

Multimeter with Temperature

Calibration Information

Warning

To avoid electrical shock, remove test leads and any input signals from the Meter before opening the case.

Caution

This Meter contains parts that can be damaged by static discharge. Follow the standard practices for handling static sensitive devices.

Introduction

The 16 Calibration Information instruction sheet provides the information necessary to calibrate and verify the Fluke Model 16 Multimeter with Temperature (hereafter known as the Meter). This instruction sheet provides the following information:

- Product specifications
- Disassembly and reassembly
- Performance test procedures
- Calibration procedures and adjustments
- Replacement parts

See the instruction sheet for operating instructions.

Service

The Meter is warranted to be free from defects in material and workmanship for one year. The complete warranty statement is in the Meter's instruction sheet.

To contact Fluke, call one of the following telephone numbers:

USA and Canada: 1-888-99-FLUKE (1-888-993-5853)

Europe: +31-402-678-200

Japan: +81-3-3434-0181

Singapore: +65-738-5655




Anywhere in the world: +1-425-356-5500

Or, visit Fluke's Web stie at www.fluke.com.

Specifications

Specifications are in Table 1. Accuracy is specified for a period of one year after calibration, at 18°C to 28°C (64°F to 82°F) with relative humidity to 90%. AC conversions are ac-coupled, average responding, and calibrated to the rms value of a sine wave input.

Table 1. Specifications

Maximum Voltage Between any Terminal and Earth Ground (excludes 10% tolerance)	600 V ac or dc
Display	3-3/4-digits, 4000 counts, updates 4/sec
Operating Temperature	-10°C to 50°C
Storage Temperature	-30°C to 60°C indefinitely (to -40°C for 100 hrs)
Temperature Coefficient	0.1 x (specified accuracy)/°C (<18°C or >28°C)
Relative Humidity	0% to 90% (-10°C to 35°C) 0% to 70% (35°C to 50°C)
Altitude Operation/Non-operation	2000 m
Battery Type	9V, NEDA 1604 or IEC 6F22
Battery Life	650 continuous hours with alkaline 450 continuous hours with carbon-zinc
Shock, Vibration	3 meter drops: Sinusoidal vibration up to 3 G @ 55 Hz
Size (HxWxL)	1.35 in x 2.75 in x 5.55 in (3.46 cm x 7.05 cm x 14.23 cm)
Weight	10 oz (286g)
EMI Regulations	Complies with FCC Part 15B, Class B, EN50081-1, EN50082-1.
Safety	Designed to Protection Class II requirement of UL1244, ANSI/ISA-S82.01 - 1988, CSA C22.2 No 231, and VDE 0411, and IEC 1010-1 overvoltage category III (CAT III), 600 V
Certification	  

Accuracy specifications are given as follows: \pm ([% of reading] + [number of least significant digits]).

Table 1. Specifications (cont)

Function	Range	Resolution	Accuracy
V_{\sim} (50 to 400 Hz)	4000 mV ¹	1 mV	$\pm(1.9\%+3)$
	4.000 V	0.001 V	$\pm(1.9\%+3)$
	40.00 V	0.01 V	$\pm(1.9\%+3)$
	300.0 V	0.1 V	NA
	400.0 V	0.1 V	$\pm(1.9\%+3)$
	600.0 V	1 V	$\pm(1.9\%+3)$
$V_{\text{---}}$	4000 mV ¹	1 mV	$\pm(0.9\%+2)$
	4.000 V	0.001 V	$\pm(0.9\%+2)$
	40.00 V	0.01 V	$\pm(0.9\%+1)$
	300.0 V	0.1 V	NA
	400.0 V	0.1 V	$\pm(0.9\%+1)$
	600 V	1 V	$\pm(0.9\%+1)$
Ω	400.0 Ω	0.1 Ω	$\pm(0.9\%+2)$
	4.000 k Ω	0.001 k Ω	$\pm(0.9\%+1)$
	40.00 k Ω	0.01 k Ω	$\pm(0.9\%+1)$
	400.0 k Ω	0.1 k Ω	$\pm(0.9\%+1)$
	4.000 M Ω	0.001 M Ω	$\pm(0.9\%+1)$
	40.00 M Ω	0.01 M Ω	$\pm(1.5\%+3)$
$\text{---} \text{---}$	1.000 μF	0.001 μF	$\pm(1.9\%+2)$
	10.00 μF	0.01 μF	$\pm(1.9\%+2)$
	100.0 μF	0.1 μF	$\pm(1.9\%+2)$
	1000 μF	1 μF	$\pm(1.9\%+2)$
	10000 μF	10 μF	$\pm(10\%+90)$ typical
$\mu\text{A}_{\text{---}}$	0 to 200 μA	0.1 μA	$\pm(1\% + 2 \text{ counts})$
μA_{\sim} (50 to 400 Hz)	0 to 200 μA	0.1 μA	$\pm 2\% + 3 \text{ counts}$
Temperature ³ (Type K Thermocouple)	-10°C to 400°C	0.1°C	$\pm(1\% + 0.8^\circ\text{C})$
	14°F to 75°F	0.2°F	$\pm(1\% + 1.5^\circ\text{F})$
	-40°C to -10°C	0.1°C	$\pm(5\% + 1.5^\circ\text{C})$
	-40°F to 14°F	0.2°F	Typical $\pm(5\% + 3.3^\circ\text{F})$ Typical
$\text{---} \text{---}$	2.000 V	0.001 V	$\pm(0.9\%+2)$

- The 4000 mV range can be entered only in the manual range mode. Use the 4000 mV range with accessories.
- The beeper is guaranteed to come on at <25 Ω and turn off at >250 Ω . The Meter detects opens or shorts of 250 μs or longer.
- Error does not include Type K Thermocouple errors.

