FLUKE®

# 87V EX

True-rms Multimeter

## Calibration Manual

April 2006

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| | |
|---|---|
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# Introduction

**⚠⚠ Warning**

**To avoid shock or injury:**

- **Read "Precautions and Safety Information" before performing the verification tests or calibration adjustment procedures documented in this manual.**
- **Do not perform the verification tests or calibration adjustment procedures described in this manual unless you are qualified to do so.**
- **The information provided in this manual is for the use of qualified personnel only.**

**⚠Caution**

- **The 87V EX True-rms Multimeter contains parts that can be damaged by static discharge.**
- **Follow the standard practices for handling static sensitive devices.**

The *87V EX Calibration Manual* provides the following information:

- Safety information
- Specifications
- Basic maintenance (cleaning, replacing the battery and fuses)
- Performance test procedures
- Calibration adjustment procedures
- Replaceable parts

For complete operating instructions, refer to the *87V EX True-rms Multimeter Users Manual*.

# Contacting Fluke

To contact Fluke or locate the nearest Service Center, call one of the following telephone numbers:

Europe: +31 402-675-200
Or, visit Fluke's Web site at www.fluke.com.

To register your product, visit register.fluke.com

**⚠⚠Warning**

**To avoid possible electric shock or personal injury, inspect the test leads for damaged insulation or exposed metal. Check the test leads for continuity. Replace damaged test leads before using the Meter.**

# Precautions and Safety Information

In this manual, a **Warning** identifies conditions and actions that pose hazard(s) to the user; a **Caution** identifies conditions and actions that may damage the Meter or the test instruments.

## General Safety Information

The Meter complies with:

- EN61010-1:2001
- ANSI/ISA S82.01-2004
- CAN/CSA C22.2 No. 1010.1:2004
- Measurement Category III, 1000V, Pollution Degree 2
- Measurement Category IV, 600V, Pollution Degree 2
- Industrial use in potentially explosive areas of zone 1 or 2, according to ATEX requirements (ATEX 137)(see the ATEX safety instructions & regulations section) In this manual, a **Warning** identifies conditions and actions that pose hazards to the user. A **Caution** identifies conditions and actions that may damage the Meter or the equipment under test.

  Electrical symbols used on the Meter and in this manual are explained in Table 1.

  To ensure safe operation of the Meter, fully observe all instructions and warnings contained in this manual.

## ATEX Safety Information

This manual contains information and safety regulations that must be followed to ensure safe, reliable operation of the Meter in hazardous areas under the described conditions. Failure to follow the information and instructions can have dangerous consequences, or may contravene applicable legislation.

Please take the time to read through the Users Manual before you start using the Meter.

To ensure safe operation of this Meter, fully observe all instructions and warnings contained in this manual.

**⚠⚠ Warning**

**To avoid possible electric shock or personal injury while working in EX-HAZARDOUS areas, follow these guidelines:**

- **Do not open the Meter while in an Ex-hazardous area.**
- **Change the Meter's battery only outside Ex-hazardous areas.**
- **Do not carry additional or spare batteries in Ex-hazardous areas.**
- **Use only type-approved batteries in the Meter. Refer to the "Replacing the Battery" section for a list of approved batteries.**
- **Do not replace fuses while in an Ex-hazardous area.**
- **Use only fuses approved for Ex-hazardous areas in this Meter. See the "Replacing the Fuses" section for a list of approved fuses.**
- **After using the Meter on a non-i.s. protected circuit, observe a 3-minute rest period before taking the Meter into an Ex-hazardous area.**
- **The Meter must be completely and securely fitted in the red holster while it is in an Ex-hazardous area.**

- **Do not open function buttons inside the Meter. Interference or damage to any of these elements removes the Ex-protection.**
- **Observe the tolerances or threshold values found in the "Specifications" section of this manual.**
- **Use only allowed accessories with this Meter in Ex-hazardous areas. See a listing of allowed Fluke accessories at www.Fluke.com.**
- **Avoid using the Meter in aggressive acidic or alkaline solutions.**
- **Do not use the Meter in zone 0.**
- **Never measure voltages greater than 65 volts in an Ex-hazardous area.**
- **Never measure currents greater than 5 amps while using the Meter in an Ex-hazardous area.**
- **Servicing not covered in this manual should be performed only by the manufacturer. Repair or service by others may void the ATEX certification of this Meter.**

**⚠⚠Warning**

**To avoid possible electric shock or personal injury in ALL areas of operation, follow these guidelines:**

- **Use this Meter only as specified in this manual or the protection provided by the Meter might be impaired.**
- **See the "ATEX Safety Information" section for additional warnings on meter use in hazardous areas.**
- **Do not use the Meter if it is damaged. Before you use the Meter, inspect the case. Look for cracks or missing plastic. Pay particular attention to the insulation surrounding the connectors.**
- **Ensure the battery door is closed and latched whenever operating the Meter.**
- **Replace the battery as soon as the battery indicator (▬) appears. See "Replacing the Battery" section for instructions and a list of approved batteries.**
- **Remove test leads from the Meter before opening the battery door.**
- **Inspect the test leads for damaged insulation or exposed metal. Check the test leads for continuity. Replace damaged leads before using the Meter.**
- **Do not apply more than the rated voltage, as marked on the Meter, between the terminals or between any terminal and earth ground.**
- **Use caution when working with voltages above 30 V ac rms, 42 V ac peak, or 60 V dc. These voltages pose a shock hazard.**
- **Use only the replacement fuses specified in this Users Manual. See "Replacing the Fuses" section for instructions and a list of approved fuses.**
- **Use the proper terminals, function, and range for measurements.**
- **Avoid working alone.**
- **When measuring current, turn off circuit power before connecting the Meter to the circuit. Remember to place the Meter in series with the circuit.**
- **When making electrical connections, connect the common test lead before connecting the live test lead; when disconnecting, disconnect the live test lead before disconnecting the common test lead.**

- **Do not use the Meter if it operates abnormally. Protection may be impaired. When in doubt, have the Meter serviced.**
- **Use only a single 9 volt battery, properly installed in the Meter case, to power the Meter. See "Replacing the Battery" section for instructions and a list of approved batteries.**
- **Only use replacement parts listed in the "Parts" section of this manual. Return the Meter to the manufacturer for all other service needs.**
- **When using probes, keep your fingers behind the probe's finger guards.**
- **Do not use the Low Pass Filter option to verify the presence of hazardous voltages. Voltages greater than what is indicated may be present. First, make a voltage measurement without the filter to detect the possible presence of hazardous voltage. Then select the filter function.**
- **Do not use in wet environments.**

**⚠Caution**

**To avoid possible damage to the Meter or to the equipment under test, follow these guidelines:**

- **Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes, or capacitance.**
- **Use the proper terminals, function, and range for all measurements.**
- **Before measuring current, check the Meter's fuses. (See "Fuse Test".)**
- **Observe all safety regulations and read the certificate.**

## *Ex-Certification Data*

- EC-type certificate no.: ZELM 05 ATEX 0274
- Ex-designation: ⟨Ex⟩ II 2 G EEx ia IIC T4
  Measuring range: 65 V Max in Ex-hazardous areas.
  5 A Max. in Ex-hazardous areas
- Power supply: 9 Volt block type, IEC 6LR61
- Measuring protected electric circuits:
  Voltage-Mass (V/ - COM):

| | | |
|---|---|---|
| Ui = 65 V | Uo = 10.35 V | Co = 2.52 µF |
| | Io = 4.0 mA. | Lo= 100 mH |

  Current-Mass (µA/mA & A - COM):

| | | |
|---|---|---|
| Ii = 5 A | Uo=2.8 V | Co = 1000 µF |
| | Io = 68 mA | Lo = 8 mH. |

- Approved for Zones 2 and 1, device group II, gas group C potentially explosive gases, vapours and mist, temperature class T4.

