Agilent U1452A, U1452AT, and U1451A Insulation Tester

User's Guide

Agilent Technologies

Notices

Manual Part Number

U1451-90003

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Safety Symbols

The following symbols on the instrument and in the documentation indicate precautions which must be taken to maintain safe operation of the instrument.

	Direct current (DC)		Caution, risk of electric shock
	Alternating current (AC)		Caution, risk of danger (refer to this manual for specific Warning or Caution information)
	Both direct and alternating current	CAT III 1000 V	Category III 1000 V overvoltage protection
	Earth (ground) terminal	CAT IV 600 V	Category IV 600 V overvoltage protection
	Equipment protected throughout by double insulation or reinforced insulation		Do not use in distribution systems with voltages higher than 600 V

Safety Considerations

Read the information below before using this tester. Model U1452A appears in all illustrations.

WARNING

- **Do not use the tester if it is damaged. Before you use the tester, inspect the case. Look for cracks or missing plastic. Pay particular attention to the insulation surrounding the connectors.**
- **Inspect the test leads for damaged insulation or exposed metal. Check the test leads for continuity. Replace damaged test leads before you use the tester.**
- **Do not operate the tester around explosive gas, vapor, or wet environments.**
- **Do not apply more than the rated voltage (as marked on the tester) between terminals, or between terminal and earth ground.**
- **Before use, verify the tester's operation by measuring a known voltage.**
- **When servicing the tester, use only the specified replacement parts.**
- **Use caution when working above 60 VDC, 30 VAC RMS, or 42.4 V peak. Such voltages pose a shock hazard.**
- **When using the probes, keep your fingers behind the finger guards on the probes.**
- **Connect the common test lead before you connect the live test lead. When you disconnect the leads, disconnect the live test lead first.**
- **Remove the test leads from the tester before you open the battery cover.**
- **Do not operate the tester with the battery cover or portions of the cover removed or loosened.**
- **To avoid false readings, which may lead to possible electric shock or personal injury, replace the battery as soon as the low battery indicator appears and flashes.**
- **Ensure that you do not perform insulation resistance tests in distribution systems with voltages higher than 600 V.**
- **For insulation resistance tests, ensure that you select a suitable test voltage for the equipment to be tested.**

CAUTION

- Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, or capacitance.
- Use the proper terminals, function, and range for your measurements.
- This device is for use at altitudes of up to 2,000 m.
- Always use the specified battery type. The power for the tester is supplied with four 1.5 V AA batteries. Observe the correct polarity markings before you insert the batteries to ensure proper insertion of the batteries in the tester.

Environmental Conditions

This instrument is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental condition	Requirement

Temperature	• **Operating condition**
	  • –20 °C to 55 °C, 0% to 80% RH (using Alkaline batteries), 20 minutes operating time
	• **Storage condition**
	  • –40 °C to 70 °C, 0% to 80% RH (without batteries)

Humidity	Full accuracy up to 80% RH for temperatures up to 30 °C, decreasing linearly to 50% RH at 55 °C
Altitude	Up to 2,000 meters
Pollution degree	Pollution degree II

NOTE

The U1452A/U1452AT/U1451A Insulation Tester complies with the following safety and EMC requirements:

- **Safety compliance**
  - Designed in compliance to IEC/EN 61010-1:2010 for Category III 1000 V and Category IV 600 V
  - Designed in compliance to IEC/EN 61557-1, IEC/EN 61557-2, and IEC/EN 61557-4
- **EMC compliance**
  - Commercial limits compliance with IEC 61326-1:2005/EN 61326-1:2006

Regulatory Markings

CE ISM 1-A	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.	N10149	The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.
ICES/NMB-001	ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est confomre a la norme NMB-001 du Canada.		This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.
	The CSA mark is a registered trademark of the Canadian Standards Association.		This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.

