FLUKE®

1651B

Electrical Installation Tester

Users Manual

May 2011

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is three years and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries, or to any product which, in Fluke's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available only if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, 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 difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product's specified rating, or normal wear and tear of mechanical components, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, ARISING FROM ANY CAUSE OR THEORY.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
U.S.A.

Fluke Europe B.V.
P.O. Box 1186
5602 BD Eindhoven
The Netherlands

11/99

Table of Contents

Title **Page**

List of Tables

List of Figures

Electrical Installation Tester

Introduction

The Fluke Model 1651B is a battery powered electrical installation tester. All figures show the Model 1653B.

The tester is designed to measure and test the following:

- Voltage and Frequency
- Insulation Resistance (EN61557-2)
- Continuity (EN61557-4)
- Loop/Line Resistance (EN61557-3)
- Residual Current Devices (RCD) Tripping Time (EN61557-6)

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)
- United Kingdom: +44 1603 256600
- Germany, Austria, Switzerland: +49 (0)69 / 2 22 22-0210
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31 402-675-200
- Japan: +81-3-3434-0181
- Singapore: +65-738-5655
- Anywhere in the world: +1-425-446-5500

Or, visit Fluke's website at www.fluke.com.

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

To view, print, or download the latest manual supplement, visit http://us.fluke.com/usen/support/manuals.

Safety

See Table 1 for a list of symbols used on the product and in this manual.

A **Warning** identifies hazardous conditions and actions that could cause bodily harm or death.

A **Caution** identifies conditions and actions that could damage the Imager or cause permanent loss of data.

⚠⚠ Warnings: Read Before Using

To prevent possible electrical shock, fire, or personal injury:

- **Use the product only as specified, or the protection supplied by the product can be compromised.**
- **Do not use the product around explosive gas, vapor or in damp or wet environments.**
- **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.**
- **Use only current probes, test leads, and adapters supplied with the product.**
- **Measure a known voltage first to make sure that the product operates correctly.**
- **Do not use the product if it is damaged.**
- **Have an approved technician repair the product.**
- **Do not apply more than the rated voltage between the terminals or between each terminal and earth ground.**
- **Remove test leads from the tester before the tester case is opened.**
- **Do not operate the product with covers removed or the case open. Hazardous voltage exposure is possible.**
- **Use caution when working with voltages above 30 V ac rms, 42 V ac peak, or 60 V dc.**
- **Use only specified replacement fuses.**
- **Use the correct terminals, function, and range for measurements.**
- **Keep fingers behind the finger guards on the probes.**

- **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.**
- **Use only specified replacement parts.**
- **Do not use the tester in distribution systems with voltages higher than 550 V.**
- **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.**
- **Do not use in CAT III or CAT IV environments without the protective cap installed. The protective cap decreases the possibility of arc flash caused by short circuits.**

Table 1. Symbols

Symbol	Description	Symbol	Description
⎓	Fuse.	⚠	Caution! Risk of Electric Shock.
CE	Conforms to requirements of European Union and European Free Trade Association.	⚠	Important information. See manual.
⧈	Double Insulated (Class II) Equipment	⏚	Earth Ground
⚠>690V	Do not use in distribution systems with voltages higher than 550 V.		
CAT III / CAT IV	CAT III Testers are designed to protect against transients in fixed-equipment installations at the distribution level; CAT IV Testers are designed to protect against transients from the primary supply level (overhead or underground utility service).		

Unpacking the Tester

The tester comes with the items listed in Table 2. If the tester is damaged or an item is missing, contact the place of purchase immediately.

Table 2. Standard Accessories

Description	Part Number
165X-8008 Probe, Multifunctional	2000757
Country Specific Mains Test Cord	See Table 3
Test lead set, 600 V, Fused Probe with alligator clips and prods, set of spare GS38 tips - Red, Blue, Green [Replacement fuse set (3-piece): Fuse F 10 A 600 V, 50 kA, 6.3 x 32 mm for TL165X/UK (PN 3588741)]	2491989
CD ROM, Users Manual	4041694
Quick Reference Guide	4041701
Case, Tool Box, Yellow	1664213
Hard Case Insert, Foam, Polyurethane	2061011
Carrying Strap, Padded	2045406
Fluke Zero Adapter	3301338

Table 3. Country Specific Mains Cords

Mains Cord	Cord Type	Part Number
British	BS1363	2061367
Schuko	CEE 7/7	2061332
Denmark	AFSNIT 107-2-DI	2061371
Australia/New Zealand	AS 3112	2061380
Switzerland	SEV 1011	2061359
Italy	CEI 23-16/VII	2061344

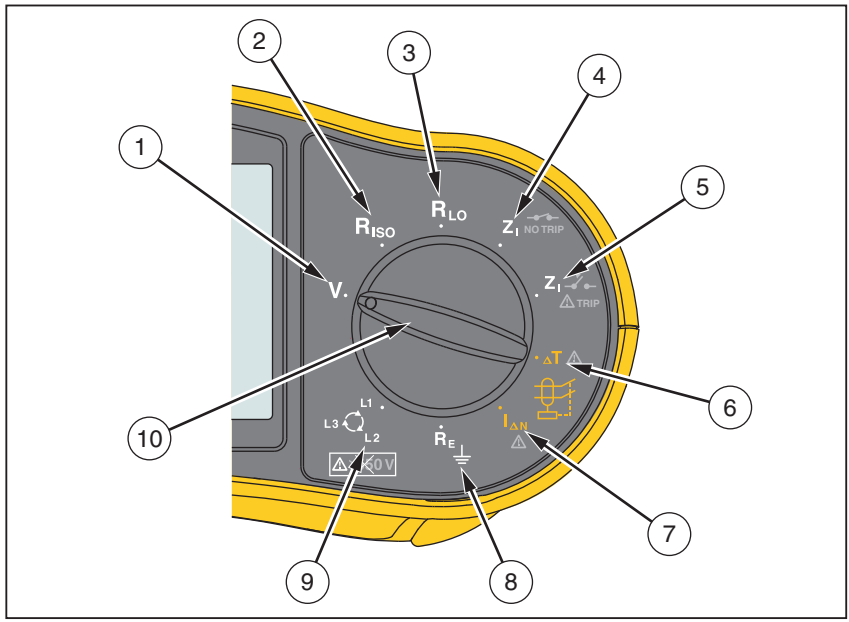
Operating the Tester

Using the Rotary Switch

⚠ Warning

Do not use in CAT III or CAT IV environments without the protective cap installed. The protective cap decreases the exposed probe metal to <4mm. This decreases the possibility of arc flash from short circuits.

Use the rotary switch (Figure 1 and Table 4) to select the type of test you want to perform.



apx013f.eps

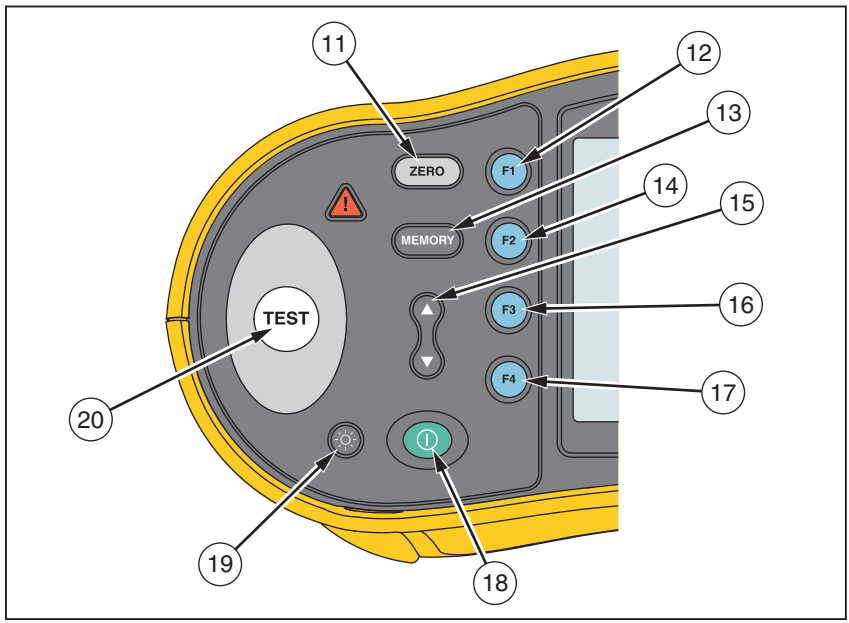
Figure 1. Rotary Switch

Table 4. Rotary Switch

Number	Symbol	Measurement Function
①	V	Volts.
②	R_{ISO}	Insulation resistance.
③	R_{LO}	Continuity.
④	Z_{I} NO TRIP	Loop impedance — No trip mode.
⑤	Z_{I} TRIP	Loop impedance — Hi current trip mode.
⑥	ΔT ⚠	RCD tripping time.
⑦	$I_{\Delta N}$ ⚠	RCD tripping level.
⑧	R_E	Earth resistance.
⑨	↻	Phase rotation.
⑩	N/A	Rotary switch.