**Table 1. Electrical Symbols**

| | | | |
|---|---|---|---|
| ~ | AC (Alternating Current) | ⏚ | Earth ground |
| ⎓ | DC (Direct Current) | ⎯▭⎯ | Fuse |
| ⊣⊢ | Capacitance | ▶\| | Diode |
| ▬+ | Battery. Low battery when displayed. | ))) | Continuity test or continuity beeper tone. |
| ⚠ | Hazardous voltage | ⧈ | Double insulated |
| ⚠ | Risk of Danger. Important information. See Users Manual. | | Do not mix with solid waste stream. Dispose using a qualified recycler or hazardous material handler. |
| CAT III | IEC Measurement Category III<br>CAT III equipment is designed to protect against transients in equipment in fixed-equipment installations, such as distribution panels, feeders and short branch circuits, and lighting systems in large buildings. | CAT IV | IEC Measurement Category IV<br>CAT IV equipment is designed to protect against transients from the primary supply level, such as an electricity meter or an overhead or underground utility service. |
| CE | Conforms to European Union directives. | c SP us | Conforms to relevant Canadian and U.S. Standards. |
| TÜV | Inspected and licensed by TÜV Product Services. | Ex | Conforms to ATEX directive. |

# General Specifications

**Maximum Voltage between any Terminal and Earth Ground: 1000 V rms**

⚠ **Fuse Protection for mA or µA inputs**: 0.44 A, 1000 V FAST Fuse

⚠ **Fuse Protection for A input:** 11 A, 1000 V FAST Fuse

**Display:** Digital: 6000 counts updates 4/sec; (Model 87 also has 19,999 counts in high-resolution mode).
**Analog Bargraph:** 33 segments, updates 40/sec. Frequency: 19,999 counts, updates 3/sec at > 10 Hz

**Temperature:** Operating: -20 ºC to +50 ºC; Storage: -40 ºC to +60 ºC

**Altitude:** Operating: 2000 m; Storage: 10,000 m

**Temperature Coefficient:** 0.05 x (specified accuracy)/ ºC (< 18 ºC or > 28 ºC)

**Electromagnetic Compatibility:** In an RF field of 3 V/m total accuracy = specified accuracy + 20 counts

Except: 600 µA dc range total accuracy=specified accuracy + 60 counts.

Temperature not specified.
**Relative Humidity:** 0 % to 80 % (0 ºC to 35 ºC); 0 % to 70 % (35 ºC to 50 ºC)

**Battery Type:** 9 V, 6LR61 according to IEC

**Battery Life:** 400 hrs typical with alkaline (with backlight off)

**Vibration:** Per MIL-PRF-28800 for a Class 2 instrument
**Shock:** 1 Meter drop per IEC 61010-1:2001

**Size (HxWxL):** 1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)

**Size with Holster and Flex-Stand:** 2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)

**Weight with Holster and Flex-Stand:** 23.3 oz (660 g)

**Safety:** Complies with ANSI/ISA S82.01-2004, CSA 22.2 No. 1010.1:2004 to 1000 V Overvoltage Category III, IEC 664 to 600 V Overvoltage Category IV. Licensed by TÜV to EN61010-1. Ex Directive 1992/92/EC (ATEX 137)

# Detailed Specifications

For all detailed specifications:

Accuracy is given as ±([% of reading] + [number of least significant digits]) at 18 ºC to 28 ºC, with relative humidity up to 90 %, for a period of one year after calibration.

In the 4 ½-digit mode, multiply the number of least significant digits (counts) by 10. AC conversions are ac-coupled and valid from 3 % to 100 % of range. The Meter is true rms responding. AC crest factor can be up to 3 at full scale, 6 at half scale. For non-sinusoidal wave forms add -(2 % Rdg + 2 % full scale) typical, for a crest factor up to 3.

## AC Voltage Function

| Function | Range | Resolution | Accuracy | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 45 - 65 Hz | 30 - 200 Hz | 200 - 440 Hz | 440 Hz - 1 kHz | 1 - 5 kHz | 5 - 20 kHz[1] |
| $\tilde{V}$ [2,4] | 600.0 mV | 0.1 mV | ± (0.7 % + 4) | ± (1.0 % + 4) | | | ± (2.0 % + 4) | ± (2.0 % + 20) |
| | 6.000 V<br>60.00 V | 0.001 V<br>0.01 V | ± (0.7 % + 2) | | | | ± (2.0 % + 4) [3] | unspecified |
| | 600.0 V | 0.1 V | | | | | | |
| | 1000 V | 1 V | | | | | unspecified | unspecified |
| | Low pass filter | | ± (0.7 % + 2) | ± (1.0 % + 4) | +1 % + 4<br>-6 % - 4[5] | unspecified | unspecified | unspecified |

[1] Below 10 % of range, add 12 counts.

[2] The Meter is a true rms responding meter. When the input leads are shorted together in the ac functions, the Meter may display a residual reading between 1 and 30 counts. A 30 count residual reading will cause only a 2-digit change for readings over 3 % of range. Using REL to offset this reading may produce a much larger constant error in later measurements.

[3] Frequency range: 1 kHz to 2.5 kHz.

[4] A residual reading of up to 13 digits with leads shorted, will not affect stated accuracy above 3 % of range.

[5] Specification increases from -1% at 200 Hz to -6% at 440 Hz when filter is in use.

## DC Voltage, Resistance, and Conductance Function

| Function | Range | Resolution | Accuracy |
|---|---|---|---|
| $\overline{\overline{V}}$ | 6.000 V | 0.001 V | ± (0.05 % + 1) |
| | 60.00 V | 0.01 V | ± (0.05 % + 1) |
| | 600.0 V | 0.1 V | ± (0.05 % + 1) |
| | 1000 V | 1 V | ± (0.05 % + 1) |
| ⎓ mV | 600.0 mV | 0.1 mV | ± (0.1 % + 1) |
| Ω | 600.0 Ω | 0.1 Ω | ± (0.2 % + 2)[1] |
| | 6.000 kΩ | 0.001 kΩ | ± (0.2 % + 1) |
| | 60.00 kΩ | 0.01 kΩ | ± (0.2 % + 1) |
| | 600.0 kΩ | 0.1 kΩ | ± (0.6 % + 1) |
| | 6.000 MΩ | 0.001 MΩ | ± (0.6 % + 1) |
| | 50.00 MΩ | 0.01 MΩ | ± (1.0 % + 3)[2] |
| nS | 60.00 nS | 0.01 nS | ± (1.0 % + 10)[1,2] |

[1] When using the REL Δ function to compensate for offsets.