Table 1. Specifications (cont)

Function	Overload Protection ¹	Input Impedance (Nominal)	Common Mode Rejection Ratio (1 kΩ Unbalanced) ⁴	Normal Mode Rejection ⁴
V_{\sim}	600 V dc	>5 MΩ <100 pF ² Automatic Selection and LoZ = >2 kΩ <200 pF (ac coupled) ³	>60 dB at dc 50 Hz or 60 Hz	
V_{---}	600 V dc	>10 MΩ <100 pF ² Automatic Selection and LoZ = >2 kΩ <200 pF ³	>100 dB at dc, 50 Hz or 60 Hz	>50 dB at 50 Hz or 60 Hz
		Open Circuit Test Voltage	Full Scale Voltage To 4.0 MΩ 40 MΩ	Short Circuit Current
Ω	600 V dc	<1.5 V dc	<450 mV dc <1.5 V dc	<500 μA
$\rightarrow $ ²	600 V dc	2.4-3.0 V dc	2.400 V dc	0.95 mA (typical)
		Burden Voltage	Common Mode Rejection Ratio	Normal Mode Rejection
μA_{---}	600 V rms or dc	<5 mV/μA	>100 dB @ dc 50 Hz or 60 Hz	>50 dB @ 50 Hz or 60 Hz
μA_{\sim}	600 V rms or dc	<5 mV/μA	>60 dB at dc, 50 Hz or 60 Hz	.
<p>1. 3×10^6 V Hz maximum.</p> <p>2. ~2 kΩ input impedance up to 50 V. Impedance increases with input voltage to >300 kΩ at 600 V.</p> <p>MIN MAX Recording Accuracy and Response Time Specified accuracy of the measurement function ±12 digits in dc for changes >200 ms in duration (±40 digits in ac). Typical 100 ms response to 80%. Example 1: this would mean ±1.2° when recording temperature. Example 2: This would mean ±12 μA when recording μA or ±12 A if used with a dc amp probe.</p> <p>MIN MAX Recording with Elapsed Time Elapsed Time: 0 to 100 hours (99.59) Resolution: 1 minute Accuracy: 0.3% typical</p> <p>Continuity Capture™ Detects opens or shorts of 250 μs or longer.</p>				

Disassembly and Reassembly

Referring to Figure 1, disassemble the Meter as follows. A Phillips-head screwdriver and small flat-blade screwdriver are required.

1. Remove the test leads and set the rotary knob to OFF.
2. Remove the Phillips-head screws from the case bottom.
3. Separate the case top from the case bottom.
4. **To replace the battery:** lift the battery from the case bottom and insert a new 9V battery. Be sure the positive and negative battery posts are oriented correctly.
5. **To remove the pca:** insert a small, flat-blade screwdriver between the edge of the case top and the pca where shown in Figure 2. Gently unsnap a side of the case top from the pca. Repeat on the other side of the pca. Unsnap the case from the top of the pca last.

Lift the pca from the case top by its edges. If the elastomeric contact strips for the switch assembly and LCD are stuck to the pca, remove them without touching the conductive edges.

Note

Before reinserting the pca, make sure that the rotary knob is in the OFF position.

7. **To reinsert the pca:** Place the pca over the four screw posts in the case top, then press gently on the center of the pca while using the small flat-edge screwdriver to shoehorn the pca under the snap on a side of the case top. Repeat on the other side and the top.
8. To remove the switch support, use a small, flat-blade screwdriver to gently unsnap the sides and top of the switch support from the snaps shown in Figure 2.
9. The LCD, switch assembly, and elastomeric contact strips for the LCD and switch assembly are accessible and can be replaced as needed. Do not allow the LCD to get wet. Before installing a new LCD, make sure that all connector contact points are clean.

Caution

Do not touch the conductive edges of the elastomeric strips or the contacts on the switch assembly. If they are contaminated, clean them with isopropyl alcohol.

9. Reassembling the Meter is the reverse of disassembling it. After the Meter is reassembled, execute the Performance Test to confirm that the Meter is working properly.

Cleaning

⚠ Warning

To avoid electrical shock, remove test leads and any input signals before cleaning.

To clean the case, wipe it with a cloth lightly dampened with water and a mild detergent. Do not use abrasives, solvents, or alcohol.