Understanding the Pushbuttons

Use the pushbuttons (Figure 2 and Table 5) to control operation of the tester, select test results for viewing, and scroll through selected test results.



apx012f.eps

Figure 2. Pushbuttons

Table 5. Pushbuttons

No.	Button	Description
⑪	ZERO	Zero test lead resistance offset.
⑫	F1	• Loop input select (L-N, L-PE). • Voltage input select (L-N, L-PE, N-PE). • RCD current rating (10, 30, 100, 300, 500, 1000 mA or VAR).
⑬	MEMORY	N/A – 1653B/1654B only.
⑭	F2	• RCD Current multiplier (x1/2, x1, x5).
⑮	▲▼	• Adjust current for VAR function. • Display results if noise is present.
⑯	F3	• Select RCD: Type AC (sinusoidal), Type AC Selective. • Battery test. • Loop RE / IK
⑰	F4	• RCD test polarity (0, 180 degrees). • Insulation test voltage (250, 500, or 1000 V).
⑱	⏻	Turns the tester on and off. The tester will also shut off automatically is there is no activity for 10 minutes.
⑲	☼	Turns the backlight on and off.
⑳	TEST	Starts the selected test. The TEST key is surrounded by a “touch pad”. The touch pad measures the potential between the operator and the tester’s PE terminal. If you exceed a 100 V threshold, the ⚠ symbol above the touch pad is illuminated.

Understanding the Display

Figure 3 and Table 6 describe the display features.

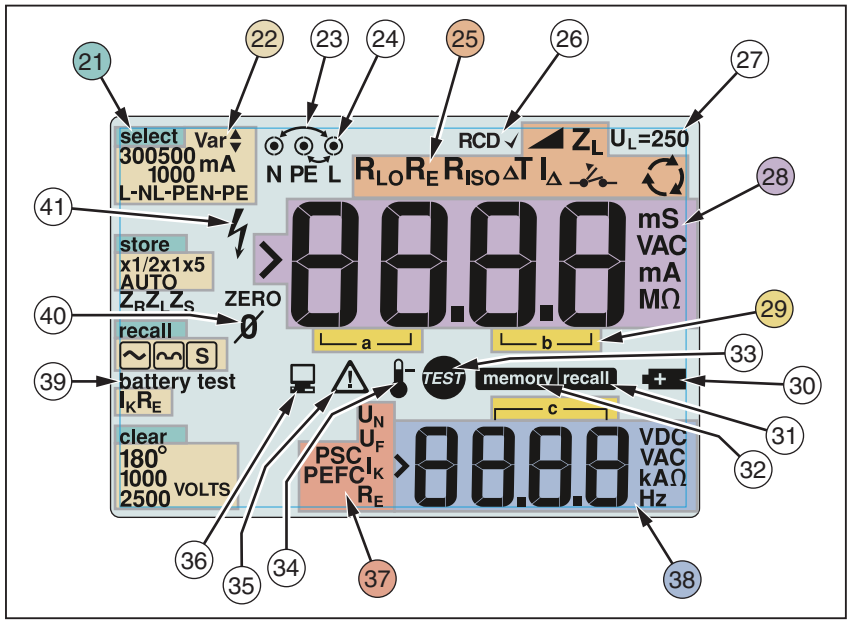


Figure 3. Display Features

Table 6. Display Features

No.	Annunciator	Meaning
(21)	select store recall clear	N/A – 1653B/1654B only.
(22)	Var 300500 mA 1000 L-NL-PEN-PE store Rx1/2x5 AUTO mΩ recall S battery test I_K R_E clear 180° 1000 2500 VOLTS	Configuration options. Settings you can make within the measurement functions. For example, in the RCD Tripping Time function (∆T) you can press (F2) to multiply the test current by x1/2, x1, or x5 and you can press (F3) to select the type of RCD you are testing.
(23)		Arrows above or below the terminal indicator symbol indicate reversed polarity. Check the connection or check the wiring to correct.
(24)	○	Terminal indicator symbol. A terminal indicator symbol with a dot (○) in the center indicates the terminal is used for the selected function. The terminals are: • L (Line) • PE (Protective Earth) • N (Neutral)

Table 6. Display Features (cont.)

No.	Annunciator	Meaning
(25)	R_{LO} R_E R_{ISO} ΔT I_Δ	Indicates the selected rotary switch setting. The measurement value in the primary display also corresponds to the switch setting. Rotary switch settings are: **V** Volts R_{ISO} Insulation R_{LO} Continuity Z_I NO TRIP Loop no trip Z_I ⚠ TRIP Loop hi current trip ΔT ⚠ RCD trip time
(26)	RCD✓	Indicates that the measured trip current (trip current test) or the measured trip time (trip time test) is according to the appropriate RCD standard and the fault voltage is below the selected limit. For more information, see Maximum Trip Time Table on page 44.
(27)	U_L=	Indicates the preset fault voltage limit. The default setting is 50 V. Some locations require the fault voltage be set to 25 V, as specified by local electrical codes. Press (F4) when you turn on the tester to toggle the fault voltage between 25 V and 50 V. The value you set will appear on the display and will be saved when you turn the tester off.
(28)	8.8.8.8 ms VAC mA MΩ mΩ	Primary display and measurement units.

Table 6. Display Features (cont.)

No.	Annunciator	Meaning
(29)	a b c	N/A – 1653B/1654B only.
(30)	+	Low battery icon. See “Testing and Replacing the Batteries” on page 30 for additional information on batteries and power management.
(31)	recall	N/A – 1653B/1654B only.
(32)	memory	N/A – 1653B/1654B only.
(33)	TEST	Appears when you press the Test button. Disappears when the test is completed.
(34)		Appears when the instrument is overheated. The Loop test and RCD functions are inhibited when the instrument is overheated.
(35)	⚠	Appears when an error occurs. Testing is disabled. See “Error Codes” on page 15 for a listing and explanation of possible error codes.
(36)		N/A – 1653B/1654B only.

Table 6. Display Features (cont.)

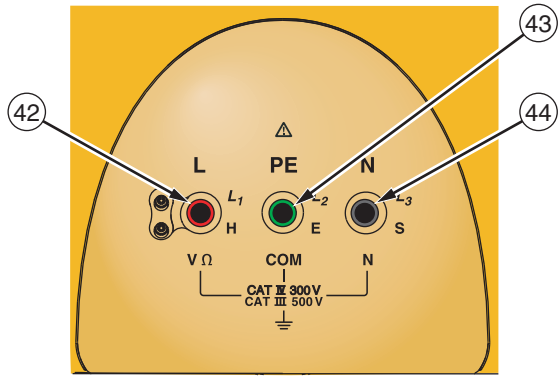
No.	Annunciator	Meaning
(37)	U_N U_F PSC I_K PEFC R_E	Name of the secondary measurement function. U_N Test voltage for insulation test. U_F Fault voltage. Measures neutral to earth. PSC Prospective Short Circuit. Calculated from measured voltage and impedance when reading line to neutral. PEFC Prospective Earth Fault Current. Calculated from voltage and loop impedance which is measured line to protective earth. I_K In combination with the PSC or PEFC symbol, indicates a short circuit current. R_E Earth resistance.