[2] Add 0.5 % of reading when measuring above 30 MΩ in the 50 MΩ range, and 20 counts below 33 nS in the 60 nS range.

## Temperature

| Temperature | Resolution | Accuracy[1,2] |
|---|---|---|
| -200 ºC to +1090 ºC | 0.1 ºC | 1 % + 10 |
| -328 ºF to +1994 ºF | 0.1 ºF | 1 % + 18 |

[1] Does not include error of the thermocouple probe.

[2] Accuracy specification assumes ambient temperature stable to ± 1 ºC. For ambient temperature changes of ± 5 ºC, rated accuracy applies after 1 hour.

## Current Function

| Function | Range | Resolution | Accuracy[1, 2] | Burden Voltage (typical |
|---|---|---|---|---|
| **mA**<br>**A~**<br>(45 Hz to 2 kHz) | 60.00 mA<br>400.0 mA[4]<br>6.000 A<br>10.00 A[3] | 0.01 mA<br>0.1 mA<br>0.001 A<br>0.01 A | ±(1.0 % + 2)<br>± (1.0 % + 2)<br>± (1.0 % + 2)<br>± (1.0 % + 2) | 1.8 mV/mA<br>1.8 mV/mA<br>0.03 V/A<br>0.03 V/A |
| **mA**<br>**A⎓** | 60.00 mA<br>400.0 mA[4]<br>6.000 A<br>10.00 A[3] | 0.01 mA<br>0.1 mA<br>0.001 A<br>0.01 A | ± (0.2 % + 4)<br>± (0.2 % + 2)<br>± (0.2 % + 4)<br>± (0.2 % + 2) | 1.8 mV/mA<br>1.8 mV/mA<br>0.03 V/A<br>0.03 V/A |
| **µA ~**<br>(45 Hz to 2 kHz) | 600.0 µA<br>6000 µA | 0.1 µA<br>1 µA | ± (1.0 % + 2)<br>± (1.0 % + 2) | 100 µV/µA<br>100 µV/µA |
| **µA⎓** | 600.0 µA<br>6000 µA | 0.1 µA<br>1 µA | ± (0.2 % + 4)<br>± (0.2 % + 2) | 100 µV/µA<br>100 µV/µA |

[1] AC conversions are ac coupled, true rms responding, and valid from 3 % to 100 % of range, except 400 mA range (5 % to 100 % of range) and 10 A range (15 % to 100 % or range).

[2] The Meter is a true rms responding meter. When the input leads are shorted together in the ac functions, the Meter may display a residual reading between 1 and 30 counts. A 30 count residual reading will cause only a 2 digit change for readings over 3 % of range. Using REL to offset this reading may produce a much larger constant error in later measurements

[3] ⚠ 10 A continuous up to 35 °C; < 20 minutes on, 5 minutes off at 35 °C to 55 °C. 20 A for 30 seconds maximum; > 10 A unspecified.

[4] 400 mA continuous; 600 mA for 18 hrs maximum.

## Capacitance and Diode Function

| Function | Range | Resolution | Accuracy |
|---|---|---|---|
| ⊣⊢ | 10.00 nF<br>100.0 nF<br>1.000 µF<br>10.00 µF<br>100.0 µF<br>9999 µF | 0.01 nF<br>0. 1 nF<br>0.001 µF<br>0.01 µF<br>0.1 µF<br>1 µF | ± (1 % + 2)[1]<br>± (1 % + 2)[1]<br>± (1 % + 2)<br>± (1 % + 2)<br>± (1 % + 2)<br>± (1 % + 2) |
| ⊣◀ | 3.000 V | 0.001 V | ± (2 % + 1) |

[1] With a film capacitor or better, using Relative mode to zero residual.

## Frequency Counter

| Function | Range | Resolution | Accuracy |
|---|---|---|---|
| Frequency<br>(0.5 Hz to 200 kHz,<br>pulse width > 2 µs) | 199.99<br>1999.9<br>19.999 kHz<br>199.99 kHz<br>> 200 kHz | 0.01 Hz<br>0.1 Hz<br>0.001 kHz<br>0.01 kHz<br>0.1 kHz | ± (0.005 % + 1)<br>± (0.005 % + 1)<br>± (0.005 % + 1)<br>± (0.005 % + 1)<br>unspecified |

## Frequency Counter Sensitivity and Trigger Levels

| Input Range[1] | Minimum Sensitivity (RMS Sine wave) | | Approximate Trigger Level |
|---|---|---|---|
| | 5 Hz - 20 kHz | 0.5 Hz - 200 kHz | (DC Voltage Function) |
| 600 mV dc | 70 mV (to 400 Hz) | 70 mV (to 400 Hz) | 40 mV |
| 600 mV ac | 150 mV | 150 mV | — |
| 6 V | 0.3 V | 0.7 V | 1.7 V |
| 60 V | 3 V | 7 V (≤140 kHz) | 4 V |
| 600 V | 30 V | 70 V (≤14.0 kHz) | 40 V |
| 1000 V | 100 V | 200 V (≤1.4 kHz) | 100 V |

| Duty Cycle Range | Accuracy |
|---|---|
| 0.0 to 99.9 % | Within ± (0.2% per kHz + 0.1 %) for rise times < 1 µs. |

[1] Maximum input for specified accuracy = 10X Range or 1000 V.

### Electrical Characteristics of the Terminals

| Function | Overload Protection[1] | Input Impedance (nominal) | Common Mode Rejection Ratio (1 kΩ unbalance) | | Normal Mode Rejection | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| V | 1000 V rms | 10 MΩ < 100 pF | > 120 dB at dc, 50 Hz or 60 Hz | | > 60 dB at 50 Hz or 60 Hz | | | | | |
| mV | 1000 V rms | 10 MΩ < 100 pF | > 120 dB at dc, 50 Hz or 60 Hz | | > 60 dB at 50 Hz or 60 Hz | | | | | |
| V~ | 1000 V rms | 10 MΩ < 100 pF (ac-coupled) | > 60 dB, dc to 60 Hz | | | | | | | |
| | | **Open Circuit Test Voltage** | **Full Scale Voltage** | | **Typical Short Circuit Current** | | | | | |
| | | | **To 6.0 MΩ** | **50 MΩ or 60 nS** | **600 Ω** | **6 k** | **60 k** | **600 k** | **6 M** | **50 M** |
| Ω | 1000 V rms | < 7.9 V dc | < 4.1 V dc | < 4.5 V dc | 1 mA | 100 µA | 10 µA | 1 µA | 1 µA | 0.5 µA |
| ⊣⊢ | 1000 V rms | < 3.9 V dc | 3.000 V dc | | 0.6 mA typical | | | | | |