Recommended Test Equipment

A list of recommended equipment for the performance test and calibration adjustment procedure is shown in Table 2.

Table 2. Recommended Equipment

Equipment	Minimum Specification	Recommended Model
AC/DC Calibrator	DC Voltage: 0 to 600 V Accuracy: $\pm 0.25\%$ AC Voltage: 0 to 600 V Accuracy: $\pm 0.5\%$ Frequency: 50 to 400 Hz	5700A, or 5500A
Decade Resistor	Resistance: 1.0 to 40 M Ω Accuracy: $\pm 0.25\%$	Fluke 5500A
Decade Capacitor	Capacitance: 0 to 1.000 μF Accuracy: $\pm 0.5\%$	Fluke 5500A
Thermocouple Wire K-Type	---	Fluke 80 PK-1
Temperature Probe	Accuracy: Certified to $\pm 0.2^\circ\text{C}$ ambient	Fluke 80T-150U
Mercury Thermometer	0.02 $^\circ\text{C}$ resolution 0.05 $^\circ\text{F}$ resolution	Princo Model ASTM 56C Princo Model ASTM 56F
Flask with cap	---	Dewar Flask

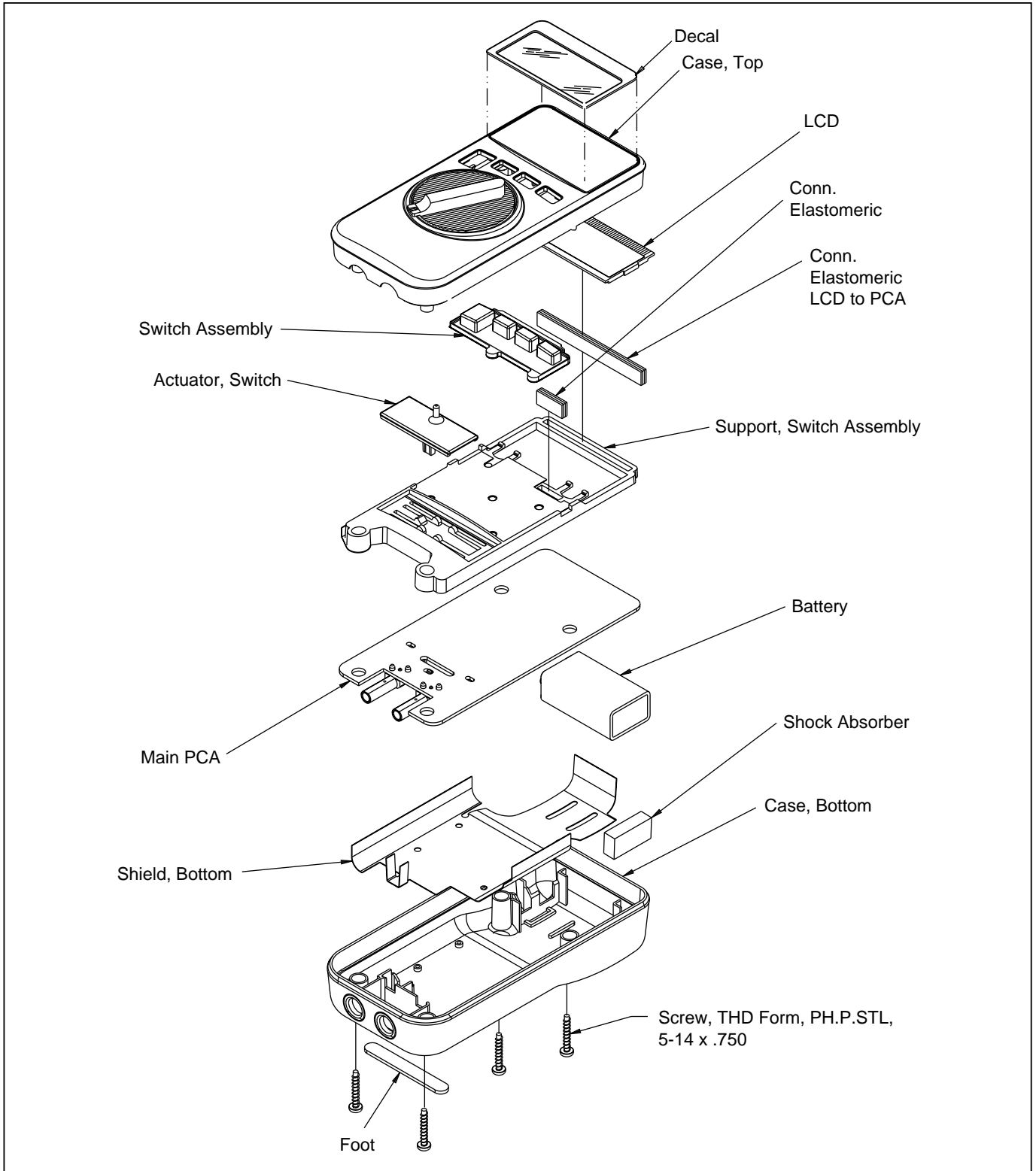
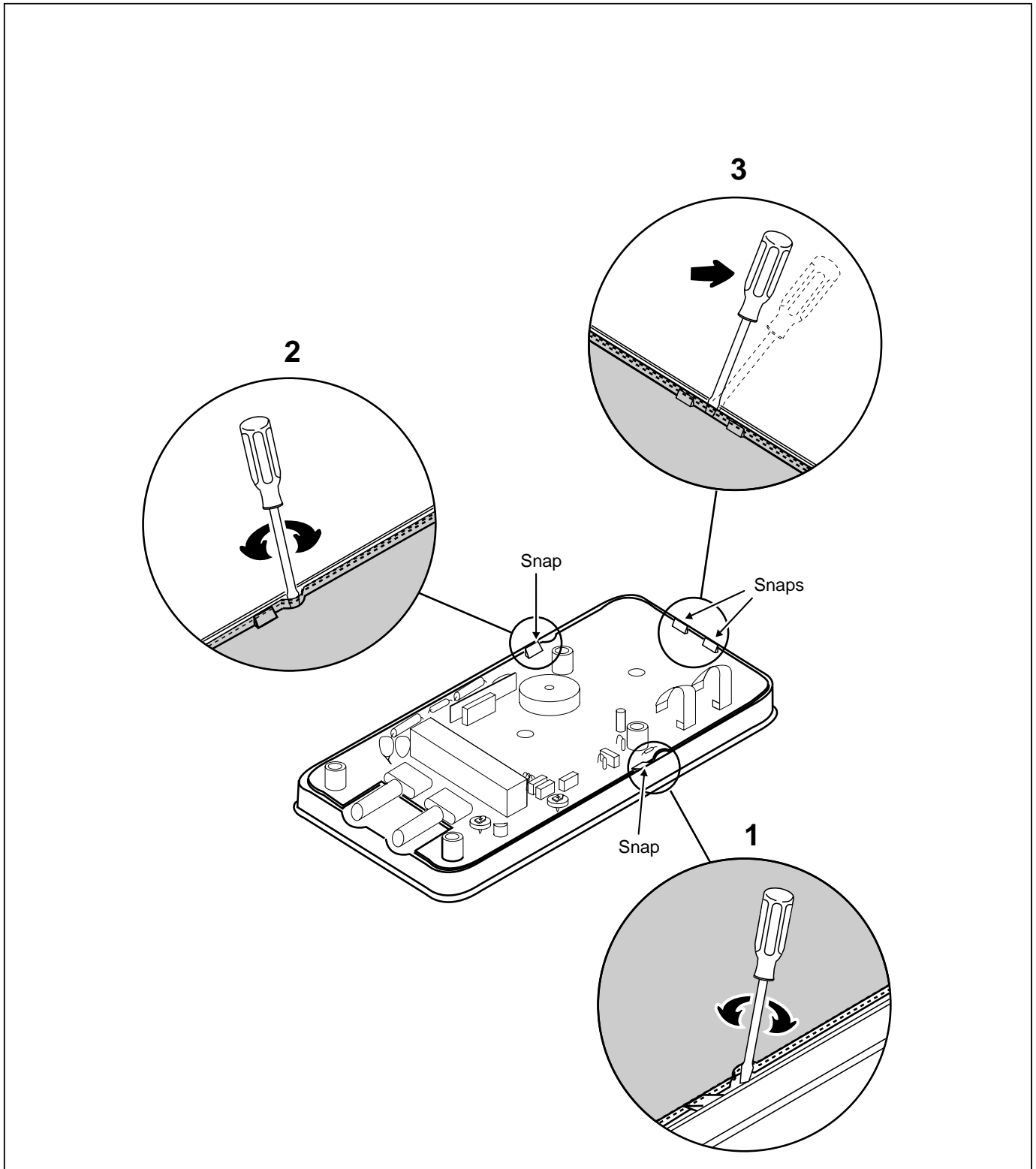


Figure 1. Model 16 Disassembled Unit

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Figure 2. Removing and Reinserting the Printed Circuit Assembly

Performance Test

⚠ Warning

To avoid electric shock, do not execute the performance tests procedures unless the Meter is fully assembled.

To ensure that the Meter is working properly and performs to specifications, use the following procedures. If the Meter fails this test, it needs calibration adjustment or repair.

Multimeter

Note

The following performance test is for all functions except for temperature. Temperature performance test follows this procedure.

1. Referring to Table 3, put the Meter in the function and range shown for Test 1.
2. Apply the input from the appropriate source to the [+] and COM jacks on the Meter. The reading on the display should be within the MINIMUM and MAXIMUM values shown in Table 3.
3. Test the remaining functions and ranges. Repeat steps 1 and 2 for test numbers 2 through 41.

Temperature

Note

The performance test for the other functions must be done before this test is done.