Table 6. Display Features (cont.)

No.	Annunciator	Meaning
(38)		Secondary display and measurement units. Some tests will return more than one result or return a computed value based on the test result. This will occur with: • Volts • Secondary display shows line frequency. • Insulation tests • Secondary display shows actual test voltage. • Loop/line impedance • Secondary display shows PEFC (Prospective Earth Fault Current) or R_E PSC (Prospective Short Circuit Current). • RCD switching time • Secondary display shows U_F fault voltage.
	battery test	Appears when you are testing the batteries. For more information see “Testing and Replacing the Batteries” on page 30.
(40)	ZERO 	Appears when you press the ZERO button to zero the leads. After the zeroing operation, the icon stays illuminated indicating that zeroing has been performed. Only used when performing continuity or loop testing.
(41)		Potential danger. Appears when measuring or sourcing high voltages.

Input Terminals

Figure 4 shows the input terminals.



Item	Description
(42)	L (Line)
(43)	PE (Protective Earth)
(44)	N (Neutral)

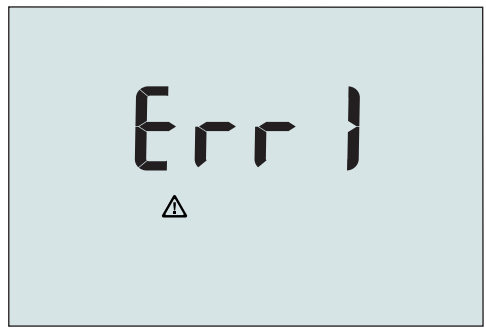
Figure 4. Input Terminals

Error Codes

Various error conditions are detected by the tester and are indicated with the ⚠ icon, “Err”, and an error number on the primary display. See Table 7. These error conditions disable testing and, if necessary, stop a running test.

Table 7. Error Codes

Error Condition	Code	Solution
Self-Test Fails	1	Return the tester to a Fluke Service Center.
Over-Temp	2	Wait while the tester cools down.
Fault Voltage	4	Check the installation, in particular, the voltage between N and PE.
Excessive Noise	5	Switch off all appliances (Loop, RCD measurements) and move the earth stakes (earth measurement).



apx032f.eps

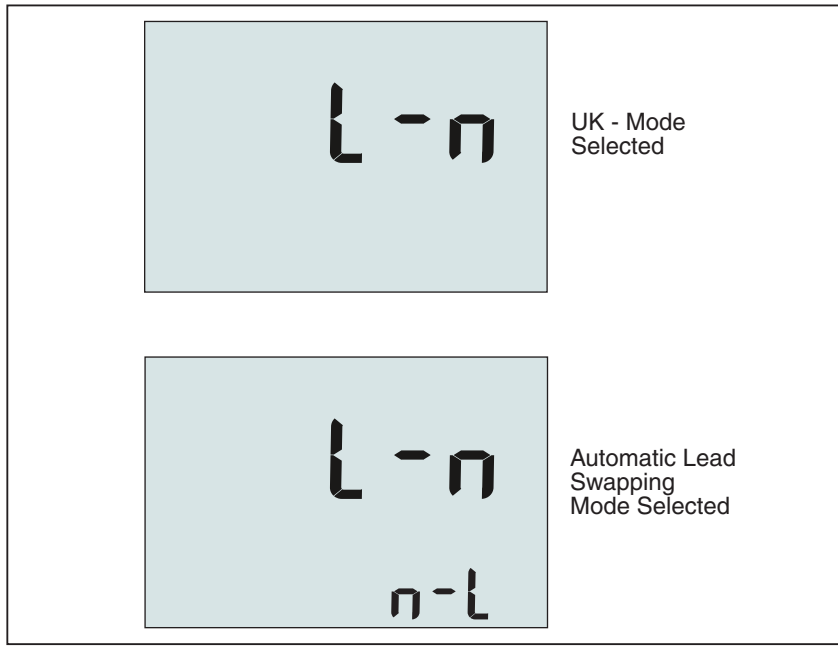
Figure 5. Error Display

Power-On Options

To select a power-on option, press ⓘ and the function key simultaneously and then release the ⓘ button. Power-on options are retained when the tester is turned OFF. See Table 8.

Table 8. Power-On Options

Keys	Power-On Options
ⓘ F2	Loop/Line Impedance I_K limit. Toggles the I_K limit between 10 kA and 50 kA. The default is 10 kA.
ⓘ F3	Line and Neutral Swap mode. Two modes of operation are available. You can configure the tester to operate in L-n mode or L-n n-L mode, see Figure 6. • In L-n mode, the L and N phase conductors must NEVER be reversed. This is a requirement in some regions including the UK. The ⦿○⦿ icon appears on the display indicating that the system L and N conductors are swapped and testing is inhibited. Investigate and rectify the cause of this system fault before proceeding. L-n mode also changes the RCD x1/2 trip time duration to 2 seconds as required in the UK. • In L-n n-L mode, the unit allows the L and N phase conductors to be swapped and testing will continue. *Note* *In locations where polarized plugs and outlets are used, a swapped lead icon (⦿○⦿) may indicate that the outlet was wired incorrectly. Correct this problem before proceeding with any testing.*
ⓘ F4	Fault voltage limit. Toggles the fault voltage between 25 V and 50 V. The default is 50 V.
ⓘ MEMORY	View the tester serial number. Primary display shows the initial four digits and the secondary display shows the next four digits.
ⓘ ☼	Continuity beeper toggle. Toggles the continuity beeper on and off. The default is on.

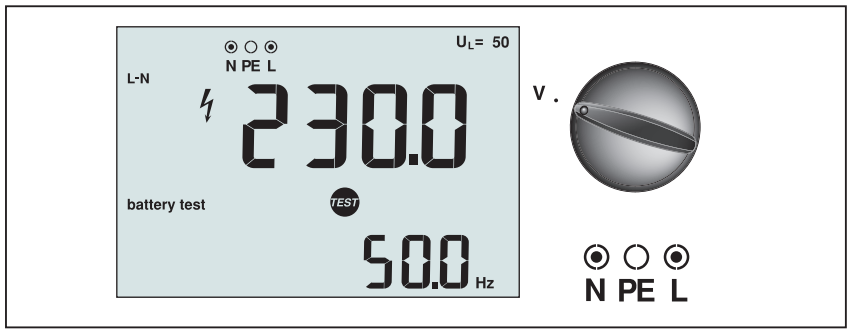


apx026f.eps

Figure 6. Lead Swapping Modes

Making Measurements

Measuring Volts and Frequency



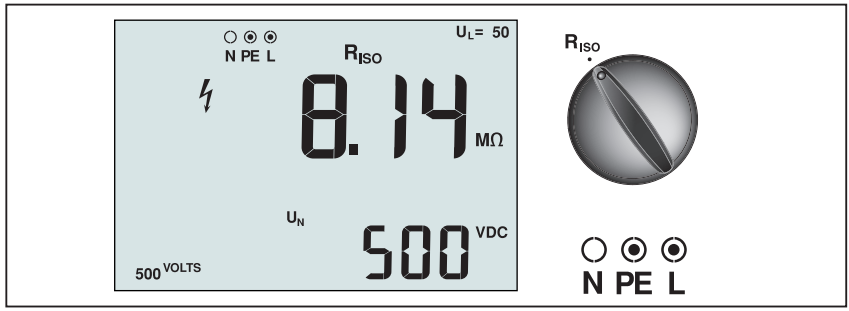
apx002f.eps

Figure 7. Volts Display/Switch and Terminal Settings

To measure voltage and frequency:

1. Turn the rotary switch to the V position.
2. Use all (red, blue, and green) terminals for this test. You can use test leads or mains cord when measuring AC voltage.
   - The primary (upper) display shows the AC voltage. The tester reads AC voltage to 500 V. Press F1 to toggle the voltage reading between L-PE, L-N, and N-PE.
   - The secondary (lower) display shows mains frequency.