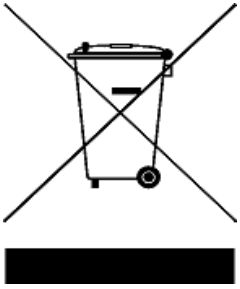
Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a "Monitoring and Control Instrument" product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

Declaration of Conformity (DoC)

The Declaration of Conformity (DoC) for this instrument is available on the Agilent website. You can search the DoC by its product model or description at:

http://regulations.corporate.agilent.com/DoC/search.htm

NOTE If you are unable to search for the respective DoC, please contact your local Agilent representative.

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Table of Contents

List of Figures

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List of Tables

1 Introduction

This chapter teaches you how to set up your tester for the first time. An introduction to all the features of the tester is also given.

About This Manual

Safety notes

The following safety notes are used throughout this manual. More pertinent safety notes for using this product are located under the "Safety Symbols" section.

CAUTION Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the product. Do not proceed beyond a caution notice until the indicated conditions are fully understood and met.

WARNING **Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.**

Preparing Your Tester

Check the shipment

When you receive your tester, check the shipment according to the following procedure.

1. Inspect the shipping container for damage. Signs of damage may include a dented or torn shipping container or cushioning material that indicates signs of unusual stress or compacting. Save the packaging material in case the tester needs to be returned.
2. Carefully remove the contents from the shipping container, and verify that the standard accessories and your ordered options are included in the shipment according to the standard shipped items list found in the printed copy of the *U1452A/U1452AT/U1451A Quick Start Guide*.
3. For any question or problems, refer to the Agilent contact numbers on the back of this manual.

Install or change the batteries

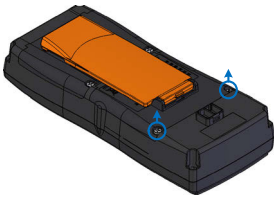
Your tester is powered by four 1.5 V AA alkaline batteries (included in the shipment). When you receive your tester, the batteries are not installed.

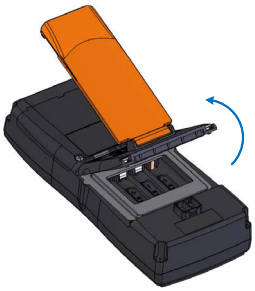
Use the following procedure to install or change the batteries.

CAUTION Before you proceed with the batteries installation, remove all cable connections to the terminals and ensure that the rotary switch is at the OFF position. Use only the battery type specified in the "Product Characteristics" on page 86.

1 Remove the orange rubber holster. Pull from a top corner and stretch the orange rubber holster off the tester.

2 Loosen and remove the two screws with a suitable Phillips screwdriver as shown on the right.

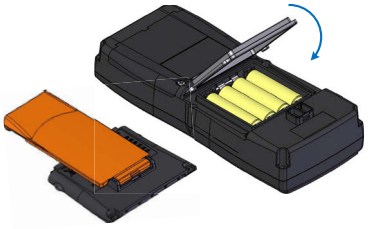


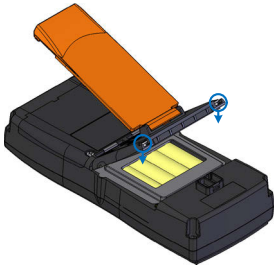


3 Lift up and remove the battery cover as shown on the left.

4 Lift the inner rubber cover to access the battery compartment.

5 Observe the proper batteries polarity. The terminal ends of each battery are indicated inside the battery compartment. Insert four 1.5 V AA batteries.



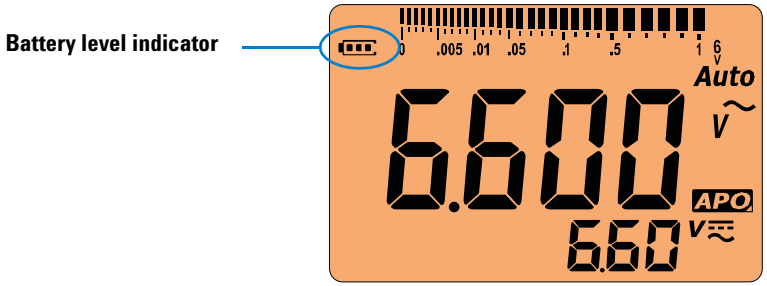


6 Ensure that the inner rubber cover is positioned properly.

7 Replace the battery cover back in its original position and tighten the screws.

8 Finally fit the orange rubber holster back on the tester.

The battery level indicator in the upper left-hand corner of the display indicates the relative condition of the batteries.



