

**FLUKE**®

# 28 II Ex

True-rms Digital Multimeter

**Getting Started**

PN 3945752

November 2011

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### **LIMITED WARRANTY AND LIMITATION OF LIABILITY**

This Fluke product will be free from defects in material and workmanship for three years from the date of purchase. This warranty does not cover fuses, disposable batteries, or damage from accident, neglect, misuse, alteration, contamination, or abnormal conditions of operation or handling. Resellers are not authorized to extend any other warranty on Fluke's behalf. To obtain service during the warranty period, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that Service Center with a description of the problem.

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## Introduction

### Warning

**Read “Safety Information” before using the Product.**

The 28 II Ex Digital Multimeter (the Product) is a compact easy to operate measurement tool for electrical and electronic circuits.

This manual contains information on how to turn on the Product, what the controls do, and Product maintenance. Refer to the *28 II Ex Users Manual* on the Product CD for complete user instructions.

The Product is designed for operation in potentially explosive areas of Zone 1, 2, 21, 22, and MI as specified in Directive 1999/92/EC (ATEX 137) and 94/9/EC (ATEX 95). There can be dangerous consequences if you do not follow these instructions.

**Read the entire Users Manual before you use the Product.**

## How to Contact Fluke

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

- Technical Support USA: 1-800-44-FLUKE (1-800-443-5853)
- Calibration/Repair USA: 1-888-99-FLUKE (1-888-993-5853)
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31 402-675-200
- Japan: +81-3-6714-3114
- Singapore: +65-738-5655
- Anywhere in the world: +1-425-446-5500

Or, visit Fluke's website at [www.fluke.com](http://www.fluke.com).

To register your product, visit <http://register.fluke.com>.

To see, print, or download the latest manual supplement, visit <http://us.fluke.com/user/support/manuals>.

## **Safety Information**

The Product complies with:

- ISA-82.02.01
- CAN/CSA-C22.2 No. 61010-1-04
- IEC Standard No. 61010-1:2001
- Measurement Category III, 1000V, Pollution Degree 2
- Measurement Category IV, 600V, Pollution Degree 2
- Industrial use in potentially explosive areas of zone 1, 2, 21, 22, or MI, in accordance with ATEX requirements (ATEX 137) (see the EX safety instructions & regulations section)

In this manual, a **Warning** identifies conditions and actions that can be dangerous to the user. A **Caution** identifies conditions and actions that can cause damage to the Product or the equipment under test.

Symbols used on the Product and in this manual are explained in Table 1.

To ensure safe operation of the Product, obey all instructions and warnings contained in this manual.

## **EX Safety Information**

*Note*

Go to [www.ecom-ex.com](http://www.ecom-ex.com) or [www.fluke.com](http://www.fluke.com) download the EC declaration of conformity and Ex certificate for this product. You can also order them from Fluke.

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

Please read through this manual before you start to use the Product.

If there is a question (because of translation and/or printing errors), refer to the English manual.

**⚠⚠ Warning**

To prevent electric shock or personal injury while in Ex-HAZARDOUS areas, follow these guidelines:

- Do not open the Product while in an Ex-hazardous area.
  - Change the Product's batteries only outside Ex-hazardous areas.
  - Do not take spare batteries into Ex-hazardous areas.
  - Use only type-approved batteries in the Product. See the "How to Replace the Batteries" 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 Product. See the "How to Replace the Fuses" section for a list of approved fuses.
  - Use the Product only when the specified connection values are met.
- After you use the Product on a non-intrinsically safe protected circuit, wait 3 minutes before you take the Product into an Ex-hazardous area.
  - The Product must be completely and securely fitted in the red holster while it is in an Ex-hazardous area.
  - Use only approved accessories with this Product in Ex-hazardous areas.
  - Do not use the Product in aggressive acidic or alkaline solutions.
  - Do not use the Product in zone 0 and 20. Measurements on intrinsically safe connections that go into zone 0 or 20 are permitted if the connection values are met.

**⚠⚠ Warning**

To prevent personal injury in mining hazardous areas:

- Avoid extreme mechanical burdens. The Product can withstand impacts with an energy of seven joules at -20 °C.
- Do not allow the Product to come in permanent contact with oils, hydraulic fluid, or grease.
- Do not install the Product in a fixed installation.

**⚠⚠ Warning**

To prevent possible electrical shock, fire, or personal injury in ALL areas of operation:

- Read all safety Information before you use the Product.
- Comply with local and national safety codes. Use personal protective equipment (approved rubber gloves, face protection, and flame-resistant clothes) to prevent shock and arc blast injury where hazardous live conductors are exposed
- See the “EX Safety Information” section for additional warnings on Product use in hazardous areas.

- Use the Product only as specified, or the protection supplied by the Product can be compromised.
- Do not use the Product in damp or wet environments.
- Do not exceed the Measurement Category (CAT) rating of the lowest rated individual component of a Product, probe, or accessory.
- Examine the case before you use the Product. Look for cracks or missing plastic. Carefully look at the insulation around the terminals.
- Do not use test leads if they are damaged. Examine the test leads for damaged insulation, exposed metal, or if the wear indicator shows. Check test lead continuity.

- Do not work alone.
- Do not touch voltages >30 V ac rms, 42 V ac peak, or 60 V dc.
- Use only correct measurement category (CAT), voltage, and amperage rated probes, test leads, and adapters for the measurement.
- Remove all probes, test leads, and accessories that are not necessary for the measurement.
- Keep fingers behind the finger guards on the probes.
- Limit operation to the specified measurement category, voltage, or amperage ratings.
- Measure a known voltage first to make sure the Product operates correctly.
- Measure for hazardous voltage without the Low-Pass Filter.
- Do not apply more than the rated voltage, between the terminals or between each terminal and earth ground.
- Do not touch the probes to a voltage source when the test leads are connected to the current terminals.
- Connect the common test lead before the live test lead and remove the live test lead before the common test lead.
- Replace the batteries when the low battery indicator shows to prevent incorrect measurements.
- The battery door must be closed and locked before you operate the Product.
- Do not use the Product if it operates incorrectly.
- Do not use and disable the Product if it is damaged.

