

1550C/1555

Insulation Tester

Users Manual

PN 3593019

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For complete operational instructions, refer to the Users Manual contained on the accompanying CD.

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Introduction

The Fluke 1550C and 1555 Insulation Testers (hereafter “the Tester”) are high-voltage insulation testers to validate general circuits, such as switchgear, motors, and cables.

The Tester features:

- Large liquid crystal display (LCD)
- Six preset test voltages: 250 V, 500 V, 1000 V, 2500 V, 5000 V, 10,000 V (1555 only)
- Programmable test voltages: 250 V to 10,000 V (50/100 V steps)
- Resistance measurement: 200 k Ω to 2 T Ω
- Polarization Index (PI)
- Dielectric Absorption Ratio (DAR)
- Ramp mode that linearly increases (100 V/s) the applied test voltage
- Test timer and storage for test results with user-defined ID tag
- Breakdown voltage indication
- Rechargeable lead-acid battery
- Auto shutoff after 30 minutes of inactivity
- Infrared (IR) port for downloading test data
- PC software (supplied)

The Tester meets EN 61557 Parts 1 and 2; and EN 61010-1, CAT IV 600 V Pollution Degree 2 standards. 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.

Safety Information

⚠ ⚠ Warning: Read before Tester use.

To prevent possible electrical shock or personal injury, follow these guidelines:

- Before and after testing, confirm that the Tester does not indicate the presence of a hazardous voltage, see Figure 3. If the Tester beeps continuously and a hazardous voltage is shown on the display, remove power from the circuit under test or allow the installation capacitance to fully discharge.
- Use the Tester only as specified in this manual. Otherwise the protection provided by the Tester can be compromised.
- Connect the common test lead before the live test lead and remove the live test lead before the common test lead.
- Do not disconnect the test leads before a test has been completed and the test voltage at the terminals has returned to zero. This ensures that any charged capacitance is fully discharged.
- Disconnect circuit power and discharge all high-voltage capacitors before you measure resistance or capacitance.
- Do not work alone or around explosive gas, vapor or dust.
- Do not use the Tester in a damp or wet environment.
- Examine the test leads for damaged insulation or exposed metal. Check test lead continuity. Replace damaged leads. Do not use the Tester if it looks damaged.
- Be careful around voltages >30 V ac rms, 42 V ac peak, or 60 V dc. Such voltages pose a shock hazard.
- Keep fingers behind the finger guards on the probes.

- **Do not exceed the voltage or measurement category (CAT) rating of the test probes/accessories. Not all accessories provided are for use at the full-rated output voltage of the Tester. Accessories rated to 1000V CAT III/ 600V CAT IV are intended for hands-free use during insulation testing and are not to be touched while the output of the Tester exceeds the accessory's marked rating. Allow the Tester to fully discharge the installation before removing the test accessory.**
- **Impedances of additional operating circuits connected in parallel can adversely affect measurements.**
- **Place test leads in proper input terminals.**
- **Do not use the Tester with any parts or cover removed.**
- **Use only specified replacement parts in the Tester.**
- **Do not use the Tester if the safety shutter is impaired in any way. The safety shutter prevents access to the test terminals and charger terminals at the same time.**
- **There are no user replaceable parts inside the Tester.**
- **Use the guard terminal only as specified in this manual.**
- **Use only recommended test leads.**
- **Do not use in distribution systems with voltages higher than 1100 V.**

Symbols

Symbols on the Tester and in the manual are explained Table 1.

Table 1. Symbols

Symbol	Meaning
	Conforms to European Union standards.
	Examined and licensed by TÜV Product Services.
	Canadian Standards Association is the certified body used for testing compliance to safety standards.
	Risk of Danger. Important information. See Manual.
	Hazardous voltage
	Equipment protected by double or reinforced insulation.
	Do not use in distribution systems with voltages higher than 1100 V.
	Interference is present. Displayed value might be outside of specified accuracy.
	Ramp mode indicator
	Electrical breakdown
	Volts AC
	Earth Ground
	Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.

Unpack the Tester

The Tester comes with the items shown in Figure 1. If the Tester is damaged or an item is missing, immediately contact the place of purchase.