[1] $10^6$ V Hz max

### MIN MAX Recording

| Nominal Response | Accuracy |
|---|---|
| 100 ms to 80 % | Specified accuracy ± 12 counts for changes > 200 ms in duration<br>(± 40 counts in ac with beeper on) |
| 100 ms to 80 %<br>(dc functions)<br>120 ms to 80 %<br>(ac functions)<br>250 µs (peak)[1] | Specified accuracy ± 12 counts for changes > 200 ms in duration<br>Specified accuracy ± 40 counts for changes > 350 ms and inputs > 25 % of range<br>Specified accuracy ± 100 counts for changes > 250 µs in duration<br>(add ± 100 counts for readings over 6000 counts)<br>(add ± 100 counts for readings in Low Pass mode) |

[1] For repetitive peaks: 1 ms for single events.

## Basic Maintenance

**⚠⚠Warning**

**To avoid possible electric shock or personal injury:**

- **Remove the test leads and any input signals before opening the case or replacing the battery or fuses.**
- **Repairs or servicing covered in this manual should be performed only by qualified personnel.**

### Cleaning the Meter

**⚠⚠Warning**

**To avoid possible electric shock, personal injury, or damage to the meter, never allow water inside the case.**

**⚠Caution**

**To avoid damaging the Meter, never apply abrasives, solvents, aromatic hydrocarbons, chlorinated solvents, or methanol-based fluids to the Meter.**

Periodically wipe the Meter case with Fluke "MeterCleaner™" or a damp cloth and mild detergent.

Dirt or moisture in the **A** or **mA μA** input terminals can affect readings and can falsely activate the Input Alert feature without the test leads being inserted. Such contamination may be dislodged by turning the Meter over and, with all test leads removed, gently tapping on the case.

Thoroughly clean the terminals as follows:

1. Turn the Meter off and remove all test leads.
2. Soak a clean swab with isopropyl alcohol and work the swab around in each input terminal to remove contaminates.
3. Use a dry clean swab to remove any left over alcohol from the terminal.

## *Opening the Meter Case*

**⚠Caution**

**To avoid unintended circuit shorting, always place the uncovered Meter assembly on a protective surface. When the case of the Meter is open, circuit connections are exposed.**

To open the Meter case, refer to Figure1 and do the following:

1. Disconnect test leads from any live source, turn the rotary knob to **OFF**, and remove the test leads from the front terminals.
2. Remove the battery door by using a flat-blade screwdriver to turn the battery door screws 1/4-turn counterclockwise.
3. The case bottom is secured to the case top by three screws and two internal snaps (at the LCD end). Using a Phillips-head screwdriver, remove the three screws.

**⚠Caution**

**To avoid damaging the Meter, the gasket that is sealed to the bottom case, and is between the two case halves, must remain with the case bottom. The case top lifts away from the gasket easily. Do not damage the gasket or attempt to separate the case bottom from the gasket.**

4. Hold the Meter display side up.
5. Pushing up from the inside of the battery compartment, disengage the case top from the gasket.
6. Gently unsnap the case top at the display end, see Figure 1.

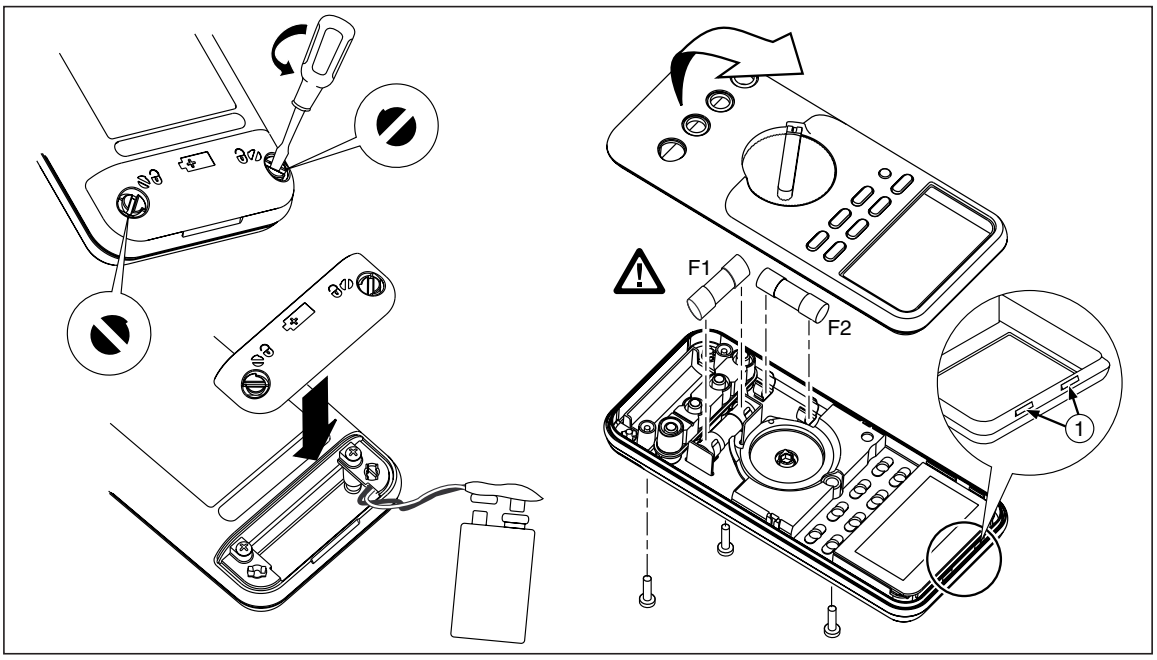


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**Figure 1. Opening the Meter, Battery and Fuse Replacement**

## Reassembling the Meter Case

To reassemble the Meter case:

1. Verify that the rotary knob and circuit board switch are in the **OFF** position, and that the gasket remains secured to the bottom case.
2. Place the PCA into the bottom case.
3. Place the case top on the case bottom.
4. To avoid damaging the battery wire, ensure the wire exits the middle of the battery compartment.
5. Properly seat the case gasket and snap the case halves together above the LCD end. See Figure 1.
6. Reinstall the three case screws and the battery door.
7. Secure the battery door by turning the screw 1/4-turn clockwise.
8. Go to “Performance Tests” later in this document, and perform the procedures described.

## Replacing the Battery

Replace the Meter's 9-volt battery with only approved batteries found in Table 2.

**⚠⚠Warning**

**To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator (▬+) appears. If the display shows "bAtt" the Meter will not function until the battery is replaced.**

Replace the battery as follows, refer to Figure 1:

1. Turn the rotary knob to **OFF** and remove the test leads from the terminals.
2. Remove the battery door by using a standard-blade screwdriver to turn the battery door screws one-quarter turn counterclockwise.
3. Remove the old battery and replace it with a new one.
4. Align the battery leads so that they not pinched between the battery door and the case bottom.
5. Secure the door by turning the screws one-quarter turn clockwise.