1. Connect the equipment as shown in Figure 3.
2. Insert a mercury thermometer to the same depth as the thermocouple wire to verify that the ice bath temperature is 0.0°C.
3. Short (or apply 0.0 mV) to the copper wires at the 5700A Calibrator.
4. Verify that the Meter reads 0.0°C ±0.8°C.
5. If this test fails, reposition the thermocouple wires and mercury thermometer in the ice bath and repeat steps 3 and 4. If the Meter continues to fail, use steps 6 through 8 to verify the temperature performance tests.
6. Remove the short applied in step 3.

7. Set the 5700A using the input voltage shown in Table 4. The reading on the display should be within the values shown in Table 4.
8. Repeat step 3 to verify that the ice bath temperature is at 0.0°C ±0.3°C.

Calibration Adjustments

Perform the following calibration adjustment procedures if the Meter fails the performance test.

Initial Steps

1. Remove any input signals to the Meter.
2. Remove the four screws on the back and separate the case bottom and case top.

Notice that when you do so the battery remains in the case top and power to the Meter is disconnected.

Note

To avoid stretching or bending the battery contacts, connect leads to the base of the contacts as shown in Figure 4.

3. Observing correct polarity, connect a 9 V battery to the battery contacts using easy hook jumpers or alligator clip leads (see Figure 4).

Multimeter

Note

The following calibration adjustment procedure is for all functions except for temperature. Temperature calibration adjustment follows this procedure.

1. Set the calibrator for 0 V dc. Put the Meter in the 4.000 V dc range.
2. Connect the calibrator to the [+] and COM jacks on the Meter.
3. Apply an input of +4.000 V dc ±0.25%
The Meter display should read between 3.997-4.003 V. If it does not, adjust R4 as described in step 4 (see Figure 4).
4. Adjust R4 (see Figure 4) so that the Meter display reads between 3.997 and 4.003 V.
5. Proceed to adjust the Temperature function.

Table 3. Performance Tests

Test No.	Meter Range	Input To Meter	Switch Position	Display Minimum	Display Maximum
1	4.000 V ac	0 V	Center	0.000	0.003
2	4.000 V ac, MIN MAX	0 V	Center	0.000	0.040
3	4.000 V ac	10 mV, 50 Hz	Center	0.007	0.013
4	4.000 V ac	10 mV, 400 Hz	Center	0.007	0.013
5	4.000 V ac	3.5 V, 50 Hz	Right	3.430	3.570
6	4.000 V ac	3.5 V, 400 Hz	Center	3.430	3.570
7	40.00 V ac	35 V, 50 Hz	Center	34.30	35.70
8	40.00 V ac	35 V, 400 Hz	Right	34.30	35.70
9 ¹	400.0 V ac	350 V, 80 Hz	Right	343.0	357.0
10	600 V ac	600 V, 400 Hz	Center	586	614
11	4.000 V dc, MIN MAX	0 V	Center	-0.012	0.012
12	4.000 V dc	0 V	Center	-0.002	0.002
13	40.00 V dc	+20 mV dc	Center	00.01	00.03
14	400.0 V dc	-200 mV dc	Center	-000.3	-000.1
15	4.000 V dc	+3.5 V	Center	+3.466	+3.534
16	40.00 V dc	-35 V dc	Center	-35.33	-34.67
17	400.0 V dc	+100 V dc	Center	+99.0	+101.0
18	600 V dc	-600 V dc	Center	-606	-594
19	200 μ A dc	0.0 μ A, dc	Right	-0.2	0.2
20	200 μ A dc	10.0 μ A, dc	Right	9.7	10.3
21	200 μ A dc	-10.0 μ A, dc	Right	-10.3	-9.7
22	200 μ A dc	200.0 μ A, dc	Right	197.8	202.2
23	200 μ A dc	-200.0 μ A, dc	Right	-202.2	-197.8
24	200 μ A ac	40.0 μ A, 50 Hz	Right	38.9	41.1
25	200 μ A ac	40.0 μ A, 400 Hz	Right	38.9	41.1
26	200 μ A ac	200.0 μ A, 50 Hz	Right	195.7	204.3
27	200 μ A ac	200.0 μ A, 400 Hz	Right	195.7	204.3
28	Continuity	+2 V dc ²	Right	1.980	2.020
29 ²	Continuity, Automatic Selection	+3.43 V dc ²	Right	3.397 ³	3.463 ³
30 ²	Continuity, Automatic Selection	-0.5 V dc ²	Right	-0.507 ³	-0.493 ³
31	400.0 Ω	0.0 Ω	Right	0.0	0.2
32	400.0 Ω	1.0 Ω	Right	0.8	1.2
33	400.0 Ω	350.0 Ω	Right	346.6	353.4
34	4.000 k Ω	1.0 k Ω	Right	0.990	1.010
35	40.00 k Ω	35 k Ω	Right	34.67	35.33
36	400.0 k Ω	100 k Ω	Right	99.0	101.0
37	4.000 M Ω	2.9 M Ω	Right	2.873	2.927
38	40.00 M Ω	35 M Ω	Right	34.44	35.56
39	Ω , Automatic Selection	1.96 V dc	Right	1.940 ³	1.980 ³
40 ⁴	1.000 μ F	0.0 μ F	Right	-0.001 μ F	0.001 μ F
41 ⁴	1.000 μ F	0.95 μ F	Right	0.930 μ F	0.970 μ F

1. In the Automatic Selection mode, the Meter uses a low-impedance thermistor (~2.5k for circuit protection and load testing (referred to as low-Z input circuitry). When using the 5100B, 5500A, or 5700A to drive the Meter with high voltages, avoid an overload/current limit condition by gradually stepping the voltage up (waiting two seconds between each step) from 90.0 V, 120.0 V, 180.0 V, and 350.0 V at 80 Hz each step.