Measuring Insulation Resistance



apx005f.eps

Figure 8. Insulation Resistance Display/Switch and Terminal Settings

⚠⚠ Warning

To avoid electric shock, measurements should only be performed on de-energized circuits.

To measure insulation resistance:

1. Turn the rotary switch to the R_{ISO} position.
2. Use the L and PE (red and green) terminals for this test.
3. Use the (F4) to select the test voltage. Most insulation testing is performed at 500 V, but observe local test requirements.
4. Press and hold (TEST) until the reading settles and the tester beeps.

Note

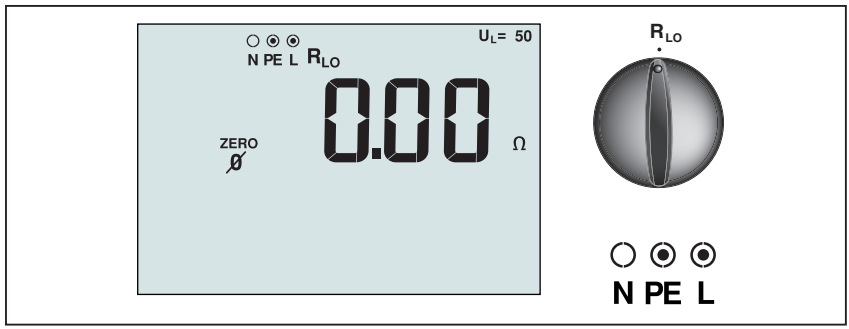
Testing is inhibited if voltage is detected in the line.

- The primary (upper) display shows the insulation resistance.
- The secondary (lower) display shows the actual test voltage.

Note

For normal insulation with high resistance, the actual test voltage (U_N) *should always be equal to or higher than the programmed voltage. If insulation resistance is bad, the test voltage is automatically reduced to limit the test current to safe ranges.*

Measuring Continuity



apx003f.eps

Figure 9. Continuity Zero Display/Switch and Terminal Settings

A continuity test is used to verify the integrity of connections by making a high resolution resistance measurement. This is especially important for checking Protective Earth connections.

Note

In countries where electrical circuits are laid out in a ring, it is recommended that you make an end-to-end check of the ring at the electrical panel.

⚠⚠ Warning

- **Measurements should only be performed on de-energized circuits.**
- **Measurements may be adversely affected by impedances or parallel circuits or transient currents.**

To measure continuity:

1. Turn the rotary switch to the R_{LO} position.
2. Use the L and PE (red and green) terminals for this test.
3. Before making a continuity test, use the Zero adapter to zero the test leads. Press and hold (ZERO) until the ZERO annunciator appears. The tester measures probe resistance, stores the reading in memory, and subtracts it from readings. The resistance value is saved even when power is turned off so you don't need to repeat the operation every time you use the instrument.

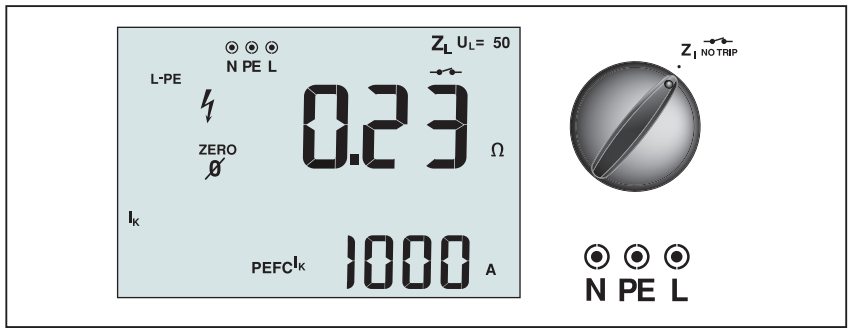
Note

Be sure the batteries are in good charge condition before you zero the test leads.

4. Press and hold (TEST) until the reading settles. If the continuity beeper is enabled, the tester beeps continuously for measured values less than 2 Ω and there is no stable reading beep for measured values greater than 2 Ω.

   If a circuit is live, the test is inhibited and the AC voltage appears in the secondary (lower) display.

Measuring Loop/Line Impedance



apx006f.eps

Figure 10. Loop/Line Impedance/Switch and Terminal Settings

Loop Impedance (Line to Protective Earth L-PE)

Loop impedance is source impedance measured between Line (L) and Protective Earth (PE). You can also ascertain the Prospective Earth Fault Current (PEFC) that is the current that could potentially flow if the phase conductor is shorted to the protective earth conductor. The tester calculates the PEFC by dividing the measured mains voltage by the loop impedance. The loop impedance function applies a test current that flows to earth. If RCDs are present in the circuit, they may trip. To avoid tripping, always use the Z_I No Trip function on the rotary switch. The no trip test applies a special test that prevents RCDs in the system from tripping. If you are certain no RCDs are in the circuit, you can use the Z_I Hi Current function for a faster test.

Note

If the L and N terminals are reversed, the tester will auto-swap them internally and continue testing. If the tester is configured for UK operation, testing will halt. This condition is indicated by arrows above or below the terminal indicator symbol (◉○◉).

To measure loop impedance no trip mode:

⚠⚠ Warning

To prevent tripping RCDs in the circuit:

- **Always use the Z_s NO TRIP position for loop measurements.**
- **Preload conditions can cause the RCD to trip.**
- **An RCD with a nominal fault current of 10 mA will trip.**

Note

To do a Loop impedance test in a circuit with a 10 mA RCD, we recommend a trip time RCD test. Use a nominal test current of 10 mA and the factor x ½ for this test.

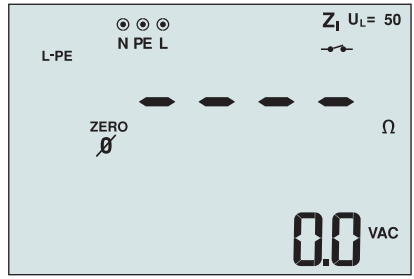
If the fault voltage is below 25 V or 50 V, dependent on the local requirement, the loop is good. To calculate the loop impedance, divide the fault voltage by 10 mA (Loop impedance = fault voltage x 100).

1. Turn the rotary switch to the Z_s NO TRIP position.
2. Connect all three leads to the L, PE, and N (red, green, and blue) terminals of the tester.
3. Press (F1) to select L-PE. The display shows the Z_L and ⊸● indicator.
4. Before you do a loop impedance test, use the zero adapter to zero the test leads or the mains cord. Press and hold (ZERO) for more than two seconds until the ZERO annunciator appears. The tester measures the lead resistance, stores the reading in memory, and subtracts it from readings. The resistance value is saved even when the power is turned off so it is unnecessary to repeat the operation each time you use the tester with the same test leads or mains cord.

Note

Be sure the batteries are in good charge condition before you zero the test leads.

5. Connect all three leads to the L, PE, and N of the system under test or plug the mains cord into the socket under test.



apx033f.eps

Figure 11. Display After Zeroing

6. Press and release (TEST). Wait for the test to complete.

   The primary (upper) display shows the loop impedance.

7. To read the Prospective Earth Fault Current, press the (F3) key and select I_K. The Prospective Earth Fault Current appears in amps or kilo amps in the secondary (lower) display.

8. If the mains is too noisy, Err 5 will be displayed. (The measured value accuracy is degraded by the noise.) Press the down arrow to display the measured value. Press the up arrow to return to the Err 5 display.

This test will take several seconds to complete. If the mains is disconnected while the test is active, the test automatically terminates.

Note

Errors may occur due to preloading the circuit under test.

To measure loop impedance—Hi current trip mode:

If no RCDs are present in the system under test, you can use the high current Line Earth (L-PE) loop impedance test.

1. Turn the rotary switch to the Z_I / ΔTRIP position.
2. Connect all three leads to the L, PE, and N (red, green, and blue) terminals of the tester.
3. Press (F1) to select L-PE. The hi current trip symbol appears to indicate that hi current trip mode is selected.
4. Repeat Steps 4 through 8 from the preceding test.

⚠⚠ Warning

The symbol on the LCD indicates the high current loop mode - any RCDs in the system will trip - ensure there are no RCDs present.