**Table 2. Approved Batteries**

| Battery Description | Manufacturer | Type |
|---|---|---|
| Alkaline Energizer<br>Energizer No. 522 | Eveready | 6LR61 |
| Alkaline | Daimon | 6LR61 |
| Alkaline<br>Alkaline Ultra<br>Professional Alkaline Battery Procell<br>Plus MN1604 6LR61<br>Procell MN1604 6LR61<br>Ultra M3 MN1604 6LR61 | Duracell | 6LR61 |
| Ucar Gold 6LR61 | Energizer | 6LR61 |
| Alkaline 4822<br>Alkaline Universal No. 4022<br>Alkaline Electric Power No. 8022<br>Electric Power No.8022<br>High Energy No.4922<br>Industrial Alkaline No.4022 | Varta | 6LR61 |
| Alkaline Power Line Industrial Battery<br>Industrial Alkaline 6LR61<br>Powermax 6LR61 | Panasonic | 6LR61 |
| Super Alkaline 1604A | GP | 6LR61 |

## Testing Fuses and Current Circuitry

If a test lead is plugged into the **mA/µA** or **A** terminal and the rotary knob is turned to a non-current function, the Meter chirps and flashes "LEAd" if the fuse associated with that current terminal is good. If the Meter does not chirp or flash "LEAd", the fuse is bad and must be replaced. Refer to Table 9 for the appropriate replacement fuse.

After replacing the fuse, use the following procedure to verify the integrity of the new fuse and the current circuitry. Refer to Figure 2.

1. Turn the rotary knob to Ω.
2. To test F2, insert a test lead into the V Ω input terminal and touch the probe to the **A** input terminal.

   *Note*

   *The input receptacles contain split contacts. Be sure to touch the probe to the half of the receptacle nearest the LCD.*
3. The display should indicate between 00.0 Ω and 00.5 Ω. If the display reads OL, replace the fuse and test again. If the display reads another value, further servicing is required.
4. To test F1, move the probe from the **A** input terminal to the **mA/μA** input terminal.
5. The display should read between 0.995 kΩ and 1.005 kΩ. If the display reads OL, replace the fuse and test again. If the display reads another value, further servicing is required.

**⚠⚠Warning**

**To avoid electrical shock or personal injury:**

- **Remove the test leads and any input signals before replacing the battery or fuses.**
- **Install ONLY specified replacement fuses with the amperage, voltage, and speed ratings shown in Table 9.**

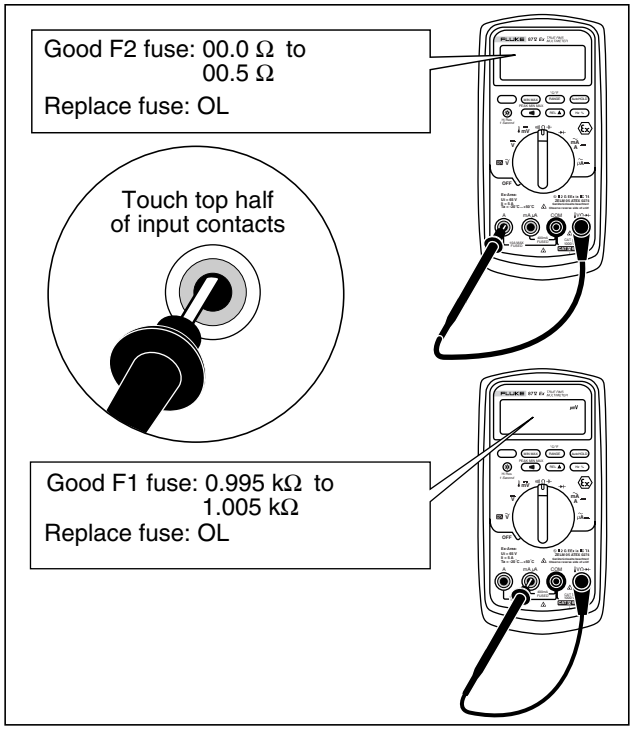


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**Figure 2. Testing the Current Input Fuses**

### Replacing the Fuses

To replace the fuse(s), perform the following procedure.

1. To open the Meter, refer to "Opening the Meter Case". See Figure 1.
2. Grasp the fuse in the center with needle nose pliers. Pull straight up on the fuse to remove it from the fuse clips.
3. Install ONLY specified replacement fuses with the amperage, voltage, and speed ratings shown in Table 9.
4. To close the Meter, refer to "Reassembling the Meter Case".

## Required Equipment

Required equipment for the performance tests are listed in Table 3. If the recommended models are not available, equipment with equivalent specifications may be used.

**⚠⚠ Warning**

- **To avoid shock or injury, do not perform the verification tests or calibration adjustment procedures described in this manual unless you are qualified to do so.**
- **Repairs or servicing should be performed only by qualified personnel.**

**Table 3. Required Equipment**

| Equipment | Required Characteristics | Recommended Model |
|---|---|---|
| Calibrator | AC Voltage Range: 0 - 1000 V ac<br>Accuracy: ± 0.12 %<br>Frequency Range: 60 - 20000 Hz<br>Accuracy: ± 3 %<br><br>DC Voltage Range: 0 - 1000 V dc<br>Accuracy: ± 0.012 %<br><br>Current Range: 350 µA - 2 A<br>Accuracy: AC (60 Hz to 1 kHz): ± 0.25 %<br>DC: ± 0.05 %<br><br>Frequency Source: 19.999 kHz - 199.99 kHz<br>Accuracy: ± 0.0025 %<br>Amplitude: 150 mV to 6V rms<br>Accuracy: ± 5 %<br><br>Range: 1 Ω - 100 MΩ<br>Accuracy: 0.065 % | Fluke 5520A Multi-Product Calibrator or equivalent |
| Fluke 80 AK<br>TC Adapter Accessory | K-type | Fluke 80 AK |
| K-type Thermocouple | K-type, mini-plug on both ends | |

# Performance Tests

The following performance tests verify the complete operability of the Meter and check the accuracy of each Meter function against the Meter's specifications. Performance tests should be performed annually to ensure that the Meter is within accuracy specifications.

Accuracy specifications are valid for a period of one year after calibration adjustment, when measured at an operating temperature of 18 °C to 28 °C and at a maximum of 90 % relative humidity.

To perform the following tests, it is not necessary to open the case. No adjustments are necessary. Make the required connections, apply the designated inputs, and determine if the reading on the Meter display falls within the acceptable range indicated.

*Note*

*If the Meter fails any of these tests, it needs calibration adjustment or repair.*

## Basic Operability Tests

Refer to the following sections to test the basic operability of the Meter.

## Testing the Fuses

Refer to "Testing the Fuses".