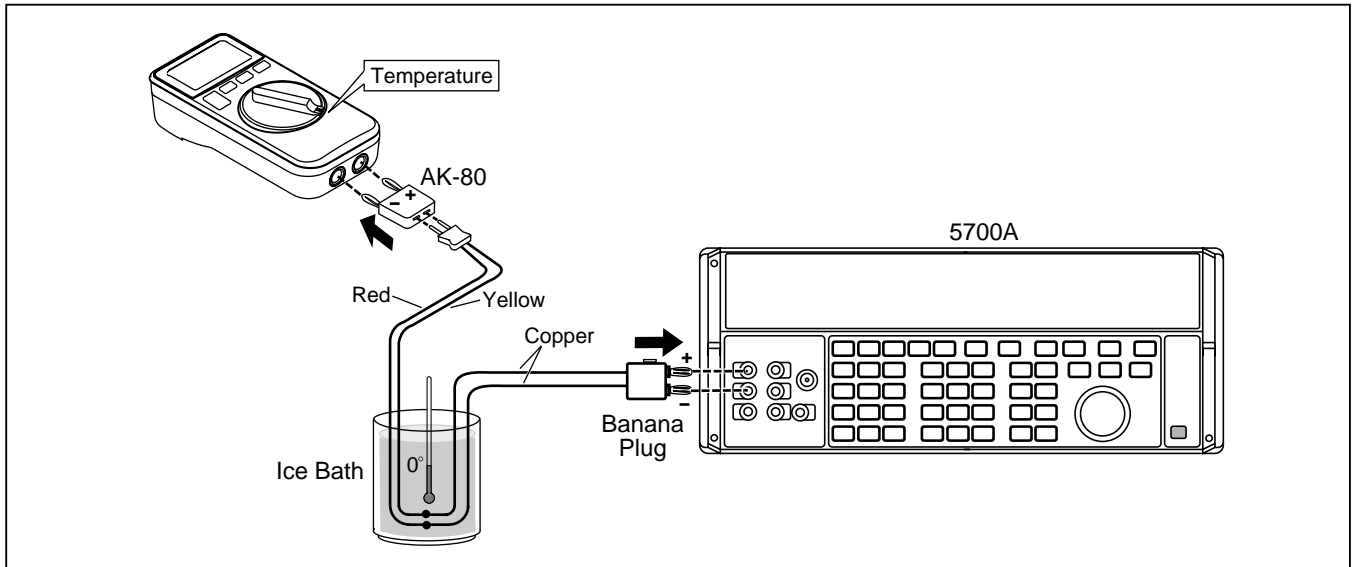
2. Calibrator 50 Ω divider override.

3. The dc volts annunciator must be on.

4. Conducting performance tests of the 400 Ω , 4 k Ω , 40 k Ω , and 1 μ F ranges (tests no. 22, 23, 24, 25, 26, 31, and 32) verifies that the discrete and integrated circuitry needed to support the other capacitance ranges are working within specifications. Therefore, the tests indirectly verify that the Meter will meet specification in the 10 μ F, 100 μ F, 1000 μ F, and 10,000 μ F ranges.