Earth Resistance Testing by Loop Method

You can also use the tester to measure the earth resistance component of the total loop resistance. Check your local regulations to determine if this method is acceptable in your area. You can use three leads or the mains cord to perform this test. Use the connection shown in Figure 12 when making a 3-wire connection for earth resistance loop test. Zero the test leads (see sequence for Loop Impedance measurement).

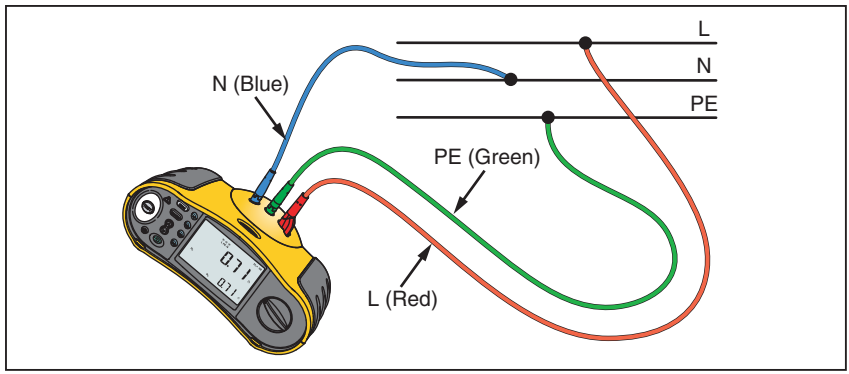


Figure 12. 3-Wire Connection for Earth Resistance Loop Test

To measure earth resistance using the loop test no trip mode:

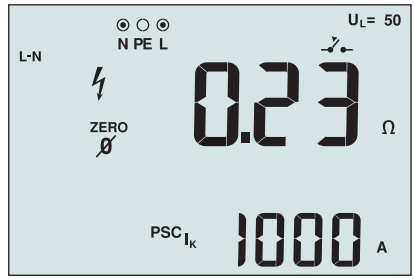
1. Turn the rotary switch to the Z_s NO TRIP position.
2. Press (F1) to select L-PE.
3. Press (F3) to select R_E (resistance).
4. Press and release (TEST). Wait for the test to complete.
   - The primary (upper) display shows the loop impedance.
   - The secondary (lower) display shows the earth resistance.

Line Impedance

Line impedance is source impedance measured between Line conductors or Line and Neutral. This function allows the following tests:

- Line to Neutral loop impedance.
- Line to Line impedance in 3-phase systems.
- L-PE loop measurement. This is a way of making a high current, 2-wire loop measurement. It cannot be used on circuits protected by RCDs because it will cause them to trip.
- Prospective Short Circuit Current (PSC). PSC is the current that can potentially flow if the phase conductor is shorted to the neutral conductor or

another phase conductor. The tester calculates the PSC current by dividing the measured mains voltage by the line impedance.



apx034f.eps

Figure 13. Line Impedance Display

To measure line impedance:

1. Turn the rotary switch to the Z_L / ΔTRIP position. The LCD indicates that the high current loop mode is selected by displaying the symbol.
2. Connect the red lead to the L (red) and the blue lead to the N (blue) terminals of the tester.
3. Press (F1) to select L-N.
4. Use the zero adapter to zero the test leads or the mains cord.
5. Press and hold (ZERO) for more than two seconds until the ZERO annunciator appears.

   The tester measures the lead resistance, stores the reading in memory, and subtracts it from readings. The resistance value is saved even when the power is turned off so it is unnecessary to repeat the operation each time you use the tester with the same test leads or mains cord.

Note

Be sure the batteries are in good charge condition before you zero the test leads.

⚠⚠ Warning

At this step, be careful not to select L-PE because a high current loop test will take place. Any RCDs in the system will trip if you proceed.

Note

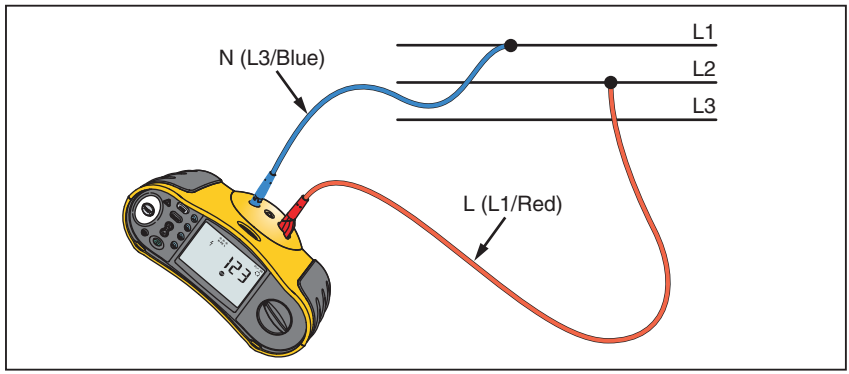
Connect the leads in a single-phase test to the system live and neutral. To measure line-to-line impedance in a 3-phase system, connect the leads to 2 phases.

6. Press and release (TEST). Wait for the test to complete.

- The primary (upper) display shows the line impedance.
- The secondary (lower) display shows the Prospective Short Circuit Current (PSC).

7. If the mains is too noisy, Err 5 will be displayed. (The measured value accuracy is degraded by the noise). Press the down arrow to display the measured value. Press the up arrow to return to the Err 5 display.

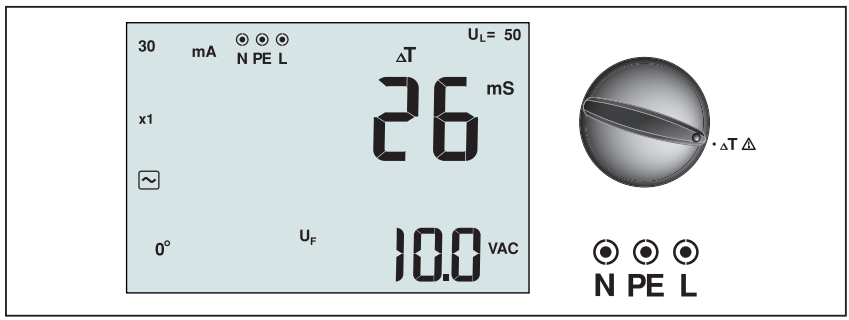
Use the connection shown in Figure 14 when measuring in a 3-phase 500 V system.



apx025f.eps

Figure 14. Measuring in a 3-Phase System

Measuring RCD Tripping Time



apx008f.eps

Figure 15. RCD Tripping Time Display/Switch and Terminal Settings

In this test, a calibrated fault current is induced into the circuit, causing the RCD to trip. The meter measures and displays the time required for the RCD to trip. You can perform this test with test leads or using the mains cord. The test is performed with a live circuit.

If the RCD has a special nominal current setting other than the standard options, 10, 30, 100, 300, 500 1000 mA, you can use a custom setting with the VAR mode.

Note

When measuring trip time for any type of RCD, the tester first does a pretest to determine if the actual test will cause a fault voltage exceeding the limit (25 or 50 V).

To avoid having an inaccurate trip time for S type (time delay) RCDs, a 30 second delay is activated between the pretest and the actual test. This RCD type needs a delay because it contains RC circuits that are required to settle before applying the full test.

⚠⚠ Warning

- **Test the connection between the N-conductor and earth before starting the test. A voltage between the N-conductor and earth may influence the test.**
- **Leakage currents in the circuit following the residual current protection device may influence measurements.**
- **The displayed fault voltage relates to the rated residual current of the RCD.**
- **Potential fields of other earthing installations may influence the measurement.**
- **Equipment (motors, capacitors) connected downstream of the RCD may cause considerable extension of the tripping time.**

Note

If the L and N terminals are reversed, the tester will auto-swap them internally and continue testing. If the tester is configured for UK operation, testing will halt and you will need to determine why the L and N are swapped. This condition is indicated by arrows above or below the terminal indicator symbol (⦿○⦿).