## Testing the Display

Turn the Meter on while holding down AutoHOLD to view all segments of the display. Compare the display with the appropriate examples in Figure 3 and Table 4.

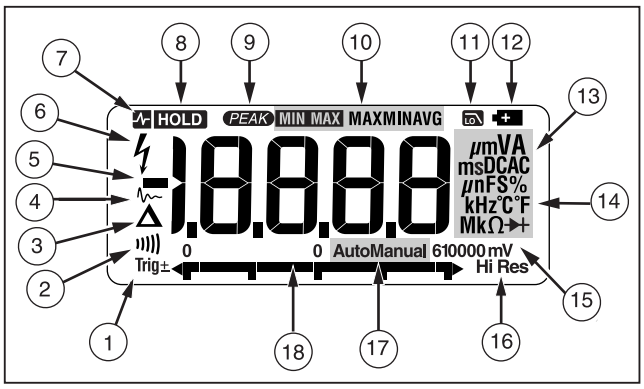


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**Figure 3. Display Features**

**Table 4. Display Features**

| Number | Feature | Indication |
|---|---|---|
| ① | ± | Polarity indicator for the analog bar graph. |
| | Trig± | Positive or negative slope indicator for Hz/duty cycle triggering. |
| ② | ))))) | The continuity beeper is on. |
| ③ | Δ | Relative (REL) mode is active. |
| ④ | ∿ | Smoothing is active. |

**Table 4. Display Features (cont)**

| Number | Feature | Indication |
|---|---|---|
| ⑤ | − | Indicates negative readings. In relative mode, this sign indicates that the present input is less than the stored reference. |
| ⑥ | ϟ | Indicates the presence of a high voltage input. Appears if the input voltage is 30 V or greater (ac or dc). Also appears in low pass filter mode. Also appears in cal, Hz, and duty cycle modes. |
| ⑦ | HOLD | AutoHOLD is active. |
| ⑧ | HOLD | Display Hold is active. |
| ⑨ | PEAK | Indicates the Meter is in Peak Min Max mode and the response time is 250 µs. |
| ⑩ | MIN MAX<br>MAX MIN<br>AVG | Indicators for minimum-maximum recording mode. |
| ⑪ | LO | Low pass filter mode. See “Low Pass Filter. |
| ⑫ | | The battery is low. ⚠⚠Warning: To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator appears. |
| ⑬ | **A, µA, mA** | Amperes (amps), Microamp, Milliamp |
| | **V, mV** | Volts, Millivolts |
| | **µF, nF** | Microfarad, Nanofarad |
| | **nS** | Nanosiemens |
| | **%** | Percent. Used for duty cycle measurements. |
| | **Ω, MΩ, kΩ** | Ohm, Megohm, Kilohm |
| | **Hz, kHz** | Hertz, Kilohertz |
| | **AC DC** | Alternating current, direct current |
| ⑭ | **°C, °F** | Degrees Celsius, Degrees Fahrenheit |
| ⑮ | **610000 mV** | Displays selected range |
| ⑯ | **HiRes** | The Meter is in high resolution (Hi Res) mode. HiRes=19,999 |
| ⑰ | **Auto** | The Meter is in autorange mode and automatically selects the range with the best resolution. |
| | **Manual** | The Meter is in manual range mode. |
| ⑱ | | The number of segments is relative to the full-scale value of the selected range. In normal operation 0 (zero) is on the left. The polarity indicator at the left of the graph indicates the polarity of the input. The graph does not operate with the capacitance, frequency counter functions, temperature, or peak min max. For more information, see “Bar Graph”. The bar graph also has a zoom function, as described under "Zoom Mode". |
| -- | OL | Overload condition is detected. |

**Table 5. Error Messages**

| Error Messages | |
|---|---|
| **bAtt** | Replace the battery immediately. |
| **diSC** | In the capacitance function, too much electrical charge is present on the capacitor being tested. |
| **EEPr Err** | Invalid EEPROM data. Have Meter serviced. |
| **CAL Err** | Invalid calibration data. Calibrate Meter. |
| **LEAd** | ⚠Test lead alert. Displayed when the test leads are in the A or mA/μA terminal and the selected rotary switch position does not correspond to the terminal being used. |

## Testing the Pushbuttons

To test the pushbuttons

1. Turn the Meter rotary knob to Ω Ṽ.
2. Press each button and note that the meter responds with a beep for each button press.
3. Press and hold (MIN MAX) a second time to exit MIN MAX mode.

## Testing Meter Accuracy

Perform the accuracy test steps in Table 6.

**Table 6. Accuracy Tests**

| Step | Test Function | Range | 5500A Output | Display Reading |
|---|---|---|---|---|
| 1 | Ṽ AC Volts | 600 mV | 330 mV, 60 Hz | 327.3 to 332.7 |
| 2 | | 600 mV | 600 mV, 13 kHz | 586.0 to 614.0 |
| 3 | | 6 V | 3.3 V, 60 Hz | 3.275 to 3.325 |
| 4 | | 6 V | 3.3 V, 20 kHz | 3.214 to 3.386 |
| 5 | | 60 V | 33 V, 60 Hz | 32.75 to 33.25 |
| 6 | | 60 V | 33 V, 20 kHz | 32.14 to 33.86 |
| 7 | | 600 V | 330 V, 60 Hz | 327.5 to 332.5 |
| 8 | | 600 V | 330 V, 2.5 kHz | 323.0 to 337.0 |
| 9 | | 1000 V | 500 V, 60 Hz | 494 to 506 |
| 10 | | 1000 V | 1000 V, 1 kHz | 986 to 1014 |
| 11 | Ṽ Hz AC Volts Frequency | 600 mV | 150 mV, 99.95 kHz | 99.93 to 99.97 |
| 12 | | 600 mV | 150 mV, 199.50 kHz | 199.48 to 199.52 |
| 13 | Sensitivity | 6 V | 0.7 V, 99.95 kHz | 99.93 to 99.97 |
| 14 | | 60 V | 7 V, 99.95 kHz | 99.93 to 99.97 |
| 15 | V⎓ Hz Trigger level | 6 V | 3.4 V, 1 kHz Sq. Wave | 999.8 to 1000.2 |
| 16 | V⎓ Hz Duty Cycle | 6 V | 5 V, 1 kHz, DC offset 2.5 V Sq. Wave | 49.7 % to 50.3 % |
| 17 | V⎓ DC Volts | 6V | 3.3 V dc | 3.297 to 3.303 |
| 18 | | 60 V | 33 V dc | 32.97 to 33.03 |
| 19 | | 600 V | 330 V dc | 329.7 to 330.3 |
| 20 | | 1000 V | 1000 V dc | 998 to 1002 |
| 21 | mV⎓ DC Volts | 600 mV | 33 mV dc | 32.9 to 33.1 |
| 22 | | 600 mV | 330 mV dc | 329.6 to 330.4 |