**⚠ Caution**

**To avoid possible damage to the Product 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 fuses in the Product. (See “Fuse Test”.)**

***Errors and Load Restrictions***

If there is a question that the safety or integrity of this Product is compromised, remove it from operation and the Ex-hazardous areas immediately. Also, do whatever is necessary to prevent Product operation by others until the Product is examined by an ecom certified technician. It is recommended that you send the Product to the manufacturer to be examined.

Because the safety and reliability of the Product can be at risk, do not operate the Product if:

- Visible damage is found in the housing of the Product.
- The Product has had an excessive load put on it for which it is not designed.
- The Product was not stored correctly.
- The Product has sustained damage in transit.
- Illegible inscriptions or lettering shows on the Product.
- A Product malfunction occurs.
- Obvious measurement inaccuracies occur.
- Measurements/simulations are no longer possible with the Product.
- Permitted tolerances or threshold values were exceeded.

**Ex-Certification Data**

- Ex-Type certificate no:
- Ex-Designation:
- Power Supply:
- CE: CE0102
- Operating Temperature: -15 °C to 50 °C
- Storage Temperature: -55 °C to +60 °C
- Batteries: 3 AAA Alkaline batteries, NEDA 24A IEC LR03. Table 7 shows the approved batteries for this Product.

For connections to intrinsically-safe circuits, observe these Product connections:

Voltage – measurement input  $U_i = 65 \text{ V}$ :

$U_0 = 9.54 \text{ V}$       $U_i = 65 \text{ V}$   
 $C_0 = 3.6 \mu\text{F}$       $C_i = \text{negligible}$   
 $I_0 = 3.7 \text{ mA}$       $I_i = \text{negligible}$   
 $L_0 = 1000 \text{ mH}$     $L_i = \text{negligible}$   
 $P_0 = 3.4 \text{ mW}$

Current – measurement input  $I_i = 5 \text{ A}$ :

$U_0 = 0 \text{ V}$       $U_i = 65 \text{ V}$   
 $C_0 = 1000 \mu\text{F}$     $C_i = \text{negligible}$   
 $I_0 = 9.7 \mu\text{A}$       $I_i = 5 \text{ A}$   
 $L_0 = 1000 \text{ mH}$     $L_i = \text{negligible}$   
 $P_0 = 0 \text{ mWH}$


















mA/ $\mu\text{A}$  Jack

$U_0 = 1.94 \text{ V}$       $U_i = 65 \text{ V}$   
 $C_0 = 1000 \mu\text{F}$     $C_i = \text{negligible}$   
 $I_0 = 9.7 \mu\text{A}$       $I_i = \text{Internally limited by a 440 mA fuse}$   
 $L_0 = 1000 \text{ mH}$     $L_i = \text{negligible}$   
 $P_0 = \text{negligible}$

For measurements on protected electric circuits:

- Approved for Zones 2 and 1, device group II, explosion group IIC (explosive gases, vapors and mist), temperature class T4.
- Approved for Zones 21 and 22, device group II, explosion group IIIC, conducting and non-conducting dust, fibers, and flyings.
- Approved for use in mines. Device group I, explosion group I, methane, and coal dust.

Table 1. Symbols

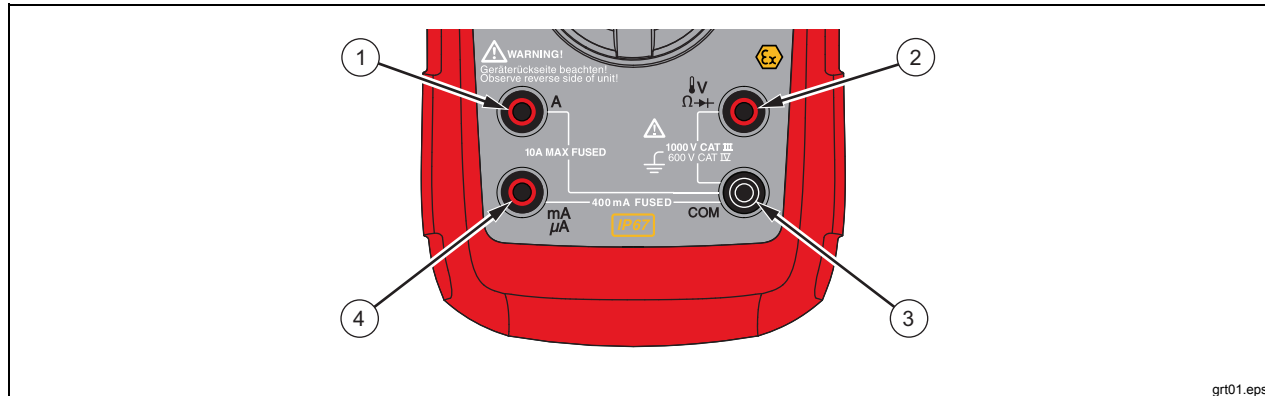
	AC (Alternating Current)		Earth ground
	DC (Direct Current)		Fuse
	Hazardous voltage		Conforms to European Union directives.
	Risk of Danger. Important information. See Manual.		Conforms to relevant Canadian Standards Association directives.
	Battery. Low battery when displayed.		Double insulated
	Continuity test or continuity beeper tone.		Capacitance
CAT III	IEC Overvoltage Category III 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 Overvoltage Category IV CAT IV equipment is designed to protect against transients from the primary supply level, such as an electricity Product or an overhead or underground utility service.
	Conforms to ATEX directive.		Conforms to relevant Australian standards.
	Inspected and licensed by TÜV Product Services.		Conforms to CAN/CSA-C22.2 No. 61010-1 2 <sup>nd</sup> , + Amendment 1.
	Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.		



