, the digital multimeter may be damaged.

(1) The digital multimeter has been removed from the case as described in paragraph 2-2.

(2) The digital multimeter has been allowed to stabilize and will be calibrated at an ambient temperature of 64 to 82 degrees F (18 to 28 degrees C).

(3) The fuses and battery have been checked and, if necessary, replaced.

(4) Set the digital multimeter switches to the following positions:

POWER	- ON
PEAK HOLD	- off (out)
Slide switch	- "V"
All other switches	- out

b. Functional Calibration. Use the following procedure to perform calibration adjustments for all functions except peak-hold:

(1) Select the V function on the digital multimeter.

(2) Connect the DMM calibrator to the digital multimeter as shown in figure 3-1.

(3) For each step in table 3-7 select the listed digital multimeter function and range, and program the DMM calibrator for the corresponding input level. Then adjust the listed control until the digital multimeter displayed value agrees with the value listed in table 3-7. Refer to fig. 3-4 for location of calibration controls.

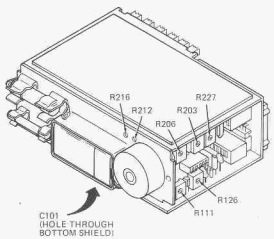


Figure 3-4. Calibration Control Locations

Table 3-7. Functional Calibration Chart

Step	Function	Range	Input level	Control (fig. 3-4)	Display
1	DC	200mV	Short	R111	Bargraph zero segment only
2	DC	200mV	+200.0mV	R126	Segment above bargraph "20"
3	DC	200mV	+170.0mV	R227	170.0
4	AC	200mV	Short	R206	00.0
5	AC	200mV	170.0mV, 1 kHz	R203	170.0
6	AC	2V	1.700V, 1 kHz	C101	1.700

(4) Disconnect digital multimeter from DMM calibrator.

c. Peak-Hold Zero Adjustment. Use the following procedure to perform the peak-hold zero adjustment:

(1) Set the digital multimeter switches to the following positions:

Function switches	- V DC
Range switch	- 20M-ohm
PEAK HOLD switch	- on (in)
Slide switch	- "+"
POWER switch	- ON

(2) Gently pull peak-hold circuit board (1, fig. 2-3) from pushbutton switches to gain access to wiring at rear of slide switch.

(3) Connect a jumper from black wire at slide switch to frame (analog ground) of either pushbutton switch assembly.

(4) Adjust R216 (fig. 3-4) for 0.00 display on digital multimeter, until minus (-) sign flashes on and off.

(5) Disconnect jumper from pushbutton switch frame and connect to red wire at slide switch. (The other end of jumper must still be connected to black wire at slide switch.)

(6) Adjust R212 (fig. 3-4) for 0.00 display on digital multimeter, until minus (-) sign flashes on and off.

(7) Disconnect both ends of jumper from slide switch wires.

(8) Toggle the slide switch while observing digital multimeter display. Digital multimeter shall display 0.00 $\pm$10 counts.

(9) If digital multimeter does not display 0.00 $\pm$10 counts, repeat steps (3) thru (8) above as necessary.

(10) Set digital multimeter POWER switch to OFF.

(11) Install circuit board assemblies in case (paragraph 2-2).