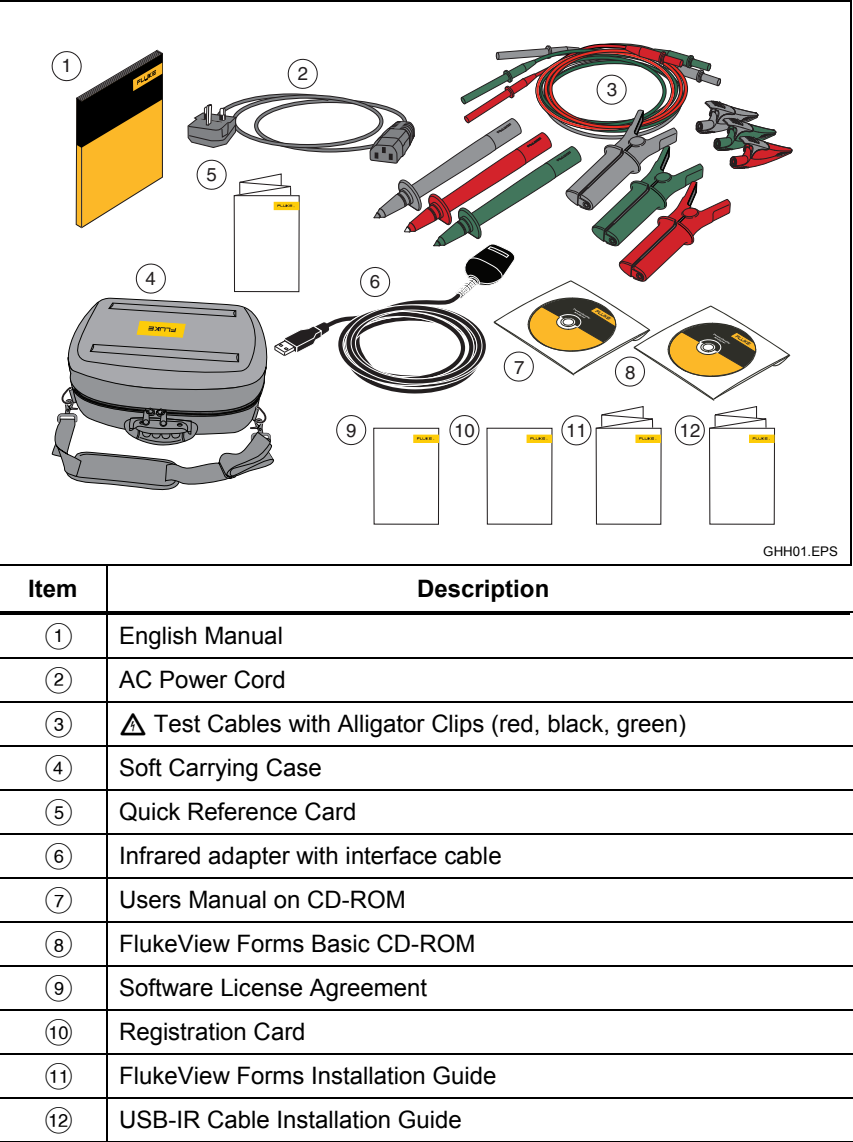


Figure 1. Standard Items Provided

The Tester

The subsequent sections tell you about the Tester and its operation. The Tester is shown in Figure 2.

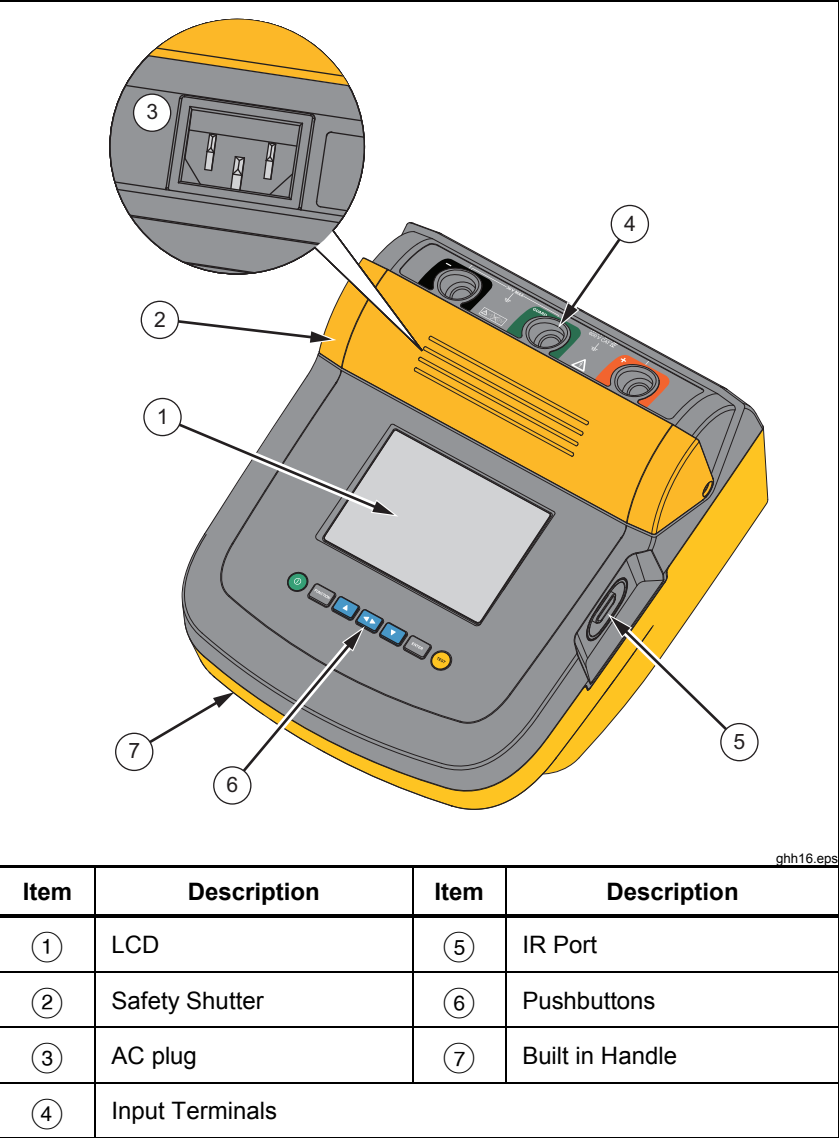


Figure 2. 1550C/1555 Insulation Tester

Pushbuttons

Use the pushbuttons to control the Tester, view test results, and scroll through chosen test results. Pushbuttons and their functionality are discussed in Figure 2.

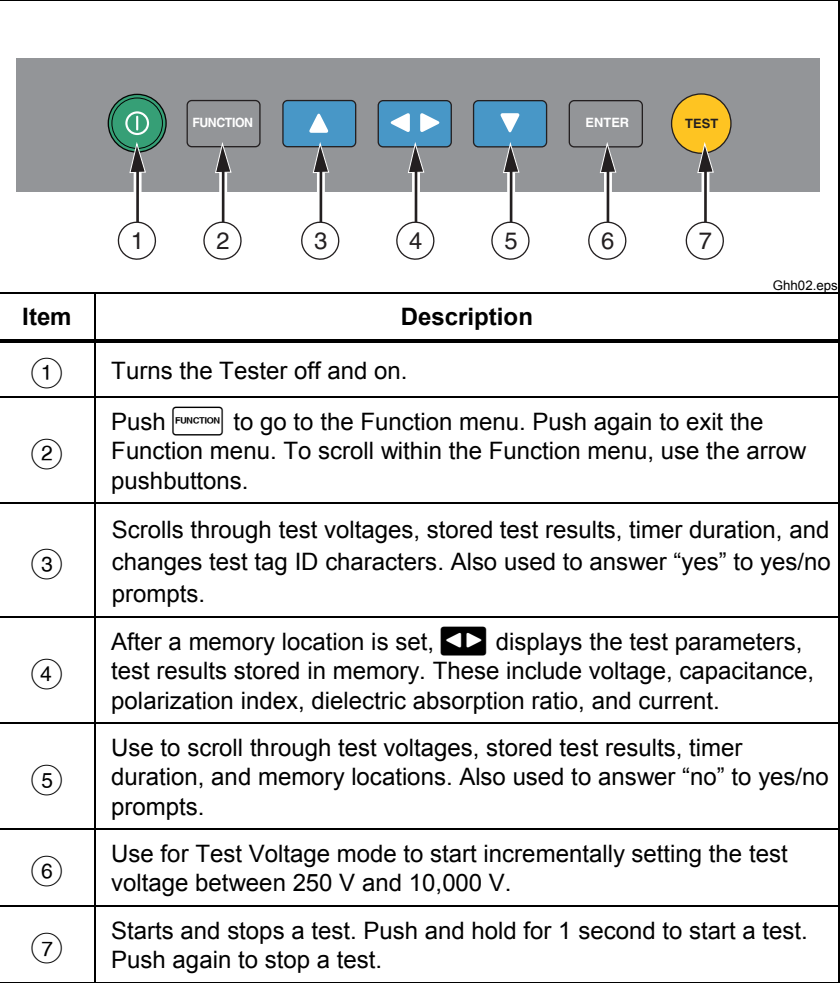


Figure 3. Pushbuttons

Additionally,  and  are also used to access the following menu items:

1.X Insulation Functions:

1.1 Ramp off (default)

1.2 Ramp on

1.3 DAR T= 01-00

1.4 DAR/PI T= 10-00

2 Time limit xx-xx

3 Show results

4 Delete results

Push  to make the selection.

Turn the Tester On and Off

Push  to turn on the Tester.

The Tester does a self-check, self-calibration, shows the current software version, and starts in the Test Voltage mode.

From here, you can:

- Change test parameters
- Start an insulation test
- View stored test results
- Download test results

Push  again to turn off the Tester.

Display

Display annunciators are shown in Figure 4.

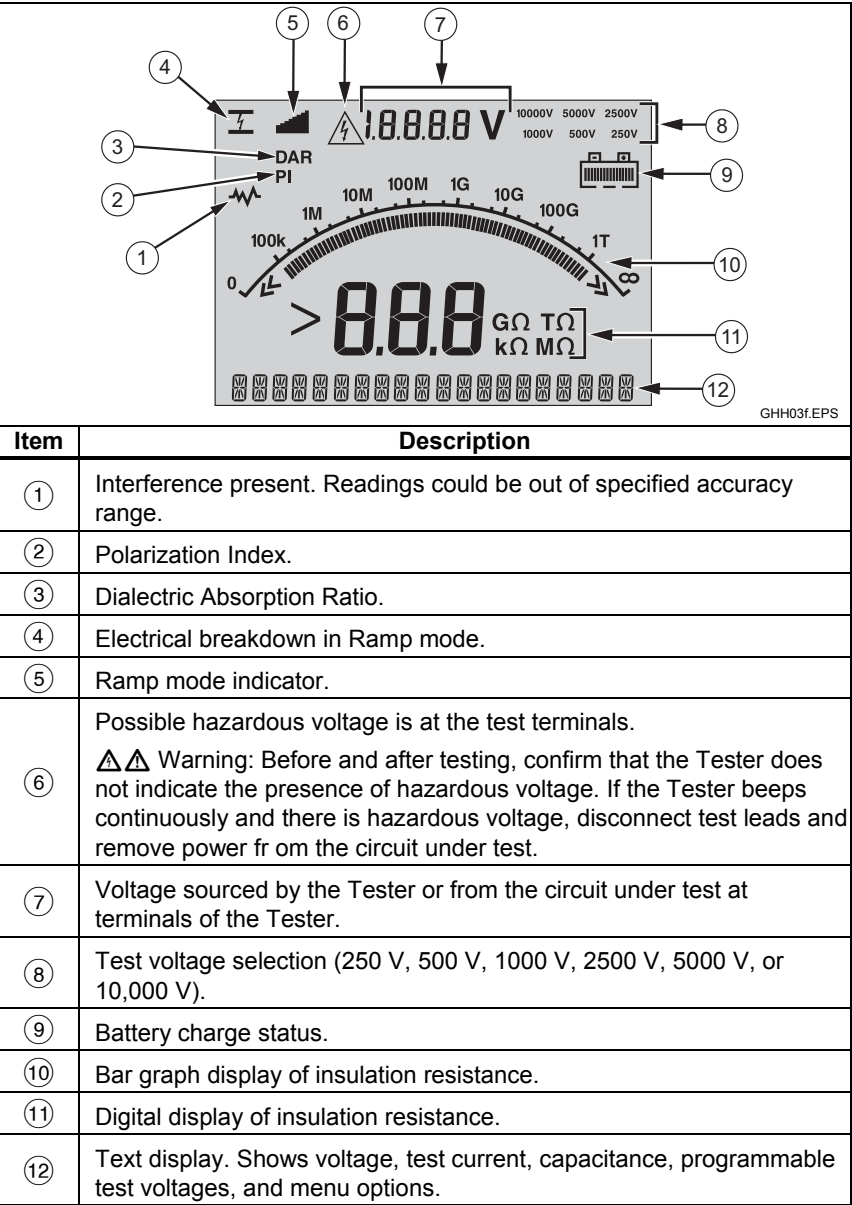


Figure 4. Display Features

Charge the Battery

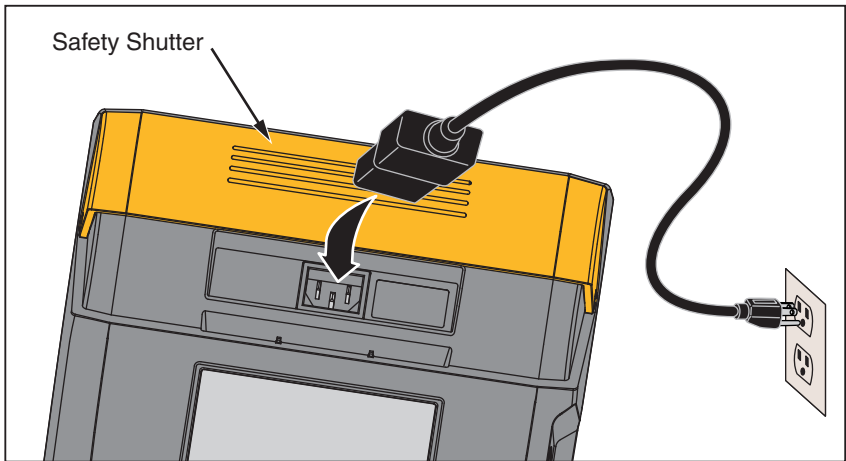
Pb **Note**

This Tester uses a rechargeable 12 V lead-acid battery for power. Do not mix with the solid waste stream. Use a qualified recycler or hazardous materials handler to discard dead batteries. Contact your approved Fluke Service Center for disposal and recycling data.