Replace the batteries as soon as possible when the low battery indicator ( ) is shown.

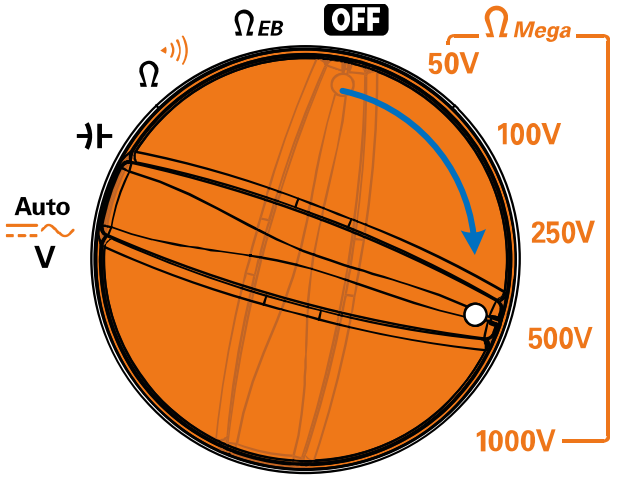
WARNING **To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the low battery indicator appears. Do not discharge the battery by shorting the battery or reverse the battery polarity in any of the subjects.**

CAUTION To avoid instruments being damage from battery leakage:

- Always remove dead batteries immediately.
- Always remove the batteries and store them separately if the tester is not going to be used for a long period.

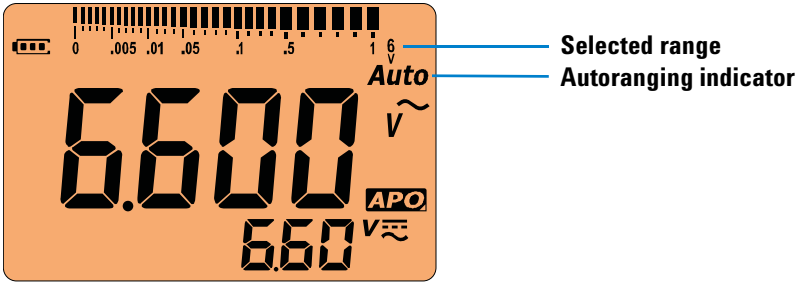
Turn on your tester

To power ON your tester, turn the rotary switch from the OFF position to any other position.



Select the range

The tester's selected range is always displayed on the right-hand end of the bar graph.



Pressing Range changes the tester range (and disables auto-ranging). Each additional press of Range (in manual ranging) sets the tester to the next higher range, unless it is already in the highest range, at which point the range switches to the lowest range.

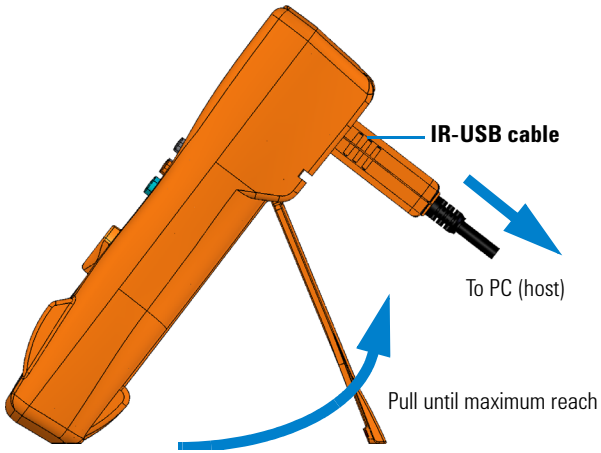
Press and hold Range to switch the tester to **auto-ranging.** Auto-ranging is convenient because the tester automatically selects an appropriate range for sensing and displaying each measurement.