To measure RCD tripping time:

1. Turn the rotary switch to the ΔT position.
2. Press F1 to select the RCD current rating (10, 30, 100, 300, 500, or 1000 mA).
3. Press F2 to select a test current multiplier (x ½, x 1,or x 5). Normally you will use x 1 for this test.
4. Press F3 to select the RCD test-current waveform:
   - ~ – AC current to test type AC (standard AC RCD) and type A (pulse-DC sensitive RCD)
   - ~ S – Delayed response to test S-type AC (time delayed AC RCD)
5. Press F4 to select the test current phase, 0° or 180°. RCDs should be tested with both phase settings, as their response time can vary significantly depending on the phase.
6. Press and release TEST. Wait for the test to complete.
   - The primary (upper) display shows the trip time.
   - The secondary (lower) display shows the fault voltage (N to PE) related to the rated residual current.
   - If the trip time is according to the appropriate standard of the RCD, the RCD ✓ indicator displays. For more information, see Maximum Trip Time Table on page 44.

To measure RCD tripping time for a custom RCD setting – VAR mode:

1. Turn the rotary switch to the ΔT position.
2. Press F1 to select the VAR current rating. The current custom setting shows on the primary display. Use the ⇕ arrow keys to adjust the value.
3. Press F2 to select a test current multiplier. Normally you will use x 1/2 or x 1 for this test.
4. Repeat steps 4 through 6 listed in the preceding RCD tripping time procedure.
5. To view the nominal setting used for the test, depress the ⇕ arrow key.

RCD Testing in IT Systems

RCD testing at locations with IT systems requires a special test procedure because the Protective Earth connection is grounded locally and is not tied directly to the power system.

The test is conducted at the electrical panel using probes. Use the connection shown in Figure 16 when performing RCD testing on IT electrical systems.

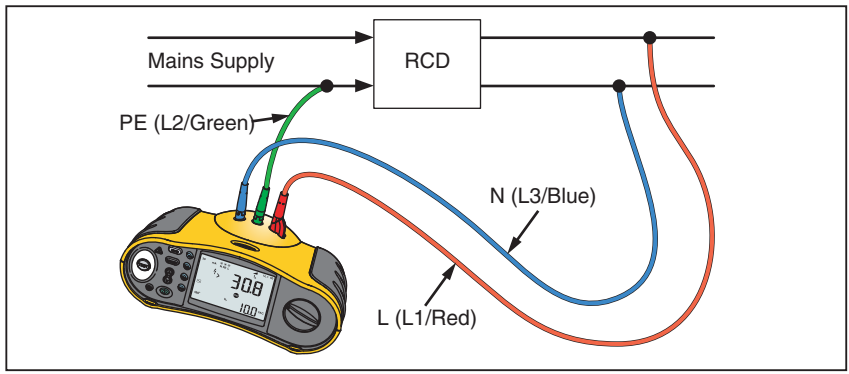


Figure 16. Connection for RCD Testing on IT Electrical Systems

The test current flows through the upper side of the RCD, into the L terminal, and returns though the PE terminal.

Maintaining the Tester

Cleaning

Periodically wipe the case with a damp cloth and mild detergent. Do not use abrasives or solvents.

Dirt or moisture in the terminals can affect readings.

To clean the terminals:

1. Turn the meter off and remove all test leads.
2. Shake out any dirt that may be in the terminals.
3. Soak a new swab with alcohol. Work the swab around each terminal.

Testing and Replacing the Batteries

Battery voltage is continuously monitored by the tester. If the voltage falls below 6.0 V (1.0 V/cell), the low battery icon appears on the display, indicating that there is minimal battery life left. The low battery icon continues to appear on the display until you replace the batteries.

⚠⚠ Warning

To avoid false readings, which could lead to possible electric shock or personal injury, replace the batteries as soon as the battery icon ( ) appears.

Be sure that the battery polarity is correct. A reversed battery can cause leakage.

Replace the batteries with six AA batteries. Alkaline batteries are supplied with the tester but you can also use 1.2 V NiCd or NiMH batteries. You can also check the battery charge so that you can replace them before they discharge.

⚠⚠ Warning

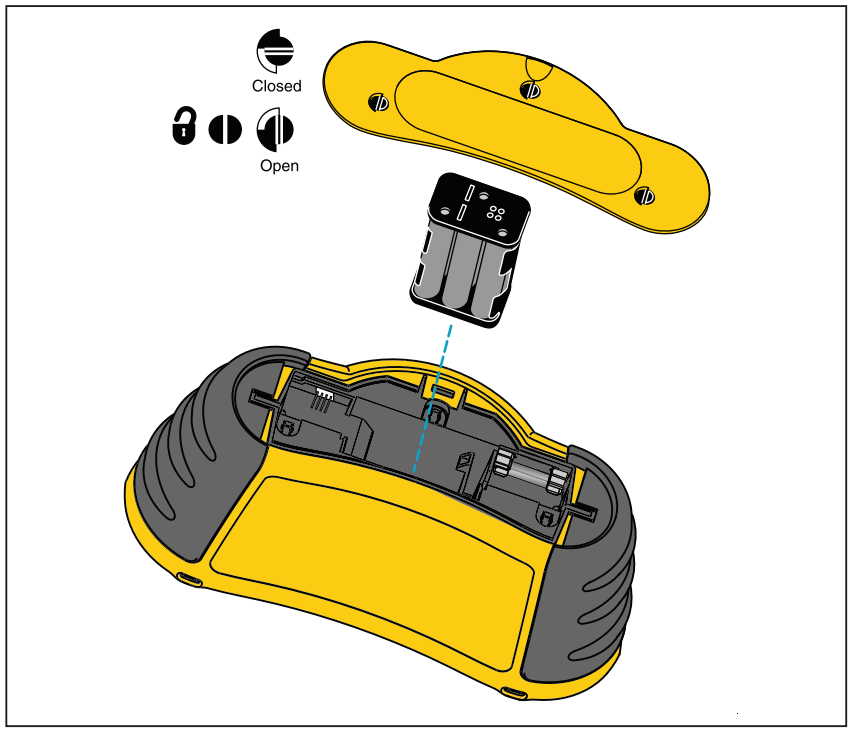
To avoid electrical shock or personal injury, remove the test leads and any input signals before replacing the battery. To prevent damage or injury, install ONLY specified replacement fuses with the amperage, voltage, and speed ratings shown in the General Specifications section of this manual.

To test the batteries:

1. Turn the rotary switch to the V position.
2. Press F3 to initiate the battery test. The Voltage function display clears and is replaced by the measured battery voltage in the secondary display for 2 seconds, the Voltage function display then returns.

To replace the batteries (refer to Figure 17):

1. Press ⏻ to turn the tester off.
2. Remove the test leads from the terminals.
3. Remove the battery door by using a standard-blade screwdriver to turn the battery door screws (3) one-quarter turn counterclockwise.
4. Press the release latch and slide the battery holder out of the tester.
5. Replace the batteries and the battery door.
6. Secure the door by turning the screws one-quarter turn clockwise.



apx028f.eps

Figure 17. Replacing the Batteries

Testing the Fuse

A fuse test is performed each time you turn on the tester. If leads are plugged into the L and PE terminals, the fuse test is skipped. If a blown fuse is detected, testing is disabled, FUSE appears on the primary display, and the tester issues a warning beep.

You can also perform a manual check of the fuse.

To manually check the fuse:

1. Turn the rotary switch to either R_{ISO} or R_{LO} switch setting.
2. Short the leads and press and hold TEST.
3. If the fuse is bad, FUSE will appear on the display to indicate the tester is damaged and needs repair. Contact Fluke Service for repair (see *Contacting Fluke*).