Storing rechargeable lead-acid batteries in a low-charged state could decrease their life and/or damage them. Fully charge the battery before storing it for extended periods and examine the charge at regular intervals.

Charge the 12 V lead-acid battery with the ac power cord.

12 hours is typically necessary to fully charge the battery. Do not charge in very high or low temperatures. Charge the battery if the Tester is not used for extended periods. Figure 5 shows how to connect the Tester to a power supply.



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Figure 5. Power Supply Connections.

To charge the battery with the ac power supply:

1. Turn the Tester off.
2. Disconnect the test leads from the Tester.
3. Move the safety shutter to access the power supply connection.
4. Connect the ac power cord to the IEC ac power socket on the Tester.
5. Connect the other end of the power cord to an ac power supply. See “General Specifications” for ac charger input specifications.

The LCD displays **CHARGING**. Downloading is possible when the Tester is in Charging mode.

Guard Terminal Use

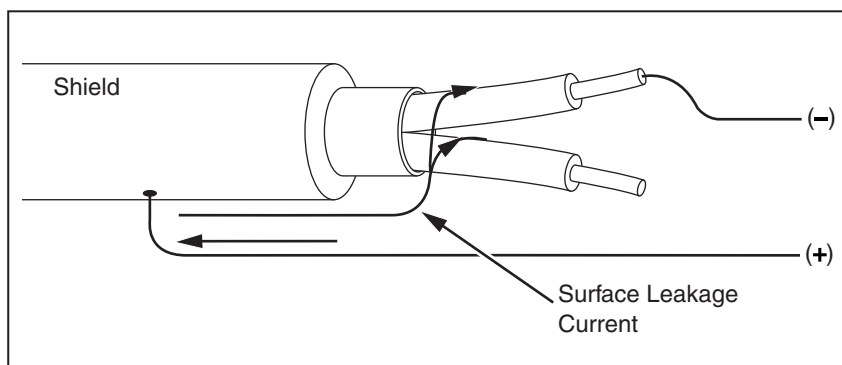
Note

Insulation resistance is measured between the (+) and (–) output connections. The Guard terminal (G) is at the same potential as the negative (–) terminal but is not in the measurement path.

For most tests, only two test leads are used. Connect the positive (+) and negative (–) test leads to the corresponding inputs on the Tester. Connect the test lead probes to the circuit under test. The Guard (G) terminal is left unconnected.

For the best accuracy when you measure very high resistances, use three-wire measurements and the Guard terminal. The Guard terminal is at the same potential as the negative (–) terminal, and can be used to prevent surface leakage or other unwanted leakage currents from degrading the accuracy of the insulation resistance measurement.

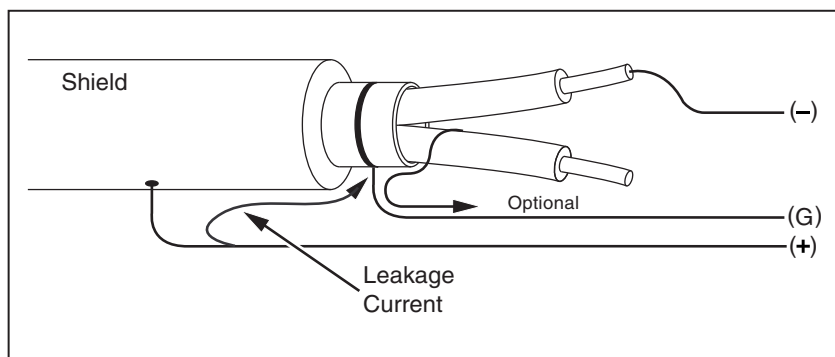
Figure 6 shows how to measure the resistance from one of the conductors to the outer shield. In this case, there is a leakage current along the surface of the inner insulation near the cables end. This leakage adds to the current that the negative terminal senses, and causes the Tester to read a lower resistance than it should.



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Figure 6. Surface Leakage Current

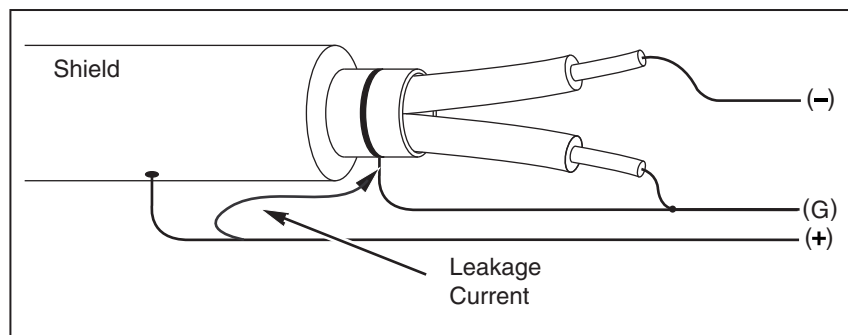
Figure 7 shows how to prevent surface current leakage with a lead connected from the Guard terminal to a conductor that surrounds the inner insulation. The surface leakage current is directed to the Guard terminal. This removes the leakage current from the measurement path between the positive and negative terminals, and improves the accuracy of the test readings.



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Figure 7. Guard Terminal Connection

Figure 8 shows how make the measurement setup better. Connect the Guard terminal to the unused wire and attach it to the inner insulation. This ensures that the Tester measures the leakage between the selected conductor and the outer shield, but removes the leakage path between conductors.



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Figure 8. Improved Guard Terminal Connection

Measurements

Common measurement procedures are discussed in this section.

Connect to the Circuit Under Test

⚠⚠ Warning

To avoid possible electric shock or personal injury:

- Remove all power from the circuit under test and discharge circuit capacitance before testing a circuit with the Tester.
- Connect the common test lead before the live test lead and remove the live test lead before the common test lead.
- Before and after testing, confirm that the Tester does not indicate the presence of a hazardous voltage, see Figure 4. If the Tester beeps continuously and a hazardous voltage is shown on the display, remove power from the circuit under test and disconnect test leads.

To connect to the circuit under test:

1. Move the safety shutter to access the input terminals.
2. Put the test leads into the correct terminals shown, see Figure 9.
3. Connect the test leads to the circuit under test.