## Features

Tables 2 through 5 briefly describe the features of the Product.
















**Table 2. Inputs**



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Item	Terminal	Description
①	A	Input for 0 A to 10.00 A current (10 A to 20 A overload for 30 seconds maximum), current frequency, and duty cycle measurements.
②	$\text{V}$ $\Omega$ $\text{diode}$	Input for voltage, continuity, resistance, diode, capacitance, frequency, temperature, and duty cycle measurements.
③	mA μA	Input for 0 μA to 400 mA current measurements (600 mA for 18 hrs) and current frequency and duty cycle.
④	COM	Return terminal for all measurements.

**Table 3. Rotary Switch Positions**

Switch Position	Function
Any Position	When the Product is turned on, the Product model number briefly shows on the display.
	AC voltage measurement Push  (yellow) for low-pass filter (  )
	DC voltage measurement
	600 mV dc voltage range
	Push  (yellow) for temperature (  )
	Push  for continuity test.
	$\Omega$ Resistance measurement
	Push  (yellow) for capacitance measurement.
	Diode test
	AC current measurements from 0 mA to 10.00 A
	Push  (yellow) for dc current measurements, from 0 mA to 10.00 A.
	AC current measurements from 0 $\mu$ A to 6000 $\mu$ A
	Push  (yellow) for dc current measurements from 0 $\mu$ A to 6000 $\mu$ A.

**Table 4. Pushbuttons**











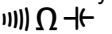







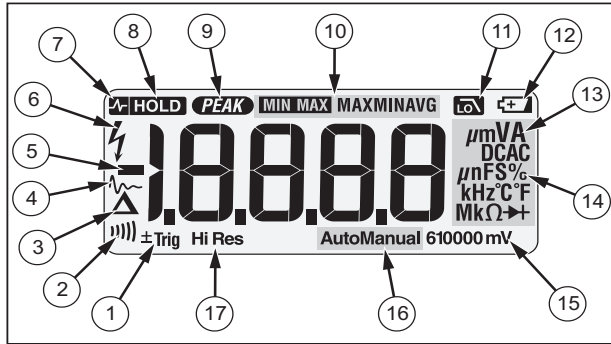
Button	Switch Position	Function
 (Yellow)	    	Set to capacitance Set to temperature Turn on ac low-pass filter Set dc or ac current Set dc or ac current
	Any position 	Change and set the range for the set function. To go to autoranging, hold the button down for 1 second. Sets to °C or °F.
	Any position MIN MAX recording Frequency counter	AutoHOLD (formerly TouchHold) captures the current measurement on the display. When a new, stable measurement is sensed, the Product beeps and shows the new measurement. Stops and starts recording. Does not erase recorded values. Stops and starts the frequency counter.

Table 4. Pushbuttons (cont.)

Button	Switch Position	Function
	Continuity  MIN MAX recording Hz, Duty Cycle	Toggle the continuity beeper on and off.  Switches between Peak (250 μs) and Normal (100 ms) response times.  Toggles the Product to trigger on positive or negative slope.
	Any position	Turns on the button backlight and display backlight, makes them brighter, and turns off the backlights. Hold  down for 1 second to enter the HiRes digit mode. The “HiRes” icon shows in the display. To go back to the 3-1/2 digit mode, hold  down for 1 second. HiRes=19.999.
	Any position	Starts recording of minimum and maximum values. Steps the display through MAX, MIN, AVG (average), and current measurement. Cancels MIN MAX (hold for 1 second)
 (Relative mode)	Any position	Stores the current measurement as a reference for subsequent measurements. The display is zeroed, and the stored measurement is subtracted from all subsequent measurements.
	Any position except diode test	Push  for frequency measurements.  Push again to go to duty cycle mode.



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

Figure 1. Display Features

Table 5. Display Features

Number	Feature	Indication
①	±Trig	Positive or negative slope indicator for Hz/duty cycle triggering.
②	)	The continuity beeper is on.
③	△	Relative (REL) mode is active.
④	~~~~	Smoothing is active.



Number	Feature	Indication
⑤	-	Negative measurement. In relative mode, this sign shows that the input is less than the stored reference.
⑥	⚡	High voltage present at the input. Appears if the input voltage is 30 V or greater (ac or dc). Also shows in low-pass filter mode. Also shows in cal, Hz, and duty cycle modes.
⑦	<b>HOLD</b>	AutoHOLD is active.
⑧	<b>HOLD</b>	Display HOLD is active.
⑨	<b>PEAK</b>	Peak Min Max modes and the response time is 250 µs.
⑩	<b>MIN MAX</b> <b>MAX MIN</b> <b>AVG</b>	Minimum-maximum recording mode.
⑪	<b>Lo</b>	Low-pass filter mode. See “Low-pass Filter”.

Table 5. Display Features (cont.)