NOTE

- Changing the tester range (and disabling auto-ranging) is not allowed for earth-bond resistance tests and insulation resistance tests.
- In auto-range, the tester selects the lowest range to display the highest available precision (resolution) for the input signal.
- If a reading is greater than maximum available range, **OL** (overload) is shown on the display — except for earth-bond resistance tests and insulation resistance tests where to indicate maximum reading, **>** is shown on the display instead.

Adjust the tilt stand

To adjust the tester to a 60° standing position, pull the tilt-stand outward to its maximum reach.



Connect to the Handheld Meter Logger Software

You can use the IR communication link (IR communication port, located at the rear panel) and the Agilent Handheld Meter Logger Software to control your tester remotely, perform data logging operations, and transfer the contents of your tester's memory to a PC.

Ensure that the Agilent logo on the U1173A IR-USB cable connected to the tester is facing up. Firmly push the IR head into the tester's IR communication port until it snaps into place.

Refer to the *Agilent Handheld Meter Logger Software Help* and *Quick Start Guide* for more information on the IR communication link and the Agilent Handheld Meter Logger Software.

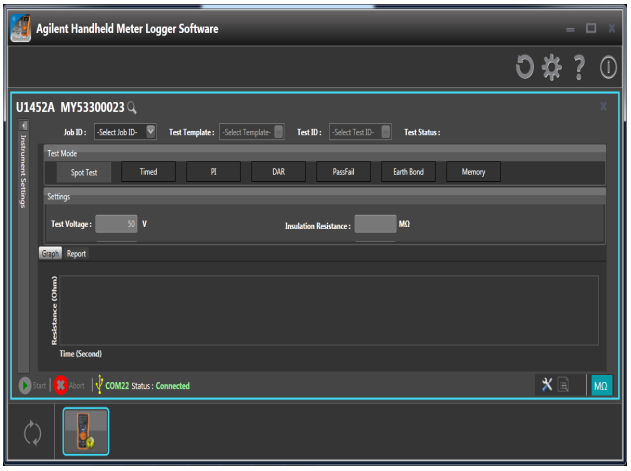


Figure 1-1 Agilent Handheld Meter Logger Software

Connect the Bluetooth adapter

The U1117A Infrared (IR)-to-**Bluetooth**® adapter allows you to connect the tester wirelessly to any Windows PC, Android device, or iOS device.

The U1117A is compatible with the following application or software:

- Agilent Handheld Meter Logger (for Windows PC)
- Agilent Mobile Meter (for Android or iOS devices)
- Agilent Mobile Logger (for Android or iOS devices)

Snap the optic side of the U1117A to the tester's IR communication port (see Figure 1-2).