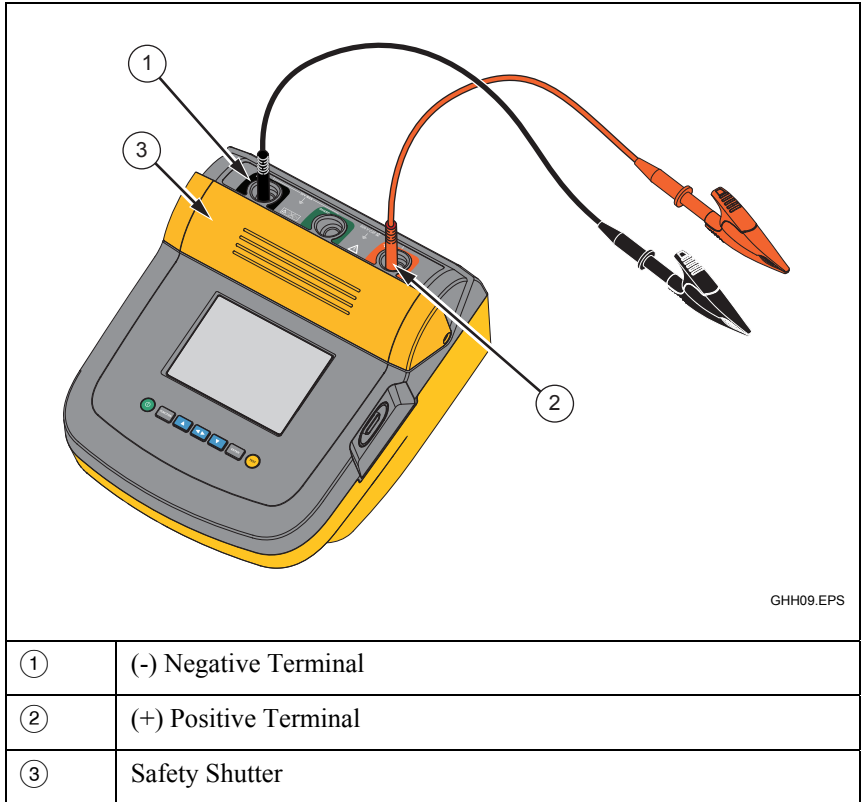


Figure 9. Test Lead Connections

Note

The Tester is NOT specified below 200 k Ω . When the leads are shorted and a test is performed, the Tester gives an unspecified reading that is greater than zero. This is normal for this Testers input circuitry configuration and does not change readings that are in the specified accuracy range.

Before an Insulation Test

The Tester includes features and functions that let you adapt the test to your requirements. These features let you:

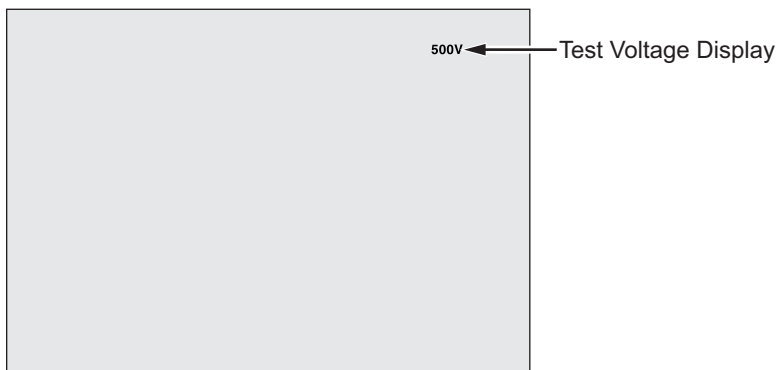
- define a test voltage
- make a ramp test selection
- set a time limit (duration) for the test
- measure polarization index (PI)
- measure dielectric absorption ratio (DAR)
- measure capacitance

Use these alone or in combination. Set, clear, or account for (as appropriate) each feature before you start an insulation test. The features are discussed in this section.

Preset Test Voltage Selection

To make a preset test voltage selection:

1. With the Tester turned on, push  to select **TEST VOLTAGE**.



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2. Push  or  to scroll through the preset test voltage options (250 V, 500 V, 1000 V, 2500 V, 5000 V, and 10,000 V).

The test voltage selection shows in the upper-right of the display.

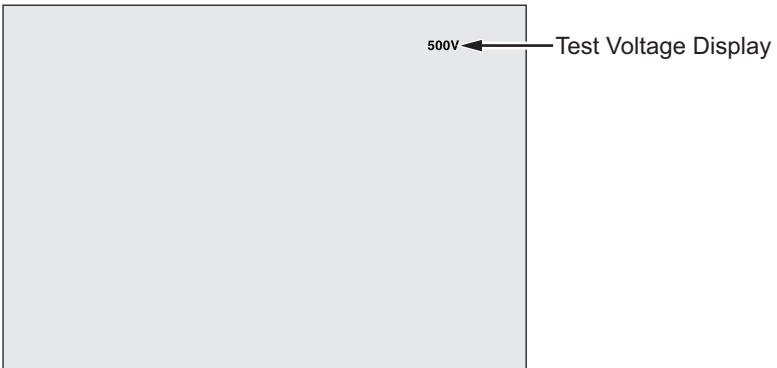
Note

The actual test voltage can be up to 10 % higher than the selected test voltage.

Program a Test Voltage

To set a test voltage in between the preset test voltages, proceed as follows:

1. With the Tester turned on, push  to select **TEST VOLTAGE**.



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2. Push  or  to scroll through the preset test voltage options (250 V, 500 V, 1000 V, 2500 V, 5000 V, and 10,000 V). Select the voltage closest to the level required.
3. The selected test voltage appears in the upper-right of the display.
4. Push . **TV=xxxxV** appears flashing in the lower-left of the display.
5. Push  or  to increment and decrement the voltage. When the correct voltage level shows, **do not** push . Doing so will return the test voltage to the next lowest last preset voltage selection. Instead, push  to go to the function menu.

Note

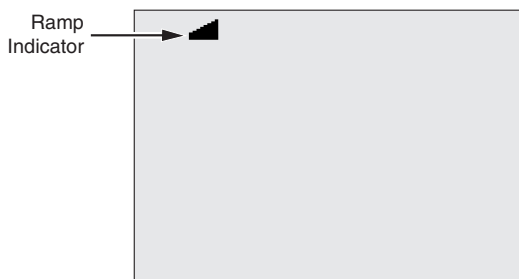
The test voltage can be up to 10 % higher than the test voltage you select.