Specifications

Features

Measurement Function

- Voltage & Frequency
- Wiring polarity checker
- Insulation Resistance
- Continuity & Resistance
- Loop & Line Resistance
- Prospective Earth Fault Current (PEFC/I_K) / Prospective Short-Circuit current (PSC/I_K)
- RCD switching time
- RCD variable current

Other Features

- Self-test
- Illuminated Display

Included Accessories

- Hard case
- Remote control probe
- Zero Adapter

General Specifications

Specification	Characteristic
Size	10 cm (L) x 25 cm (W) x 12.5 cm (H)
Weight (with batteries)	1.3 kg
Battery size, quantity	Type AA, 6 ea.
Battery type	Alkaline supplied. Usable with 1.2 V NiCd or NiMH batteries (not supplied)
Battery life (typical)	200 hours idling
Fuse	T3.15 A, 500 V, 1.5 kA 6.3 x 32 mm (PN 2030852)
Operating Temperature	-10 °C to 40 °C
Storage Temperature	-10 °C to 60 °C indefinitely (to -40 °C for 100 hrs)
Relative Humidity	80 % 10 to 35 °C; 70 % 35 to 40 °C
Operating Altitude	0 to 2000 meters
Shock, Vibration	Vibration to Class 3 per Mil-Prf-28800F 1 meter drop test, six sides, oak floor
Sealing	IP 40
EMC	Complies with EN61326-1: 2006
Safety	Complies with EN61010-1 Ed 2.0 (2001-02), UL61010, ANSI/ISA –s82.02.01 2000 and CAN/CSA c22.2 No.1010 2nd edition Overvoltage Category: 500 V/CAT III 300 V/CAT IV Complies with EN/IEC 61010-031:2002+A1:2008 Measurement Category III is for measurements performed in the building installation. Examples are distribution panels, circuit breakers, wiring and cabling. Category IV equipment is designed to protect against transients from the primary supply level, such as an electrical meter or an overhead or underground utility service. Performance EN61557-1, EN61557-2, EN61557-3, EN61557-4, EN61557-5, EN61557-6, EN61557-7 Second edition. EN61557-10 First edition.
Pollution Degree	2
Maximum voltage between any terminal and earth ground	500 V
Surge Protection	6 kV peak per EN 61010-1 Ed. 2.0 (2001-02)

Category Ratings and Usage

Part/Accessory	Printed CAT Rating	CAT II 250 V	CAT III 500 V	CAT IV 300 V
165XB Electrical Installation Tester	CAT III 500 V CAT IV 300 V	√ √	√ √	√ √
Country-Specific Mains Cord	CAT II 250 V	√		
Multifunction Probe (red)	CAT III 1000 V	√	√	√
Test Lead (red/green/blue)	CAT III 1000 V	√	√	√
Test Probe (red/green/blue)	CAT III 1000 V	√	√	√
Alligator Clip (red/green/blue)	CAT III 1000 V	√	√	√
UK Test Leads and Probes: Non-fused (red/green/blue) Fused (red/green/blue)	 CAT III 1000 V CAT III 600 V	 √ √	 √ √	 √ √

Electrical Measurement Specifications

The accuracy specification is defined as ±(% reading +digit counts) at 23 °C ±5 °C, ≤80 % RH. Between -10 °C and 18 °C and between 28 °C and 40 °C, accuracy specifications may degrade by 0,1 x (accuracy specification) per °C. The following tables can be used for the determination of maximum or minimum display values considering maximum instrument operating uncertainty per EN61557-1, 5.2.4.

Insulation Resistance (R_{ISO})

250 V		500 V		1000 V	
Limit Value	Maximum Display Value	Limit Value	Maximum Display Value	Limit Value	Maximum Display Value
1	1.3	1	1.3	1	1.3
2	2.4	2	2.4	2	2.4
3	3.5	3	3.5	3	3.5
4	4.6	4	4.6	4	4.6
5	5.7	5	5.7	5	5.7
6	6.8	6	6.8	6	6.8
7	7.9	7	7.9	7	7.9
8	9.0	8	9.0	8	9.0
9	10.1	9	10.1	9	10.1
10	11.2	10	11.2	10	11.2
20	22.2	20	22.2	20	22.2
30	33.2	30	33.2	30	33.2
40	44.2	40	44.2	40	44.2
50	55.2	50	55.2	50	55.2
60	66.2	60	66.2	60	66.2
70	77.2	70	77.2	70	77.2
80	88.2	80	88.2	80	88.2
90	99.2	90	99.2	90	99.2
100	110.2	100	110.2	100	110.2
200	220.2	200	220.2	200	220.2
-	-	300	347	300	345
-	-	400	462	400	460
-	-	500	577	500	575
-	-	-	-	600	690
-	-	-	-	700	805
-	-	-	-	800	920
-	-	-	-	900	1035
-	-	-	-	1000	1150

Continuity (R_{LO})

Limit Value	Maximum Display Value	Limit Value	Maximum Display Value
0.2	0.16	3	2.68
0.3	0.25	4	3.58
0.4	0.34	5	4.48
0.5	0.43	6	5.38
0.6	0.52	7	6.28
0.7	0.61	8	7.18
0.8	0.7	9	8.08
0.9	0.79	10	8.98
1	0.88	20	17.98
2	1.78	30	26.8

Loop Tests (Z_l)

Loop Z_l Hi Current		Loop Z_l No Trip		Loop Z_l		Loop R_E	
Limit Value	**Maximum Display Value**	**Limit Value**	**Maximum Display Value**	**Limit Value**	**Maximum Display Value**	**Limit Value**	**Maximum Display Value**
0.20	0.14	-	-	3	2.53	3	2.72
0.30	0.23	-	-	4	3.38	4	3.62
0.40	0.32	0.40	0.28	5	4.23	5	4.52
0.50	0.41	0.50	0.37	6	5.08	6	5.42
0.60	0.50	0.60	0.45	7	5.93	7	6.32
0.70	0.59	0.70	0.54	8	6.78	8	7.22
0.80	0.68	0.80	0.62	9	7.63	9	8.12
0.90	0.77	0.90	0.71	10	8.48	10	9.02
1.00	0.86	1.00	0.79	20	16.98	20	18.02
1.10	0.95	1.10	0.88	30	25.3	30	27.2
1.20	1.04	1.20	0.96	40	33.8	40	36.2
1.30	1.13	1.30	1.05	50	42.3	50	45.2
1.40	1.22	1.40	1.13	60	50.8	60	54.2
1.50	1.31	1.50	1.22	70	59.3	70	63.2
1.60	1.40	1.60	1.30	80	67.8	80	72.2
1.70	1.49	1.70	1.39	90	76.3	90	81.2
1.80	1.58	1.80	1.47	100	84.8	100	90.2
1.90	1.67	1.90	1.56	200	169.8	200	180.2
2.00	1.76	2.00	1.64	300	253	300	272
-	-	-	-	400	338	400	362
-	-	-	-	500	423	500	452
-	-	-	-	600	508	600	542
-	-	-	-	700	593	700	632
-	-	-	-	800	678	800	722
-	-	-	-	900	763	900	812
-	-	-	-	1000	848	1000	902

RCD/FI Tests ($_{\Delta}T$)

RCD/FI Time	
Limit Value	**Maximum Display Value**
20	18.1
30	27.1
40	36.1
50	45.1
60	54.1
70	63.1
80	72.1
90	81.1
100	90.1
200	180.1
300	271
400	361
500	451
600	541
700	631
800	721
900	811
1000	901
2000	1801

AC Voltage Measurement (V)

Range	Resolution	Accuracy 50 Hz – 60 Hz	Input Impedance	Overload Protection
500 V	0.1 V	0.8 % + 3	3.3 MΩ	660 V rms

Continuity Testing (R_{LO})

Range (Autoranging)	Resolution	Open Circuit Voltage	Accuracy
20 Ω	0.01 Ω	>4 V	±(1.5 % + 3 digits)
200 Ω	0.1 Ω	>4 V	±(1.5 % + 3 digits)
2000 Ω	1 Ω	>4 V	±(1.5 % + 3 digits)
Note The number of possible continuity tests with a fresh set of batteries is 3000.			

Range R_{LO}	Test Current
7.5 Ω	210 mA
35 Ω	100 mA
240 Ω	20 mA
2000 Ω	2 mA

Test Probe Zeroing	Press the ZERO to zero the test probe. Can subtract up to 2 Ω of lead resistance. Error message for >2 Ω.
Live Circuit Detection	Inhibits test if terminal voltage >10 V ac detected prior to initiation of test.