**Table 5. Accuracy Tests (cont.)**

| Step | Test Function | Range | 5500A Output | Display Reading |
|---|---|---|---|---|
| 23 | Ω Ohms | 600 Ω | 330 Ω ( Use 2 wire Comp)[1] | 329.1 to 330.9 |
| 24 | | 6 kΩ | 3.3 kΩ (Use 2 wire Comp) [1] | 3.292 to 3.308 |
| 25 | | 60 kΩ | 33 kΩ | 32.92 to 33.08 |
| 26 | | 600 kΩ | 330 kΩ | 327.9 to 332.1 |
| 27 | | 6 MΩ | 3.3 MΩ | 3.279 to 3.321 |
| 28 | | 50 MΩ | 30 MΩ | 29.67 to 30.33 |
| 29 | **nS** Conductance | 60 nS | Open input | - 0.30 to 0.30 |
| 30 | | 60 nS | 100 MΩ | 9.60 to 10.40 |
| 31 | Diode | 6 V | 3.0 V dc | 2.939 to 3.061 |
| 32 | AC Amps | 6 A | 3.0 A, 60 Hz | 2.968 to 3.032 |
| 33 | DC Amps | 6 A | 3.0 A | 2.990 to 3.010 |
| 33B | DC Amps | 10A[6] | 10A | 9.96 to 10.04 |
| 34 | mA AC Milliamps | 60 mA | 33 mA, 60 Hz | 32.65 to 33.35 |
| 35 | | 400 mA | 330 mA, 60 Hz | 326.5 to 333.5 |
| 36 | mA DC Milliamp | 60 mA | 33 mA | 32.89 to 33.11 |
| 37 | | 400 mA | 330 mA | 329.1 to 330.9 |
| 38 | μA AC Microamps | 600 μA | 330 μA, 60 Hz | 326.5 to 333.5 |
| 39 | | 6000 μA | 3300 μA, 60 Hz | 3265 to 3335 |
| 40 | μA DC Microamps | 600 μA | 330 μA | 328.9 to 331.1 |
| 41 | | 6000 μA | 3300 μA | 3291 to 3309 |
| 42 | Capacitance | 10 nf | Open input[2] | 0.21 to 0.31 |
| 43 | | 100 nf | 5 nf[5] | 04.7 to 05.3 |
| 44 | | 100 μf | 9.5 μf | 09.2 to 09.8 |
| 45 | Low Pass Filter | 1000 V | 400 V, 400 Hz | 372 to 408 |
| 46 | | 1000 V | 400 V, 800 Hz[4] | 226 to 340[4] |

**Table 5. Accuracy Tests (cont.)**

| Step | Test Function | Range | 5500A Output | Display Reading |
|---|---|---|---|---|
| 47 | $\overline{\overline{\text{V}}}$ (87 and 88 only) Peak Min/Max | 6 V dc | 8 Vpp, 2 kHz Sq. Wave, DC offset 2 V | Max = 5.896 to 6.104 |
| 48 | | | | Min = -1.898 to -2.102 |
| 49 | $\text{m}\overline{\overline{\text{V}}}$ (87 and 88 only) Temperature [3] | | 0 °C | -1.0 to 1.0 |
| 50 | | | 100 °C | 98.0 to 102.0 |
| 51 | Backlight | | Press backlight button | Backlight comes on |
| 52 | | | Press backlight button | Backlight Intensifies |
| 53 | | | Press backlight button | Backlight off |

1. Or short test leads and use REL to offset test lead resistance.
2. Remove test leads from unit.
3. To ensure accurate measurement, the Meter and thermocouple adapter must be at the same temperature. After connecting the thermocouple adapter to the Meter allow for reading to stabalize before recording display reading.
4. The Meter accuracy is not specified at this input signal frequency with Low-pass filter selected. The display reading shown, check that the Low-pass filter is active and follows an expected roll-off curve.
5. Use REL to compensate for internal Meter and lead capacitance. Test leads must be disconnected from the calibrator before using REL.
6. ⚠ 10 A continuous up to 35 °C; < 20 minutes on, 5 minutes off at 35 °C to 55 °C. 20 A for 30 seconds maximum; >10A unspecified.

# Calibration Adjustment

The Meter features closed-case calibration adjustment using known reference sources. The Meter measures the applied reference source, calculates correction factors and stores the correction factors in nonvolatile memory.

The following sections present the features and Meter pushbutton functions that can be used during the Calibration Adjustment Procedure. Perform the Calibration Adjustment Procedure should the Meter fail any performance test listed in Table 6.

## Calibration Adjustment Counter

The Meter contains a calibration adjustment counter. The counter is incremented each time a Calibration Adjustment Procedure is completed. The value in the counter can be recorded and used to show that no adjustments have been made during a calibration cycle.

Use the following steps to view the Meter's calibration counter.

1. While holding down (MIN MAX), turn the rotary knob from **OFF** to **VAC**. The Meter should display "**CAL**".
2. Press (AutoHOLD) once to see the calibration counter. For example "n001".
3. Turn the rotary knob to **OFF**.

## Calibration Adjustment Password

**⚠Caution**

**To avoid having to replace the Meter, do not change the calibration password.**

To start the Calibration Adjustment Procedure, the correct 4-button password must be entered. The password is “1234”.

## Meter Buttons Used in the Calibration Steps

The Meter buttons behave as described in Table 6 when performing the Calibration Adjustment Procedure. This may be of help determining why a calibration step is not accepted and for determining the input value without referring to Table 8.

**Table 7. Meter Button to Calibration Function**

| Button | Calibration function |
|---|---|
| ( ) | Press and hold to show the measured value. The measurement value is not calibrated so it may not match the input value. This is normal. |
| MIN MAX | Press and hold to display the required input amplitude. |
| Hz % | Press and hold to display the frequency of the required input. |
| AutoHOLD | Press to store the calibration value and advance to the next step. This button is also used to exit calibration mode after the calibration adjustment sequence is complete. |

## Calibration Adjustment Procedure

Use the following steps to adjust the Meter's calibration. If the Meter is turned off before completion of the adjustment procedure, the calibration constants are not changed.

1. While holding down MIN MAX, turn the rotary knob from **OFF** to **VAC**. The Meter displays “ϟ **CAL**”.
2. Press AutoHOLD once to see the calibration counter.
3. Press AutoHOLD again to start the password entry. The Meter displays "????".
4. Press 4 buttons to enter the password ( ( ) = 1, MIN MAX = 2, RANGE = 3, and AutoHOLD = 4).
5. Press AutoHOLD to go to the first calibration step. The Meter displays "C-01" if the password is correct. If the password is not correct, the Meter emits a double beep, displays "????" and the password must be entered again. Repeat step 4.
6. Using Table 8, apply the input value listed for each calibration adjustment step. For each step, position the rotary switch and apply the input to the terminals as indicated in the table.
7. After each input value is applied, press AutoHOLD to accept the value and proceed to the next step (C-02 and so forth).