Select a Ramp or Steady-State Test

The ramp-test function is an automated test that checks insulation for a breakdown. During a ramp test, the output voltage starts at 0 V and increases linearly (100 V/s) until it reaches the specified test voltage or until a sudden drop in measured resistance is detected. Then, the Ramp stops, the test voltage drops to zero, and the voltage at the breakdown point is stored in memory on the Tester. All other test results are declared invalid if the test does not reach the specified test voltage. If the test successfully meets compliance without breakdown, then the only valid test results are test voltage and insulation resistance.

To enable or disable the ramp function:

1. With the Tester turned on, push **FUNCTION** to enter the 1.X Function Menu.
2. Push **ENTER** to call the menu item.



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3. Push **▲** or **▼** to toggle the Ramp on or off. When the ramp is on a blinking ramp icon appears in the upper left-hand corner of the display.
4. Push **ENTER** or **TEST** to use the settings. **TEST** starts the test.

Set a Timed Test

You can control the length of an insulation test by setting a timer. The time (test duration) can be set in 1-minute increments up to 99 minutes. During a timed test, the time limit appears on the right bottom of the display, and the elapsed time is shown in the middle of the display. At the end of the elapsed time, the insulation test has been completed and the test is terminated.

To set a test time limit:

1. With the Tester turned on, push **FUNCTION** to enter the Function Menu.
2. Push **▲** or **▼** to select the **2.Time Limit** function.

3. Push  to call the menu item.
4. Push  or  to select the time.
5. Push  or  to use the settings.  starts the test.

Polarization Index (PI)

As part of the insulation test, the Tester measures and stores polarization index (PI), when appropriate. A polarization index test requires 10 minutes to complete. Therefore, the Tester will start a countdown at 10 minutes. When an insulation test is 10 minutes or more, the polarization test is completed and stored. The results are available for display during a test by pushing the  button or by storing the test results and scanning the **RESULTS** fields. The field is identified by **PI**.

$$PI = \frac{R \times 10 \text{ min}}{R \times 1 \text{ min}}$$

Dielectric Absorption Ratio

As part of the insulation test, the Tester measures and stores dielectric absorption ratio (DAR), when appropriate. A DAR test requires 1 minute to complete. Therefore, it is measured and stored as invalid data for all insulation tests less than 1 minute. When an insulation test is 1 minute or more the DAR test is included in the results. The results are available for display during a test by pushing the  button or by storing the test results and scanning the **RESULTS** fields. The field is identified by **DAR**.

$$DAR = \frac{R \times 1 \text{ min}}{R \times 30 \text{ sec}}$$

Capacitance

As part of the insulation test, the Tester measures and stores capacitance when appropriate. The results are available for display during a test by pushing the  button or by storing the test results and scanning the **RESULTS** fields. The field is identified by **C**.

Insulation Test

Warning

To avoid possible electric shock or personal injury:

- **Be aware that measuring insulation resistance requires the application of potentially dangerous voltages to the circuit. This may include exposed bonded metalwork.**
- **Remove all power from the circuit under test and discharge circuit capacitance before testing a circuit with the Tester.**
- **Before proceeding, ensure that the installation is wired correctly and no personnel are endangered by any tests.**
- **First connect the test leads to the Tester inputs before you make connection to the circuit under test.**

PI/DAR Limits:

- Cap. Mdx > 1 μ F and Res. Max > 100 M Ω
- Res. Min < 200 k Ω
- Current min < 50 μ A
- If one of the limits is beyond, the Tester will display **UNSPEC.**

To perform an insulation test:

1. With the Tester turned on, set the available measurement options to meet your test requirements. These include:
 - Test Voltage – Set range: 250 V to 10,000 V (50 V/100 V steps)
 - Ramp Test – Toggle on or off
 - Time Limit – No limit or from 1 to 99 minutes
2. Connect the probes to the circuit under test.

⚠ ⚠ Warning

Before and after testing, confirm that the Tester does not indicate the presence of a hazardous voltage, see Figure 4. If the Tester beeps continuously and a hazardous voltage is shown on the display, disconnect test leads and remove power from the circuit under test.

3. Push  for 1 second to start the insulation test.

The Tester beeps three times as the test begins, and  flashes on the display indicating potentially hazardous voltages may be present on the test terminals.

The display indicates the measured insulation resistance after the circuit has stabilized. The bar graph displays this value continuously (in real time) as a trend, see Figure 10.

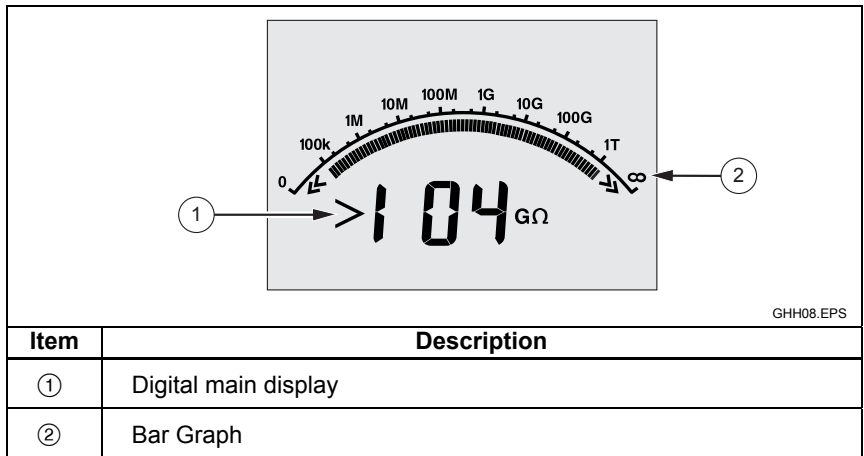


Figure 10. Displayed Measured Insulation Resistance

Any of the following conditions will terminate an insulation test:

- User stop (pushing 

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If breakdown occurs with ramp test enabled, push  before going to step 4.

Following termination of an insulation test, the Tester beeps when a potentially hazardous voltage remains on the test terminals due to charged-circuit capacitance or from the presence of an external voltage.

4. When the test is terminated, **STORE RESULT?** Is displayed. If appropriate, store the test results as described in the next procedure. Otherwise, terminate the **STORE RESULT?** Prompt by pushing . The results are not stored.

Store Test Results

Upon completion of an insulation test, the Tester displays **STORE RESULT?** As a prompt to save the measurement results for future use. The Tester includes enough memory to store the results of 99 insulation tests for future use.