Insulation Resistance Measurement (R_{ISO})

Test Voltages	Accuracy of Test Voltage (at rated test current)
250-500-1000 V	+10 %, -0 %

Test Voltage	Insulation Resistance Range	Resolution	Test Current	Accuracy
250 V	10 kΩ to 20 MΩ	0.01 MΩ	1 mA @ 250 kΩ	±(1.5 % + 3 digits)
	20 MΩ to 200 MΩ	0.1 MΩ		±(1.5 % + 3 digits)
500 V	10 kΩ to 20 MΩ	0.01 MΩ	1 mA @ 500 kΩ	±(1.5 % + 3 digits)
	20 MΩ to 200 MΩ	0.1 MΩ		±(1.5 % + 3 digits)
	200 MΩ to 500 MΩ	1 MΩ		±10 %
1000 V	100 kΩ to 200 MΩ	0.1 MΩ	1 mA @ 1 MΩ	±(1.5 % + 3 digits)
	200 MΩ to 1000 MΩ	1 MΩ		±10 %
Note The number of possible insulation tests with a fresh set of batteries is 2000.				

Auto Discharge	Discharge time constant <0.5 second for C = 1 µF or less.
Live Circuit Detection	Inhibits test if terminal voltage >30 V prior to initiation of test.
Maximum Capacitive Load	Operable with up the 5 µF load.

No Trip and Hi Current Modes RCD/FI

Mains Input Voltage Range	100 - 500 V ac (50/60 Hz)
Input Connection (soft key selection)	Loop Impedance: phase to earth
	Line impedance: phase to neutral
Limit on Consecutive Tests	Automatic shutdown when internal components are too hot. There is also a thermal shutdown for RCD tests.
Maximum Test Current @ 400 V	20 A sinusoidal for 10 ms
Maximum Test Current @ 230 V	12 A sinusoidal for 10 ms

Range	Resolution	Accuracy [1]
20 Ω	0.01 Ω	No Trip mode: ±(3 % + 6 digits)
		Hi Current mode: ±(2 % + 4 digits)
200 Ω	0.1 Ω	No Trip mode: ±(3 %)
		Hi Current mode: ±(2 %)
2000 Ω	1 Ω	±6 % [2]

[1] Valid for resistance of neutral circuit <20 Ω and up to a system phase angle of 30 °. Test leads must be zeroed before testing.

[2] Valid for mains voltage >200 V.

Prospective Earth Fault Current Test (PSC/I_K)

Computation	Prospective Earth Fault Current (PEFC/I_K) or Prospective Short Circuit Current (PSC/I_K) determined by dividing measured mains voltage by measured loop (L-PE) resistance or line (L-N) resistance, respectively.	
Range	0 to 10 kA or 0 to 50 kA (See Power-On Options earlier in this manual)	
Resolution and Units	Resolution	Units
	I_K <1000 A	1 A
	I_K >1000 A	0.1 kA
Accuracy	Determined by accuracy of loop resistance and mains voltage measurements.	

RCD Testing

RCD Types Tested

RCD Type [1]	
AC [2]	G [3]
AC	S [4]

[1] RCD test inhibited for V >265 ac. RCD tests permitted only if the selected current, multiplied by earthing resistance, is <50 V.
[2] AC - Responds to ac
[3] G - General, no delay
[4] S - Time delay

Test Signals

RCD Type	Test Signal Description
AC (sinusoidal)	The waveform is a sinewave starting at zero crossing, polarity determined by phase selection (0 ° phase starts with low to high zero crossing, 180 ° phase starts with high to low zero crossing). The magnitude of the test current is $I_{\Delta}n$ x Multiplier for all tests.

Tripping Speed Test (ΔT)

Test Function	RCD Current Selection						
	10 mA	30 mA	100 mA	300 mA	500 mA	1000 mA	var
x ½, 1	√	√	√	√	√	√	√
x 5	√	√	√				
Ramp	√	√	√	√	√	√	√
Note Mains voltage 100 V – 265 V ac, 50/60 Hz							

Current Multiplier	RCD Type [1]	Measurement Range		Trip Time Accuracy
		Europe	UK	
x ½	G	310 ms	2000 ms	±(1 % Reading + 1 ms)
x ½	S	510 ms	2000 ms	±(1 % Reading + 1 ms)
x 1	G	310 ms	310 ms	±(1 % Reading + 1 ms)
x 1	S	510 ms	510 ms	±(1 % Reading + 1 ms)
x 5	G	50 ms	50 ms	±(1 % Reading + 1 ms)
x 5	S	160 ms	160 ms	±(1 % Reading + 1 ms)
[1] G – General, no delay, S – Time delay				

Maximum Trip Time

The RCD ✓ symbol switches on when testing the RCD trip time if the trip time meets the following conditions:

RCD	$I_{\Delta N}$	Trip Time Limits
AC G	x 1	Less than 300 ms
AC S	x 1	Between 130 ms and 500 ms
AC G	x 5	Less than 40 ms
AC S	x 5	Between 50 ms and 150 ms

Mains Wiring Test

Icons (, ,) indicate if L-PE or L-N terminals are reversed. Instrument operation is inhibited and an error code is generated if the input voltage is not between 100 V and 500 V. The UK Loop and RCD tests are inhibited if the L-PE or the L-N terminals are reversed.

Operating Ranges and Uncertainties per EN 61557

Function	Display Range	EN 61557 Measurement Range Operating Uncertainty	Nominal Values
V EN 61557-1	0.0 V ac – 500 V ac	50 V ac – 500 V ac ±(2% + 2 dgt)	U_N = 230/400 V ac f = 50/60 Hz
R_{LO} EN 61557-4	0.00 Ω - 2000 Ω	0.2 Ω - 2000 Ω ±(10 % + 2 dgt)	4.0 V dc <U_Q <24 V dc R_{LO} ≤2.00 Ω I_N ≥200 mA
R_{ISO} EN 61557-2	0.00 MΩ - 1000 MΩ	1 MΩ - 200 MΩ ±(10 % + 2 dgt) 200 MΩ - 1000 MΩ ±(15 % + 2 dgt)	U_N = 250 / 500 / 1000 V dc I_N = 1.0 mA
Z_I EN 61557-3	Z_I (No Trip) 0.00 Ω - 2000 Ω	0.4 Ω - 2000 Ω ±(15 % + 6 dgt)	U_N = 230/400 V ac f = 50/60 Hz I_K = 0 A – 10.0 kA
	Z_I (Hi Current) 0.00 Ω - 2000 Ω	0.2 Ω - 200 Ω ±(10 % + 4 dgt)	
	R_E 0.00 Ω - 2000 Ω	10 Ω - 1000 Ω ±(10 % + 2 dgt)	
$_{\Delta}T$ EN 61557-6	$_{\Delta}T$ 0.0 ms – 2000 ms	25 ms – 2000 ms ±(10 % + 1 dgt)	$_{\Delta}T$ @ 10 / 30 / 100 / 300 / 500 / 1000 / VAR mA

Operating Uncertainties per EN 61557

The Operating Uncertainty shows the maximum possible uncertainty when all influence factors E1-E10 are counted.

	Volts	R_{Lo} EN 61557-4	R_{ISO} EN 61557-2	Z_I EN 61557-3	ΔT EN 61557-6
Intrinsic Uncertainty A	0.80 %	1.50 %	10.00 %	6.00 %	1.00 %

Influence Quantity	Volts	R_{Lo} EN 61557-4	R_{ISO} EN 61557-2	Z_I EN 61557-3	ΔT EN 61557-6
E1 - Position	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
E2 - Supply Voltage	0.50 %	3.00 %	3.00 %	3.00 %	3.00 %
E3 - Temperature	0.50 %	3.00 %	3.00 %	3.00 %	3.00 %
E4 - Series Interferences Voltage	-	-	-	-	-
E5 - Resistance of the probes and auxiliary earth electrodes	-	-	-	-	-
E6.2 - System phase angle	-	-	-	1.00 %	-
E7 - System frequency	0.50 %	-	-	2.50 %	-
E8 - System voltage	-	-	-	2.50 %	2.50 %
E9 - Harmonics	-	-	-	2.00 %	-
E10 - D.C. Quantity	-	-	-	2.50 %	-