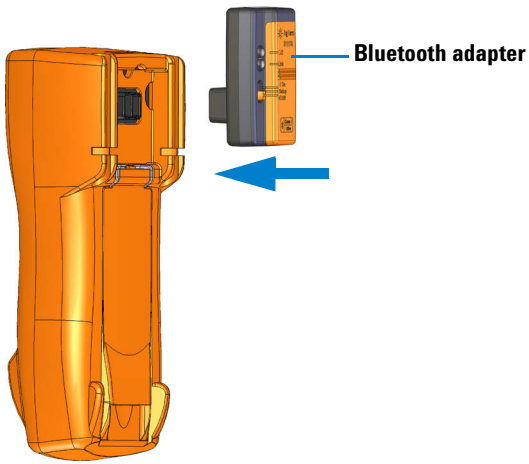


Figure 1-2 Bluetooth adapter connection

Your Tester in Brief

Dimensions

Front view

Figure 1-3 Width dimension

Rear and side view

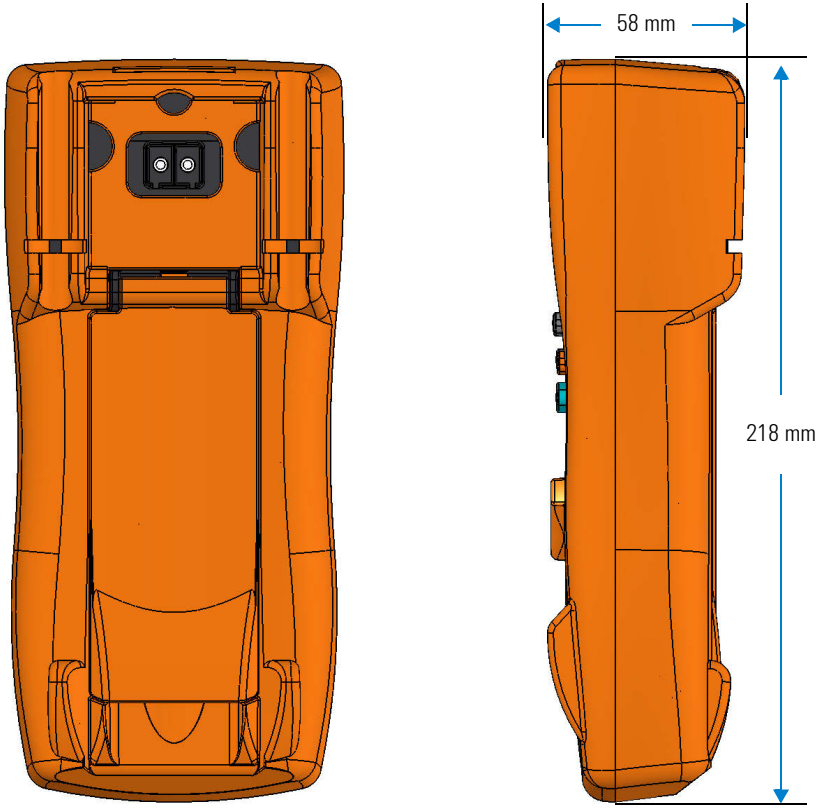


Figure 1-4 Height and depth dimensions

Overview

Front panel

The front panel parts of your tester are described in this section.

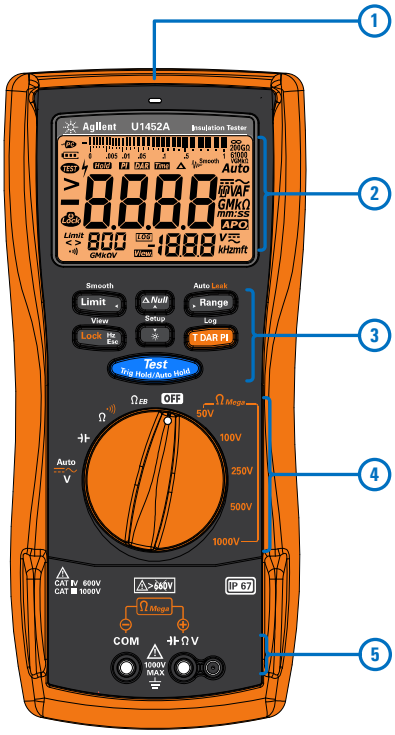


Table 1-1 Front panel part descriptions

Legend	Description	Learn more on:
1	Red LED indicator	page 54
2	Display screen	page 20
3	Keypad	page 16
4	Rotary switch	page 14
5	Input terminals	page 24

Rear panel

The rear panel parts of your tester are described in this section.