To store the results of an insulation test:

1. Push  to save the measurement results. The Tester will assign and display a sequential tag number (00 to 99) to identify the measurement.
2. If the tag number is acceptable, push  to store the data. If a different tagging convention is required, proceed as follows to provide a custom 4-character tag.
 - a. Notice that * is blinking on the display. This is the first of the four characters available for tagging the test results. Repeatedly push  to cycle through the character positions.
 - b. At each character position use  or  to assign a character (0-9, A-Z).
 - c. Push  to store the results.

View Results Stored in Memory

Note

*Parameters not appropriate for a test are shown as **INVALID**.*

The Tester can store 99 sets of test data, including:

- Tags
- Ramp on or off
- Insulation Resistance
- Timer reading at termination of test (Timer)
- Test Voltage Selected (TV)
- Actual Test voltage (V)
- Capacitance I
- Polarization Index (PI)
- Dielectric absorption ratio (DAR)
- Test current (I)
- Reason for ending the test
- Limit – off or timer setting (1 to 99 minutes) (T. Limit)

To view stored test data, see Figure 11:

1. With the Tester turned on, push  to call the Function menu.
2. Push  or  to select **3. Show Results**.
3. Push  to select the menu item.

Note

When a voltage is present at the terminals, that voltage is always shown on the top-center of the display, regardless of whether that voltage is sourced by the Tester or is from the circuit under test.

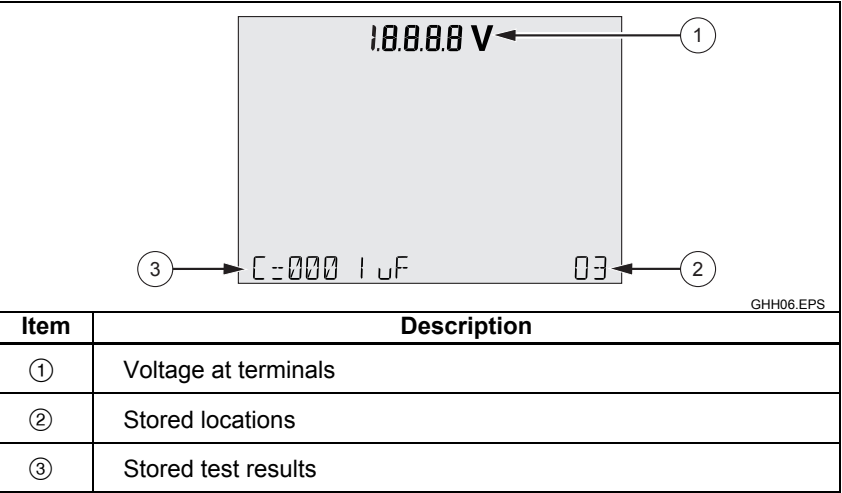


Figure 11. Viewing Stored Test Data

- 4. Push ▲ or ▼ to step through the stored locations.
- 5. Stop at the location you want to view.
- 6. Push ◀▶ to view the stored test data for a specific test. Test data appears on the alphanumeric text display and on the LCD.
- 7. Push ENTER to call the menu selection.

Download Your Test Results

You can use FlukeView Forms software to download all of your stored test data to a PC. An infrared adapter is supplied with the Tester for use in downloading stored test data. Figure 10 shows the location of the IR port on the Tester.

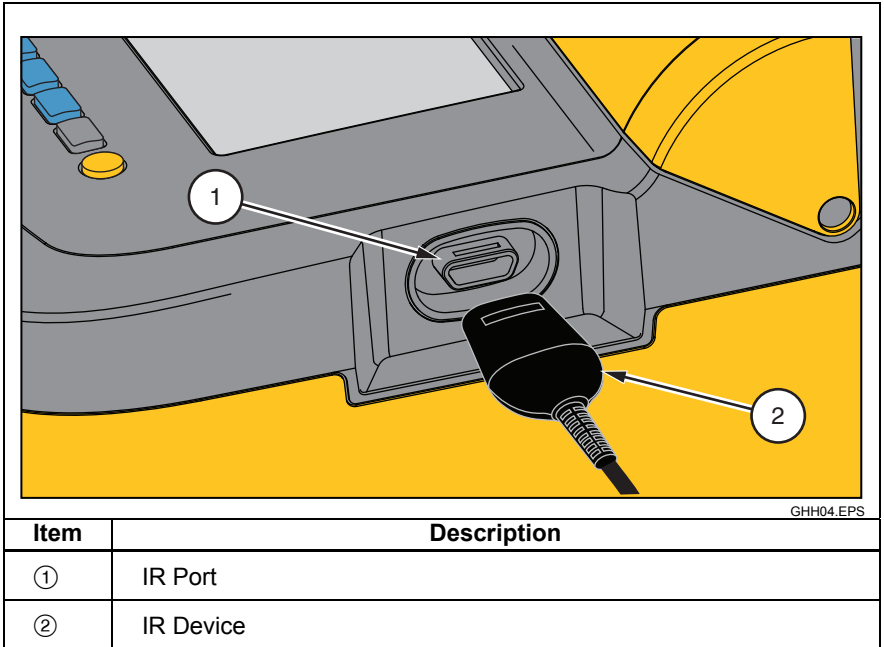


Figure 12. IR Port on 1550C/1555 Insulation Tester

Install FlukeView Forms Basic Software

FlukeView Forms Basic software must be installed on your PC to download stored test data.

To install FlukeView Forms Basic, see the *FlukeView Forms Installation Guide*.

To install the infrared adapter, see the *USB-IR Cable Installation Guide*.

Download Results to PC

Note

Before the USB-IR cable can be used, software drivers must be installed on your Windows PC. See the USB-IR Installation Guide for more information.

To connect the Tester to the PC for use with *FlukeView Forms Basic Documenting Software*:

The Tester should not be running a test; otherwise, serial communications will be disabled.

1. Connect the USB-IR cable to an available USB port on the PC.
2. Attach the IR device to the IR port on the Tester.
3. Open *FlukeView Forms Basic Documenting Software*.
4. The current COM serial port setting is displayed at the bottom right of the FlukeView Forms Basic window. Double-click on it to change the COM port setting to the virtual COM port used by the USB-IR cable.
5. Turn the Tester on.
6. Follow the instructions for transferring data from the Tester to the PC found in the online *FlukeView Forms Users Manual*.