Number	Feature	Indication
⑫		Low battery. <b>⚠️⚠️ 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.</b>
⑬	A, $\mu$ A, mA	amperes (amps), microamp, milliamp
	V, mV	volts, millivolts
	$\mu$ F, nF	microfarad, nanofarad
	nS	nanosiemens
	%	Percent. Used for duty cycle measurements.
	$\Omega$ , M $\Omega$ , k $\Omega$	ohm, megohm, kilohm
	Hz, kHz	hertz, kilohertz
		Diode test mode
AC DC	Alternating current, direct current	

Number	Feature	Indication
⑭	$^{\circ}$ C $^{\circ}$ F	Degrees Celsius, Degrees Fahrenheit
⑮	610000 mV	Displays selected range
⑯	Auto	Autorange mode. Automatically selects the range with the best resolution.
	Manual	Manual range mode
⑰	HiRes	High resolution (Hi Res) mode HiRes=19,999

**Table 5. Display Features (cont.)**

Number	Feature	Indication
--		Overload condition is detected.
<b>Error Messages</b>		
bAt t		Replace the battery immediately.
d, Sc		In the capacitance function, too much electrical charge is on the capacitor under test.
Cal Err		Invalid calibration data. Calibrate Product.
EePr Err		Invalid EEPROM data. Have the Product serviced.
OpEn		Open thermocouple detected.
F2-		Invalid model. Have the Product serviced.
LEAd		 Test lead alert. Shows when the test leads are in the <b>A</b> or <b>mA/μA</b> terminal and the selected rotary switch position does not correspond to the terminal being used.

**Automatic Power-Off**

The Product automatically turns off if you do not turn the rotary switch or push a button for 30 minutes. If MIN MAX Recording mode is on, the Product will not turn off. Refer to Table 6 to disable automatic power-off.

**Input Alert™ Feature**

If a test lead is connected to the mA/μA or A terminal, but the rotary switch is not set to the correct current position, the beeper warns you by making a chirping sound and the display flashes “LEAd”. This warning is intended to stop you from attempting to measure voltage, continuity, resistance, capacitance, or diode values with the leads are plugged into a current terminal.













 **Caution**

**To prevent damage, do not put the probes across (in parallel with) a circuit with power with a lead connected to a current terminal. This can cause damage to a circuit with power and blow the Product fuse. This can occur because the resistance through the current terminals of the Product is very low, and causes a short circuit.**

### Power-Up Options

To set a power-up option, push a button down while you energize the Product. Table 6 shows the power-up option.

**Table 6. Power-Up Options**

Button	Power-Up Option
 (Yellow)	Disables automatic power-off feature (Product normally powers off in 30 minutes). The Product reads "PoFF" until  is released.
	Sets the Product in calibration mode and prompts for a password. The Product shows "CAL" in the display and enters calibration mode. See 28 II Ex Calibration Information.
	Turns on the smoothing feature. The Product reads "S--" until  is released.
	Turns on all LCD segments.
	Disables the beeper for all functions. The Product reads "bEEP" until  is released.
	Disables auto backlight off (backlight normally disables after 2 minutes). The Product reads "LoFF" until  is released.
	Sets the Product into the high impedance mode when the mV dc function is used. The Product reads "Hi Z" until  is released.



## **Maintenance**

### **⚠⚠ Warning**

**To prevent electrical shock or personal injury, have the Product repaired by ECOM Instruments GmbH or an ECOM authorized service center to keep Product certification.**

### **General Maintenance**

To clean the external surfaces of the Product, wipe the case with a damp cloth and mild detergent. Do not use abrasives or solvents.

Dirt or moisture in the terminals can cause incorrect measurements and can falsely set off the Input Alert feature. Clean the terminals as follows:

1. Turn the Product off and remove all test leads.
2. Shake out dirt that can be in the terminals.
3. Soak a clean swab with mild detergent and water. Move the swab around in each terminal. Dry each terminal with canned air to push the water and detergent out of the terminals.

It is recommended that the Product be calibrated by Fluke in two-year intervals.

### **Fuse Test**

As shown in Figure 2, with the Product in the  $\Omega$  function, put a test lead into the  $\Omega$  jack and place the probe tip on the other end of the test lead against the metal of the current input jack. If “ $\Omega$  ERd” appears in the display, the probe tip has been inserted too far into the amps input jack. Lift the lead out a bit until the message no longer shows in the display and OL or a resistance measurement shows in the display. The resistance value must be as shown in Figure 2. If the tests give measurements other than those shown, have the Product serviced.

### **⚠⚠ Warning**

**To prevent electric shock or personal injury, remove the test leads and all input signals before you replace the batteries or fuses. To prevent damage or injury, install ONLY specified replacement fuses with the amperage, voltage, and speed ratings shown in Table 8.**

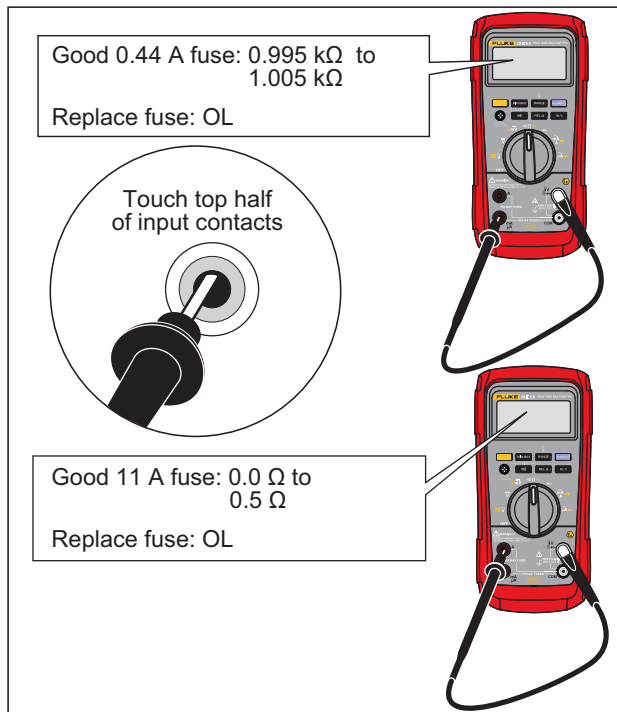


Figure 2. Current Fuse Test

### How to Replace the Batteries

Replace the batteries with three AAA batteries (NEDA 24A IEC LR03).