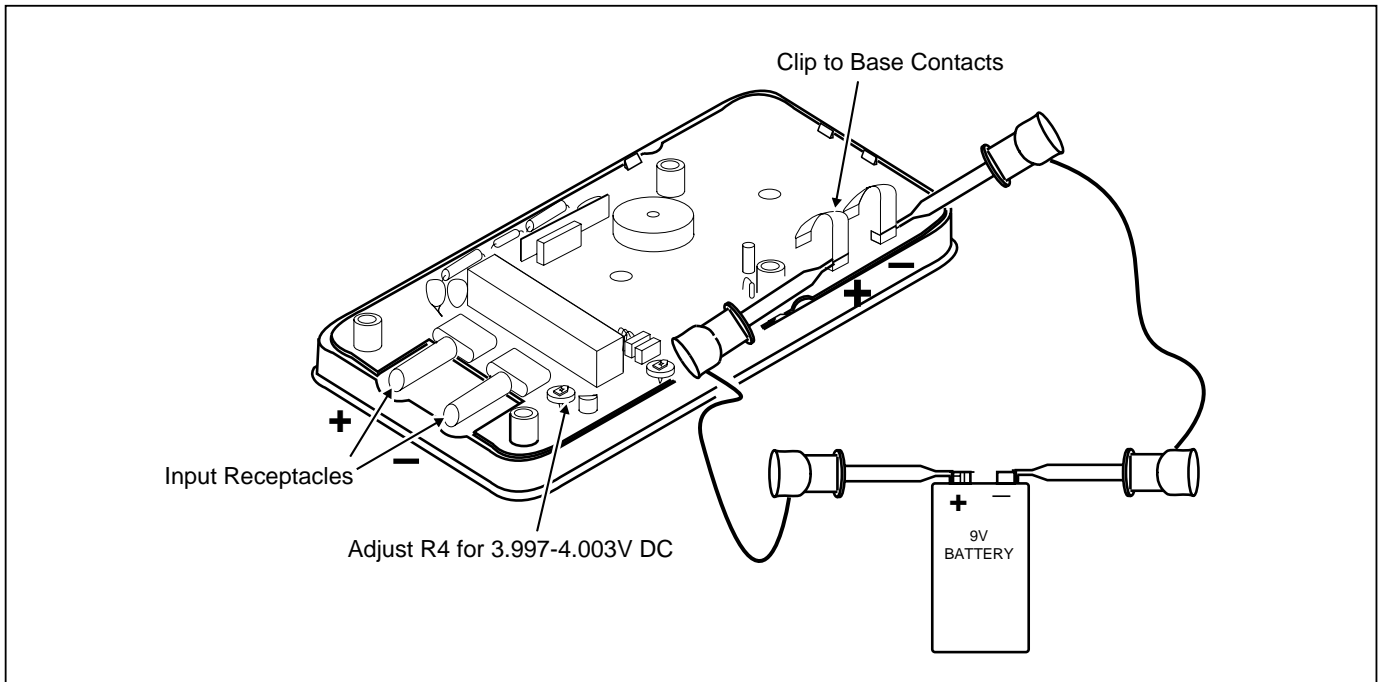
Table 4. Temperature Performance Tests

Input Voltage	Display Readings	
	$^{\circ}$ C	$^{\circ}$ F
0.0	0.0 \pm 0.8	32.0 \pm 1.5
0.919 mV	23.0 \pm 1.0	73.4 \pm 2.2
4.095 mV	100.0 \pm 1.8	212.0 \pm 3.6



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Figure 3. Performance Test for Temperature



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Figure 4. Calibration Adjustment for DC Voltage

Temperature

Note

Adjust DC voltage (R4) before adjusting temperature (R38).

The following describes three temperature calibration procedures:

- Calibrating at room temperature. Use this procedure if it is not necessary to optimize the Meter's performance.
- Calibrating in an ice bath. Use this procedure to optimize the Meter's performance at around 0.0°C.
- Calibrating in a lag bath. Use this procedure to optimize the Meter's performance at room temperature.

Room Temperature Calibration

The following procedure allows you to make the calibration adjustment at room temperature.

1. Allow the Meter to stabilize at room temperature. After the temperature stabilizes, do not touch the COM jack.
2. Turn to temperature function and °C mode.
3. Observing the correct polarity, connect a copper short across the input jacks of the Meter (see Figure 5).
4. Using a temperature probe with the appropriate Meter (Fluke 45 or equivalent), measure the temperature of the COM input jack (see Figure 5). Be sure to place the probe on the COM closest to the pca.
5. Adjust R38 so the Meter display is the same as the temperature probe reading.

Ice Bath Calibration

The following procedure optimizes the Meter's performance near 0°C (32°F) using a specific thermocouple.

1. Put the Meter in the temperature function and °C mode.
2. Insert a thermocouple in an ice bath (see Figure 6).
3. Insert a mercury thermometer to the same depth as the thermocouple wire to verify that the ice bath temperature is 0.0°C .

4. Connect the other end of the thermocouple wire to the Meter using a Fluke 80AK Adapter Plug (see Figure 6). Allow the instrument reading to settle.
5. Adjust R38 so that the Meter display has the same reading of the ice bath temperature.

Lag Bath Calibration

The following adjustment optimizes the Meter's performance at room temperature using a specific thermocouple.

1. Put the Meter in the temperature function and °C mode.
2. Insert a thermocouple in a lag bath (see Figure 6).
3. Insert a mercury thermometer to the same depth as the thermocouple wire to verify that the lag bath temperature is at room temperature
4. Connect the other end of the thermocouple wire to the Meter using an 80AK Adapter Plug(see Figure 6). Allow the instrument reading to settle.
5. Adjust R38 so that the Meter display has the same reading of the lag bath thermometer.

Replacement Parts

Replacement parts are listed in Table 4 and shown in Figure 1.