*Notes*

*After pressing AutoHOLD, wait until the step number advances before changing the calibrator source or turning the Meter rotary knob.*

*If the Meter rotary knob is not in the correct position, or if the measured value is not within the anticipated range of the input value, the Meter emits a double beep and will not continue to the next step.*

*Some adjustment steps take longer to execute than others (10 to 15 seconds). For these steps, the Meter will beep when the step is complete. Not all steps have this feature.*

8. After the final step, the display shows "End" to indicate that the calibration adjustment is complete. Press (AutoHOLD) to go to meter mode.

*Notes*

*Set the calibrator to Standby prior to changing the function switch position and or after completing adjustment of each function.*

*If the calibration adjustment procedure is not completed correctly, the Meter will not operate correctly.*

**Table 8. Calibration Adjustment Steps**

| Function (Switch Position) | Input Terminal | Adjustment Step | Input Value |
|---|---|---|---|
| Ṽ (AC Volts) | V Ω →\| | C-01 | 600.0 mV, 60 Hz |
| | | C-02 | 600.0 mV, 20 kHz |
| | | C-03 | 6.000 V, 60 Hz |
| | | C-04 | 6.000 V, 20 kHz |
| | | C-05 | 60.00 V, 60 Hz |
| | | C-06 | 60.00 V, 20 kHz |
| | | C-07 | 600.0 V, 60 Hz |
| | | C-08 | 600.0 V, 10 kHz |
| V̿ (DC Volts) | | C-09 | 6.000 V |
| | | C-10 | 60.00 V |
| | | C-11 | 600.0 V |
| mV̿ (DC Millivolts) | | C-12 | 600.0 mV |
| | | C-13 | 60.00 mV |
| Ω (Ohms) | | C-14 | 600.0 |
| | | C-15 | 6.000 k |
| | | C-16 | 60.00 k |
| | | C-17 | 600.0 k |
| | | C-18 | 6.000 M |
| | | C-19 | 0.000 |
| | | C-20 | 50.0 M |
| →\| (Diode Test) | | C-21 | 3.000 V |
| A (Amps) | A | C-22 | 6.000 A, 60 Hz |
| | | C-23 | 6.000 A dc |

**Table 7. Calibration Adjustment Steps (Cont.)**

| Function (Switch Position) | Input Terminal | Adjustment Step | Input Value |
|---|---|---|---|
| **mA** (Milliamps) | **mA /μA** | C-24 | 60.00 mA, 60 Hz |
| | | C-25 | 400.0 mA, 60 Hz |
| | | C-26 | 60.00 mA dc |
| | | C-27 | 400.0 mA dc |
| **μA** (Microamps) | | C-28 | 600.0 μA ac, 60 Hz |
| | | C-29 | 6000 μA, 60 Hz |
| | | C-30 | 600.0 μA dc |
| | | C-31 | 6000 μA dc |

## Service and Parts

Replacement parts are shown in Table 7 and Figure 4. To order parts and accessories, refer to "Contacting Fluke".

**Table 9. 87V EX Final Assembly**

| Item | Description | Qty. | Fluke Part or Model Number |
|---|---|---|---|
| BT1 ⚠ | Battery, 9 V (see Table 2) | 1 | 822270 |
| F1 ⚠ | Fuse, 0.44 A, 1000 V, FAST | 1 | 943121 |
| F2 ⚠ | Fuse, 11 A, 1000 V, FAST | 1 | 803293 |
| H1-3 | Screw, Case | 3 | 832246 |
| MP1 | Shock absorber | 1 | 828541 |
| MP2-3 | Foot, Non-Skid | 2 | 824466 |
| MP4 | Ex-Holster (Red) | 1 | 2520563 |
| MP5 | Battery Door | 1 | 2520595 |
| AC72 | Alligator Clip, Black | 1 | 1670652 |
| AC72 | Alligator Clip, Red | 1 | 1670641 |
| TL75 | Test Lead Set | 1 | 855742 |
| MP6-7 | Access Door Fastener | 2 | 948609 |
| 80BK | Thermocouple Assembly, K-Type, Beaded, Molded Dual Banana Plug, Coiled | 1 | 1273113 |
| NA | Tiltstand of the Ex holster | 1 | 2520056 |
| TM1 | 87V Ex Users Manual (English, French, & German) | 1 | 2518115 |
| TM2 | CD ROM,87V Ex Users Manual | 1 | 2520777 |

⚠To ensure safety, use exact replacement only.

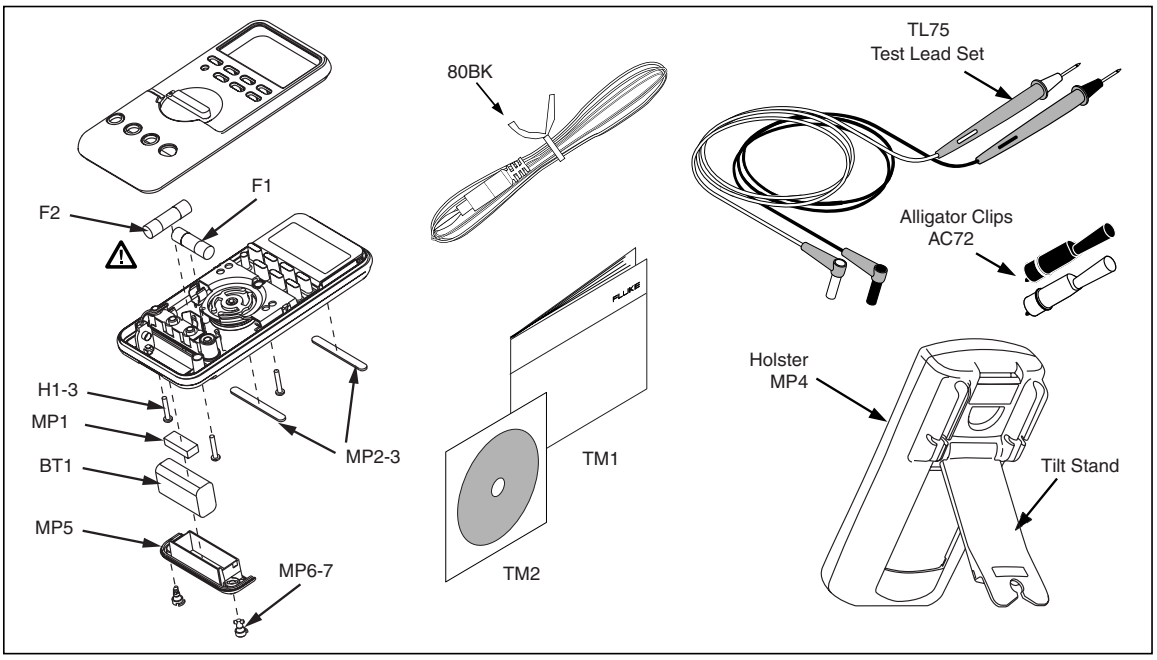


**Figure 4. 87V EX Final Assembly**