#### ⚠⚠ Warning

To prevent electrical shock or personal injury:

- Replace the batteries when the low battery indicator (🔋) shows to prevent incorrect measurements. If the display shows “batt” the Product will not function until the batteries are replaced.
- Use only three AAA 1.5-volt batteries, correctly installed to power the Product. See the table on the subsequent page for a list of approved batteries. All cells are to be replaced at the same time with same part number cells in fresh air locations only.

Replace the batteries as follows, refer to Figure 3:

1. Turn the rotary switch to OFF and remove the test leads from the terminals.
2. Remove the six Torx-head screws from the case bottom and remove the battery door (①).

*Note*

*When you lift the battery door, make sure the rubber gasket stays attached to the battery compartment barrier.*

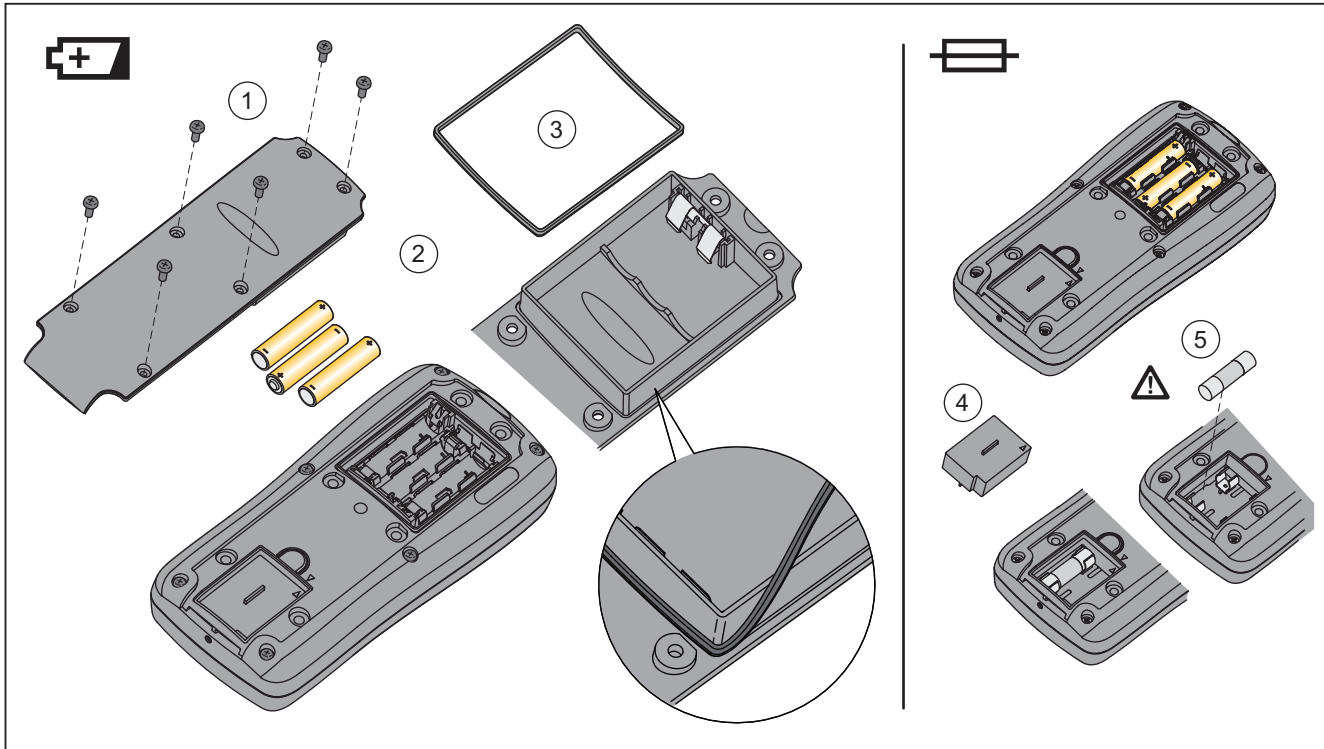
3. Remove the three batteries and replace all three with AAA Alkaline batteries (②).
4. Make sure the battery compartment gasket (③) is properly installed around the outside edge of the battery compartment barrier.
5. Align the battery compartment barrier with battery compartment while you replace the battery door.
6. Attach the door with the six Torx-head screws.

*Note*

*It is recommended the batteries be removed from the Product for long periods of storage.*

**Table 7. Approved Batteries**

<b>Battery Description</b>	<b>Manufacturer</b>
Duracell Procell MN2400 LR03	Duracell
Duracell Plus MN2400 LR03	
Max Tech No. 4703	Varta
Industrial Alkaline No. 4003 <sup>[1]</sup>	
Eveready Energizer No. E92	Eveready
Rayovac Alkaline AAA (U.S. Type)	Rayovac
Panasonic LR03XWA	Panasonic
[1] Minimum operating temperature is -10 °C.	



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Figure 3. Battery and Fuse Replacement

### **How to Replace the Fuses**

Examine or replace the fuses in the Product as follows (See Figure 3):

1. Turn the rotary switch to OFF and remove the test leads from the terminals
2. Refer to step 2 in the “How to Replace the Batteries” section above to remove the battery door.
3. Carefully lift out the fuse assembly (④) from the fuse compartment.
4. Remove the 11 A fuse by carefully prying one end loose, then lift the fuse out of its bracket (⑤).
5. Install ONLY specified replacement fuses with the amperage, voltage, and speed ratings shown in Table 8. The 440-mA fuse is attached to the fuse assembly. You must use a new fuse assembly to replace the 440 mA fuse.
6. Install the fuse assembly into the fuse compartment.
7. Refer to steps four through six in the “How to Replace the Batteries” section above to replace the battery door.