Note

Verify that the download was successful before deleting the stored test results on the Tester.

Note

Results data stored in the Tester can be deleted from the PC using the FlukeView Forms Basic application. See the FlukeView Forms Users Manual file for details.

Delete Test Results

To delete all saved test results:

1. Push  to call the Function menu.
2. Push  or  to select the menu item **DELETE RESULT**.
3. Push  to call the menu item.
4. Push . **REALLY DEL?** Appears.
5. Push  to confirm the deletion or push  to return to **Test Voltage**.

Notes

Individual test locations cannot be deleted; however, they can be overwritten.

The Delete function deletes all stored test results.

Maintenance

⚠ ⚠ Warning

To avoid possible electric shock or personal injury:

- **Do not attempt to repair or service your Tester beyond what is described in this manual.**
- **Only qualified service personnel should service the Tester.**
- **There are no user-replaceable parts inside the Tester.**

Cleaning

⚠ ⚠ Warning

To avoid possible electric shock or personal injury, remove excess water from the cloth before cleaning the Tester to ensure that water does not enter any terminal.

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

Replaceable Parts and Accessories

Table 2 lists the replaceable parts that are available for the Tester. Table 3 identifies the accessories available for use with the Tester.

Table 2. List of Replaceable Parts

Parts	Part No.
Test Lead – Red	1642584
Test Lead – Black	1642591
Test Lead – Green	1642600
Test Clip – Red	1642617
Test Clip – Black	1642621
Test Clip – Green	1642639
AC Power Cord (North America)	284174
AC Power Cord (Continental Europe)	769422
AC Power Cord (UK)	769455
AC Power Cord (Australia)	658641
AC Power Cord (S. Africa)	1552363
Soft Carrying Case	3592805
Infrared Cable Assembly	1578406
Users Manual CD-ROM	3592810
English Users Manual	3593019
Quick Reference Card	3592822

Table 3. Accessories

Accessories	Part No.
Extended Test Lead Set, 25 feet (7.6 meters)	2032761
Rugged Alligator Clamps	3611951
Soft Case	3592805
Hard Case	3671624

Specifications

General Specifications

Display	75 mm x 105 mm
Power	12 V lead-acid rechargeable battery. 2.6 Ahr
Charger Input (AC)	85 V to 250 V ac, 50/60 Hz, 20 VA This Class II (double insulated) instrument is supplied with a Class 1 (grounded) power cord. The protective earth terminal (ground pin) is not connected internally. <u>The extra pin is for added plug retention only.</u>
Dimensions (H x W x L)	170 mm x 242 mm x 330 mm (6.7 in. x 9.5 in. x 13.0 in.)
Weight	3.6 kg (7.94 lbs.)
Temperature (operating)	-20 °C to 50 °C (-4 °F to 122 °F)
Temperature (storage)	-20 °C to 65 °C (-4 °F to 149 °F)
Relative Humidity	80 % to 31 °C decreasing linearly to 50 % at 50 °C
Altitude	2000 m
Enclosure Sealing	IP40
Input Overload Protection	1000 V ac

Electromagnetic Compatibility	EN 61326-1, EN 61326-2-2	
Certifications	CE  	
Safety Compliance	EN 61010-1, EN 61557 Parts 1 and 2 CAT III 1000V, CAT IV 600V	
Pollution Degree	2	
Typical Battery Charge Capability Note At temperature extremes, the battery needs to be charged more frequently.	Test Voltages	Number of Tests
	250 V	4100
	500 V	3600
	1 kV	3200
	2.5 kV	2500
	5 kV	1000
	10 kV	500

Electrical Specifications

The Tester’s accuracy is specified for 1 year after calibration at operating temperatures of 0 °C to 35 °C. For operating temperatures outside the range (- 20 °C to 0 °C and 35 °C to 50 °C), add ±0.25 % per °C, except on the 20 % bands add ±1 % per °C.

Insulation		
Test Voltage (DC)	Insulation Resistance Range	Accuracy (±reading)
250 V	< 200 kΩ	unspecified
	200 kΩ to 5 GΩ	5 %
	5 GΩ to 50 GΩ	20 %
	> 50 GΩ	unspecified
500 V	< 200 kΩ	unspecified
	200 kΩ to 10 GΩ	5 %
	10 GΩ to 100 GΩ	20 %
	> 100 GΩ	unspecified

1000 V	< 200 k Ω 200 k Ω to 20 G Ω 20 G Ω to 200 G Ω > 200 G Ω	unspecified 5 % 20 % unspecified
2500 V	< 200 k Ω 200 k Ω to 50 G Ω 50 G Ω to 500 G Ω > 500 G Ω	unspecified 5 % 20 % unspecified
5000 V	< 200 k Ω 200 k Ω to 100 G Ω 100 G Ω to 1 T Ω > 1 T Ω	unspecified 5 % 20 % unspecified
10,000 V	< 200 k Ω 200 k Ω to 200 G Ω 200 G Ω to 2 T Ω > 2 T Ω	unspecified 5 % 20 % unspecified
Bar graph range: Insulation test voltage accuracy: Induced ac mains current rejection: Charging rate for capacitive load:		0 to 2 T Ω -0 %, +10 % at 1 mA load current 2 mA maximum 5 seconds per μ F
Discharge rate for capacitive load:		1.5 s/ μ F

Leakage Current Measurement	Range	Accuracy
	1 nA to 2 mA	$\pm(20 \% + 2 \text{ nA})$
Capacitive Measurement	0.01 μ F to 20.00 μ F	$\pm(15 \% \text{ of reading} + 0.03 \mu\text{F})$

Timer	Range	Resolution
	0 to 99 minutes	Setting: 1 minute Indication: 1 second

Live circuit warning	Warning Range	Voltage Accuracy
	30 V to 1100 V ac/dc, 50/60 Hz	$\pm(15 \% + 2 \text{ V})$

Short circuit current > 1 mA and < 2 mA

Principle of Measurement and Resistance

The Tester measures insulation parameters and displays the results using with the following formulas.

Ohm's Law	Capacitance (charge)	PI (Polarization Index)	DAR (Dielectric absorption ratio)
$R = \frac{V}{I}$	$C = \frac{Q}{V}$	$PI = \frac{R \times 10 \text{ min}}{R \times 1 \text{ min}}$	$DAR = \frac{R \times 1 \text{ min}}{R \times 30 \text{ s}}$