Table 4. Replacement Parts

Parts	Part No.
Window decal	617974
Case, top	617966
LCD	643541
Connection elastomeric	867242
Connection Elastomeric LCD to PCA	867247
Switch assembly	618022
Actuator, Switch	203445
Support, Switch Assembly	879031
Battery	696534
Case, Bottom assembly	618097
Screw, THD Form, PH.P.STL, 5014 x .750	832246
Foot	885884

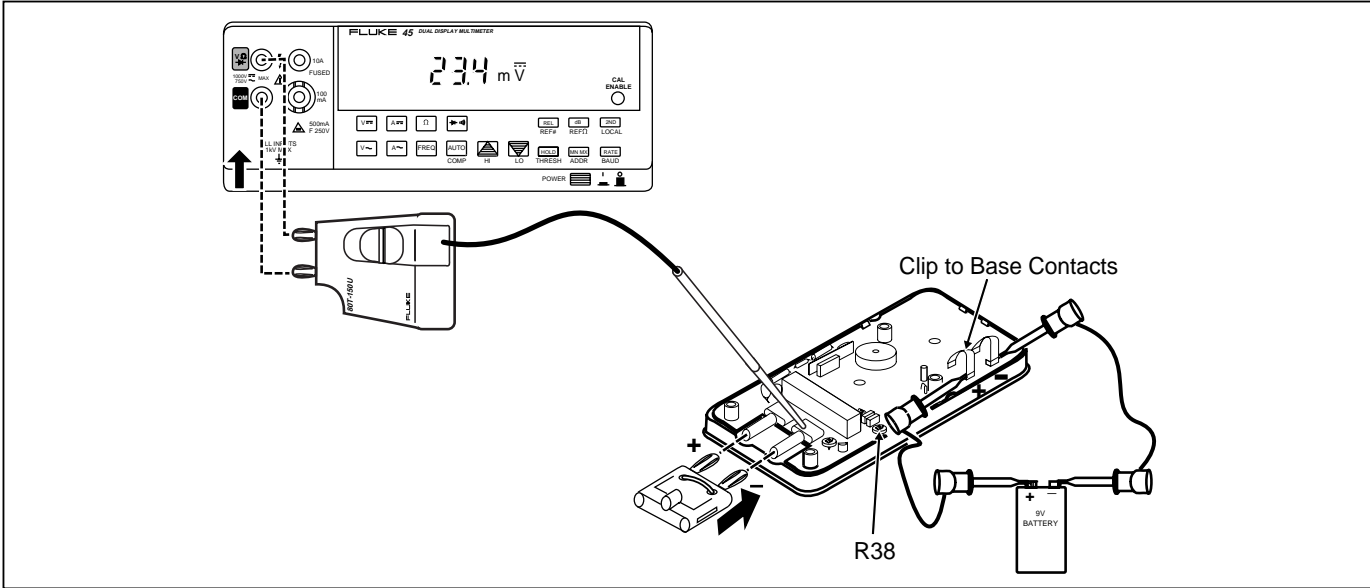


Figure 5. Calibration Adjustment for Temperature Using the 80T-150U

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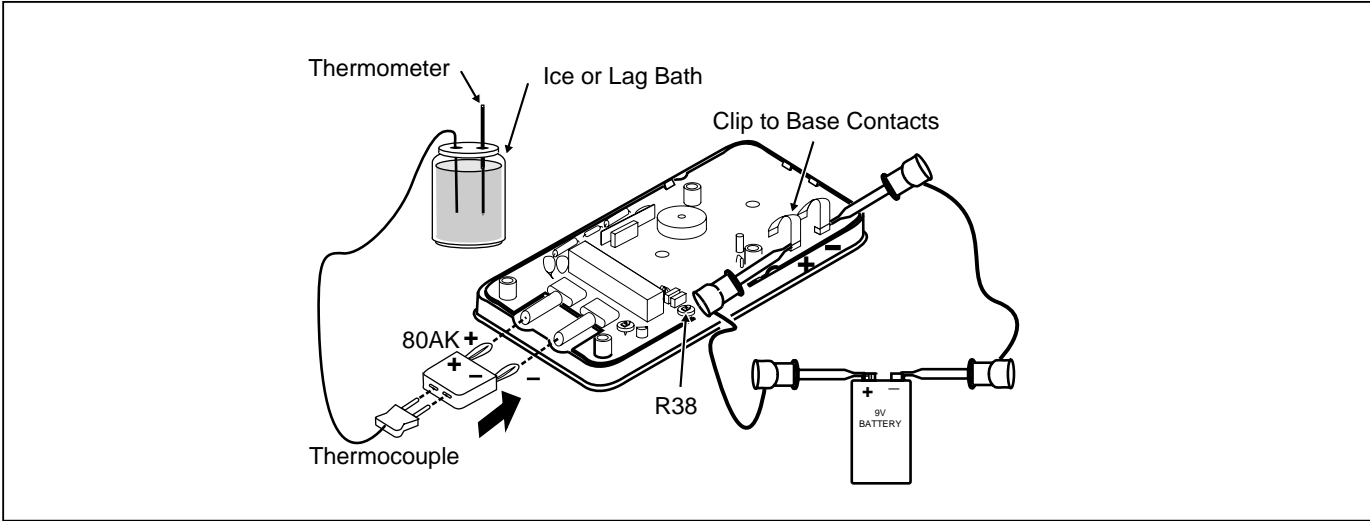


Figure 6. Calibration Adjustment for Temperature Using an Ice or Lag Bath

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