### **Service and Parts**

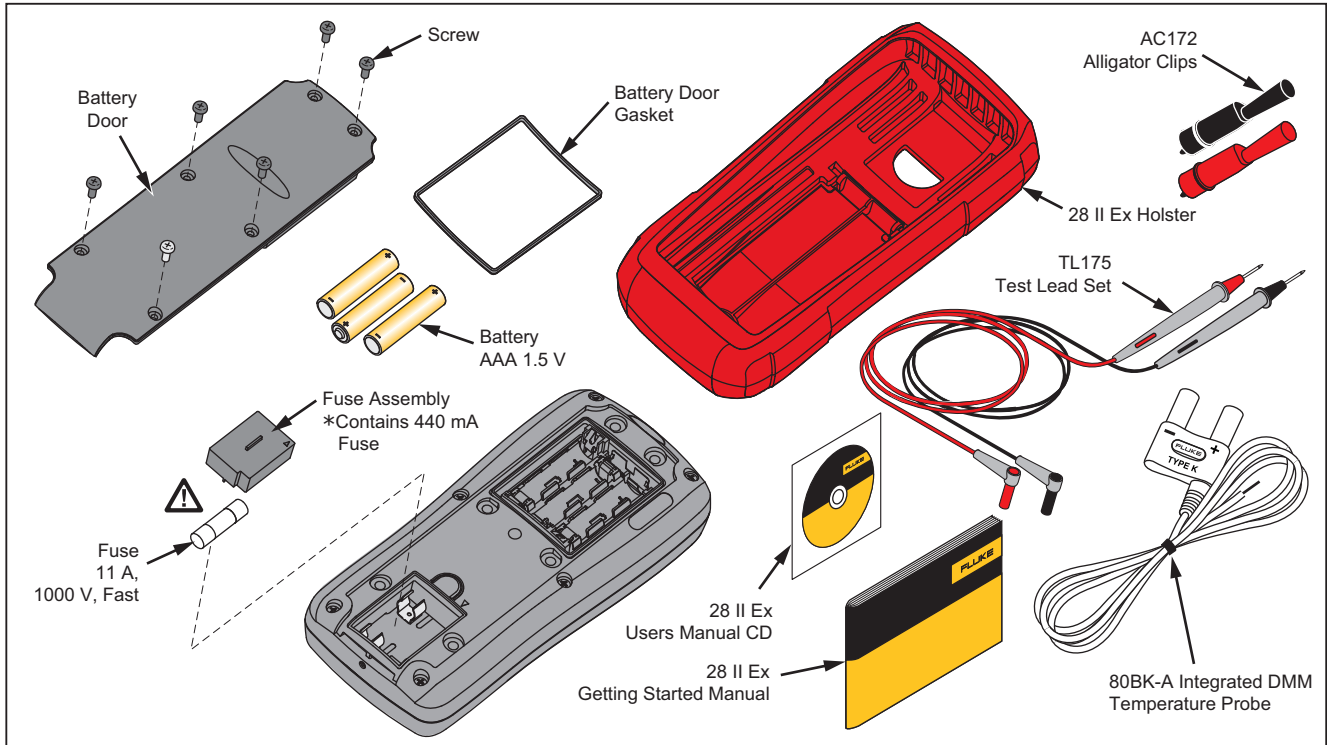
If the Product fails, examine the batteries and fuses. Refer to this manual to make sure the Product is used correctly.

Replacement parts and accessories are shown in Table 8 and Figure 4.

To order parts and accessories, refer to the “How to Contact Fluke” section.

**Table 8. Replacement Parts**

Description	Qty.	Fluke Part or Model Number
Battery, AAA 1.5 V	3	2838018
Fuse, 11 A, 1000 V, FAST	1	803293
Screw	6	3861068
Gasket, Battery Door	1	3439087
28 II Ex Fuse Assembly	1	4016494
28 II Ex Holster	1	4013542
28 II Ex Battery Door Assembly	1	4093984
Alligator Clip, Black	1	AC172
Alligator Clip, Red	1	
Test Lead Set	1	TL175
Integrated DMM Temperature Probe	1	80BK-A
28 II Ex Users Manual CD	1	3945765
28 II Ex Getting Started Manual	1	3945752
 To ensure safety, use exact replacement only.		



**Figure 4. Replacement Parts**

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**Table 9. Accessories**

<b>Item</b>	<b>Description</b>
AC172	Alligator Clips
80BK-A	Bead Temperature Probe
TPAK	ToolPak Magnetic Hanger
TL175	Silicone test lead set with probes
I400	⚠ AC Current Clamp <sup>[1]</sup>
80PK-27	⚠ Temperature Probe <sup>[2]</sup>
<p>All accessories in this table are approved for use in explosive hazardous environments. Fluke accessories are available from an authorized Fluke distributor.</p> <p>[1] ⚠ <b>Warning</b> - To prevent personal injury or property damage, do not use this accessory in hazardous areas where dust is moved, transported, or conveyed.</p> <p>[2] ⚠ <b>Warning</b> - To prevent personal injury or property damage, do not use this accessory in dust hazardous areas.</p>	




**General Specifications**

<b>Maximum voltage between any terminal and earth ground</b> .....	1000 V rms
<b>⚠ Fuse for mA inputs</b> .....	440 mA, 1000 V FAST Fuse
<b>⚠ Fuse for A inputs</b> .....	11 A, 1000 V FAST Fuse
<b>Display</b> .....	6000 counts, updates 4/sec (19,999 counts in high-resolution mode).
<b>Altitude</b>	
Operating .....	2,000 meters
Storage.....	10,000 meters
<b>Temperature</b>	
Operating .....	-15 °C to 50 °C
Storage.....	-55 °C to +85 °C (without battery) -55 °C to +60 °C (with battery)
<b>Temperature coefficient</b> .....	0.05 X (specified accuracy) / °C (<18 °C or >28 °C)

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### Getting Started

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<b>Electromagnetic Compatibility (EN 61326-1:2005)</b> .....	In an RF field of 3 V/M, accuracy = specified accuracy +20 counts, except 600 $\mu$ A dc range total accuracy = specified accuracy +60 counts. Temperature not specified
<b>Relative Humidity</b> .....	0 % to 80 % (0 °C to 35 °C) 0 % to 70 % (35 °C to 50 °C)
<b>Battery Type</b> .....	3 AAA Alkaline batteries, NEDA 24A IEC LR03
<b>Approved Batteries</b> .....	Duracell Procell MN2400 LR03 Duracell Plus MN2400 LR03 Varta Max Tech No. 4703 Varta Industrial Alkaline No. 4003 (min. operating temperature is -10 °C) Eveready Energizer No. E92 Rayovac Alkaline AAA (U.S. Type) Panasonic LR03XWA
<b>Battery Life</b> .....	400 hrs typical without backlight (Alkaline)
<b>Vibration</b> .....	Per MIL-PRF-28800 for a Class 2 instrument
<b>Shock</b> .....	1 Meter drop per IEC 61010 (3 Meter drop with holster)
<b>Size (H x W x L)</b> .....	4.57 cm x 10.0 cm x 21.33 cm (1.80 in x 3.95 in x 8.40 in)
<b>Size with Holster</b> .....	6.35 cm x 10.0 cm x 19.81 cm (2.50 in x 3.95 in x 7.80 in)
<b>Weight</b> .....	567.8 g (1.25 lb)
<b>Weight with Holster and Flex-Stand</b> .....	769.8 g (1.70 lb)
<b>Safety Compliance</b> .....	Complies with ANSI/ISA S82.01-2004, CAN/CSA C22.2 61010-1-04 to 600 V Measurement Category IV. Licensed by TÜV to EN61010-1, Pollution degree 2
<b>Certifications</b> .....	CSA, TÜV, CE,  GOST, ATEX, IECEx
<b>IP Rating</b> .....	67 (Non-operating. Protected against dust and the effect of immersion up to 1 m for 30 min.)

## Detailed Specifications

For all detailed specifications:

Accuracy is specified for 2 years after calibration, at operating temperatures of 18 °C to 28 °C, with relative humidity at 0 % to 80 %.

Accuracy specifications take the form of  $\pm$ ([% of Reading] + [Number of least-significant digits]). In the 4 ½-digit mode, multiply the number of least-significant digits (counts) by 10.

### AC Voltage

AC conversions are ac-coupled and valid from 3 % to 100 % of range.

Range	Resolution	Accuracy					
		45 – 65 Hz	30 – 200 Hz	200 – 440 Hz	440 Hz – 1 kHz	1 – 5 kHz	5 – 20 kHz
600.0 mV	0.1 mV	$\pm(0.7 \% + 4)$		$\pm(1.0 \% + 4)$		$\pm(2 \% + 4)$	$\pm(2 \% + 20)^{[1]}$
6.000 V	0.001 V					$\pm(2 \% + 4)^{[2]}$	Unspecified
60.00 V	0.01 V					Unspecified	Unspecified
600.0 V	0.1 V					Unspecified	Unspecified
1000 V	1 V	$\pm(0.7 \% + 2)$				Unspecified	Unspecified
Low-Pass Filter			$\pm(1.0 \% + 4)^{[1]}$	+1.0 % + 4 -6.0 % - 4 <sup>[3]</sup>	Unspecified	Unspecified	Unspecified
<p>[1] Below 10 % of range, add 12 counts.</p> <p>[2] Frequency range: 1 kHz to 2.5 kHz</p> <p>[3] Specification increases from -1 % to -6 % at 440 Hz when filter is used.</p>							

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**DC Voltage, Conductance, and Resistance**

Function	Range	Resolution	Accuracy
<b>mV dc</b>	600.0 mV	0.1 mV	$\pm(0.1 \% + 1)$
<b>V dc</b>	6.000 V	0.001 V	$\pm(0.05 \% + 1)$
	60.00 V	0.01 V	
	600.0 V	0.1 V	
	1000 V	1 V	
<b><math>\Omega</math></b>	600.0 $\Omega$	0.1 $\Omega$	$\pm(0.2 \% + 2)$ <sup>[2]</sup>
	6.000 k $\Omega$	0.001 k $\Omega$	$\pm(0.2 \% + 1)$
	60.00 k $\Omega$	0.01 k $\Omega$	
	600.0 k $\Omega$	0.1 k $\Omega$	$\pm(0.6 \% + 1)$
	6.000 M $\Omega$	0.001 M $\Omega$	
	50.00 M $\Omega$	0.01 M $\Omega$	
<b>nS</b>	60.00 nS	0.01 nS	$\pm(1.0 \% + 3)$ <sup>[1,3]</sup>
			$\pm(1.0 \% + 10)$ <sup>[1,2,3]</sup>

[1] Add 0.5 % of reading when measuring above 30 M $\Omega$  in the 50 M $\Omega$  range, and 20 counts below 33 nS in the 60 nS range.  
 [2] When using the rel function to compensate for offsets.  
 [3] >40 °C temperature coefficient is 0.1 x (specified accuracy)/°C.


**Temperature**

Range	Resolution	Accuracy <sup>[1,2]</sup>
-200 °C to +1090 °C	0.1 °C	±(1.0 % + 10)
-328 °F to +1994 °F	0.1 °F	±(1.0 % + 18)

[1] Does not include error of the thermocouple probe.  
 [2] Accuracy specification assumes ambient temperature stable to ± 1 °C. For ambient temperature changes of ± 5 °C, rated accuracy applies after 2 hours.

**AC Current**

Function	Range	Resolution	Burden Voltage	Accuracy
				(45 Hz – 2 kHz) <sup>[1]</sup>
<b>µA ac</b>	600.0 µA	0.1 µA	100 µV/µA	±(1.0 % + 2)
	6000 µA	1 µA	100 µV/µA	
<b>mA ac</b>	60.00 mA	0.01 mA	1.8 mV/mA	
	400.0 mA <sup>[2]</sup>	0.1 mA	1.8 mV/mA	
<b>A ac</b>	6.000 A	0.001 A	0.03 V/A	
	10.00 A <sup>[3,4]</sup>	0.01 A	0.03 V/A	


[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 % of range).  
 [2] 400 mA continuous. 600 mA for 18 hr maximum.  
 [3]  10 A continuous up to 35 °C. <20 minutes on, 5 minutes off at 35 °C to 55 °C. >10 A to 20 A for 30 seconds maximum, 5 minutes off.  
 [4] >10 A accuracy unspecified.

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#### DC Current

Function	Range	Resolution	Burden Voltage	Accuracy
<b>μA dc</b>	600.0 μA	0.1 μA	100 μV/μA	±(0.2 % + 4)
	6000 μA	1 μA	100 μV/μA	±(0.2 % + 2)
<b>mA dc</b>	60.00 mA	0.01 mA	1.8 mV/mA	±(0.2 % + 4)
	400.0 mA <sup>[1]</sup>	0.1 mA	1.8 mV/mA	±(0.2 % + 2)
<b>A dc</b>	6.000 A	0.001 A	0.03 V/A	±(0.2 % + 4)
	10.00 A <sup>[2,3]</sup>	0.01 A	0.03 V/A	±(0.2 % + 2)

[1] 400 mA continuous; 600 mA for 18 hr maximum.  
 [2]  10 A continuous up to 35 °C. <20 minutes on, 5 minutes off at 35 °C to 55 °C. >10 A to 20 A for 30 seconds maximum, 5 minutes off.  
 [3] >10 A accuracy unspecified.

#### Capacitance

Range	Resolution	Accuracy
10.00 nF	0.01 nF	±(1.0 % + 2) <sup>[1]</sup>
100.0 nF	0.1 nF	
1.000 μF	0.001 μF	±(1.0 % + 2)
10.00 μF	0.01 μF	
100.0 μF	0.1 μF	
9999 μF	1 μF	

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

**Diode**

Range	Resolution	Accuracy
2.000 V	0.001 V	$\pm(2.0\% + 1)$

**Frequency**

Range	Resolution	Accuracy
199.99 Hz	0.01 Hz	$\pm(0.005\% + 1)$ <sup>[1]</sup>
1999.9 Hz	0.1 Hz	
19.999 kHz	0.001 kHz	
199.99 kHz	0.01 kHz	
>200 kHz	0.1 kHz	Unspecified

[1] From 0.5 Hz to 200 kHz and for pulse widths > 2  $\mu$ s.

**Frequency Counter Sensitivity and Trigger Levels**

Input Range	Minimum Sensitivity (RMS Sine Wave)		Approximate Trigger Level (DC Voltage Function)
	5 Hz – 20 kHz	0.5 Hz – 200 kHz	
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 ( $\leq 140$ kHz)	4 V
600 V	30 V	70 V ( $\leq 14.0$ kHz)	40 V
1000 V	100 V	200 V ( $\leq 1.4$ kHz)	100 V

### Duty Cycle (Vdc and mVdc)

Range	Accuracy
0.0 % to 99.9 % [1]	Within $\pm$ (0.2 % per kHz + 0.1 %) for rise times $< 1 \mu\text{s}$ .
[1] 0.5 Hz to 200 kHz, pulse width $> 2 \mu\text{s}$ . Pulse width range is determined by the frequency by the frequency of the signal.	

### Input Characteristics

Function	Overload Protection	Input Impedance (nominal)	Common Mode Rejection Ratio (1 k $\Omega$ unbalance)		Normal Mode Rejection					
$\bar{\bar{V}}$	1000 V rms	10 M $\Omega$ < 100 pF	> 120 dB at dc, 50 Hz or 60 Hz		> 60 dB at 50 Hz or 60 Hz					
$\bar{\text{mV}}$	1000 V rms		> 120 dB at dc, 50 Hz or 60 Hz		> 60 dB at 50 Hz or 60 Hz					
$\tilde{V}$	1000 V rms	10 M $\Omega$ < 100 pF (ac-coupled)	> 60 dB, dc to 60 Hz							
		Open Circuit Test Voltage	Full Scale Voltage		Typical Short Circuit Current					
			To 6 M $\Omega$	5 M $\Omega$ or 60 nS		600 $\Omega$	6 k $\Omega$	60 k $\Omega$	600 k $\Omega$	6 M $\Omega$
$\Omega$	1000 V rms	< 7.0 V dc	< 1.7 V dc	< 1.9 V dc	500 $\mu\text{A}$	100 $\mu\text{A}$	10 $\mu\text{A}$	1 $\mu\text{A}$	0.4 $\mu\text{A}$	0.2 $\mu\text{A}$
$\rightarrow$	1000 V rms	< 7.0 V dc	2.200 V dc		1.0 mA typical					



**MIN MAX Recording**

<b>Nominal Response</b>	<b>Accuracy</b>
100 ms to 80 % (dc functions)	Specified accuracy $\pm 12$ counts for changes $> 200$ ms in duration
120 ms to 80 % (ac functions)	Specified accuracy $\pm 40$ counts for changes $> 350$ ms and inputs $> 25$ % of range
250 $\mu$ s (peak) <sup>[1]</sup>	Specified accuracy $\pm 100$ counts for changes $> 250$ $\mu$ s in duration (add $\pm 100$ counts for readings over 6000 counts) (add $\pm 100$ counts for readings in Low Pass mode)
[1] For 6 V range: 1 ms	