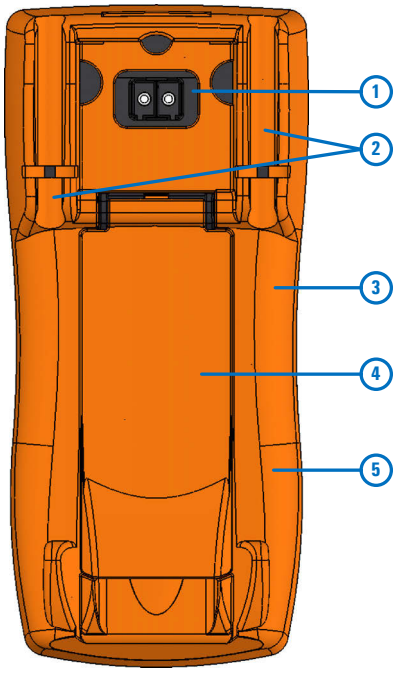


Table 1-2 Rear panel parts

Legend	Description	Learn more on:
1	IR communication port	page 8
2	Test lead/probe holders	-
3	Battery access (under the orange rubber holster)	page 3
4	Tilt stand	page 7
5	Fuse access (under the orange rubber holster)	-

Rotary switch

The measurement functions for each rotary switch position are described in Table 1-3. Turning the rotary switch changes the measurement function and resets all other measurement options.

WARNING **Remove the test leads from the measuring source or target before changing the rotary switch position.**

NOTE Press T DAR PI to select the alternate measurement function(s) or test methods for insulation resistance tests. See page 16 for more information on the T DAR PI key.

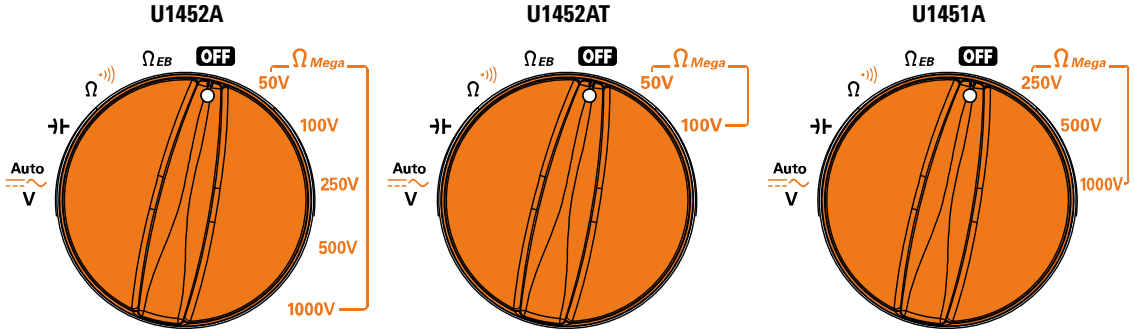


Table 1-3 U1452A/U1452AT/U1451A rotary switch functions

Legend	Measurement function	U1452A	U1452AT	U1451A	Learn more on:
ΩMega 50V	50 V Insulation resistance test	✔	✔	-	page 38
	T - Timed test	✔	✔	-	
	DAR - Dielectric Absorption Ratio test	✔	✔	-	
	PI - Polarization Index Test	✔	✔	-	

Table 1-3 U1452A/U1452AT/U1451A rotary switch functions (continued)

Legend	Measurement function	U1452A	U1452AT	U1451A	Learn more on:
Ω Mega 100V	100 V Insulation resistance test	✔	✔	-	page 38
	T - Timed test	✔	✔	-	
	DAR - Dielectric Absorption Ratio test	✔	✔	-	
	PI - Polarization Index Test	✔	✔	-	
Ω Mega 250V	250 V Insulation resistance test	✔	-	✔	page 38
	T - Timed test	✔	-	✔	
	DAR - Dielectric Absorption Ratio test	✔	-	-	
	PI - Polarization Index Test	✔	-	-	
Ω Mega 500V	500 V Insulation resistance test	✔	-	✔	page 38
	T - Timed test	✔	-	✔	
	DAR - Dielectric Absorption Ratio test	✔	-	-	
	PI - Polarization Index Test	✔	-	-	
Ω Mega 1000V	1000 V Insulation resistance test	✔	-	✔	page 38
	T - Timed test	✔	-	✔	
	DAR - Dielectric Absorption Ratio test	✔	-	-	
	PI - Polarization Index Test	✔	-	-	
Ω EB	Earth-bond resistance test	✔	✔	✔	page 38
	T - Timed test	✔	✔	✔	
Ω	Resistance measurement	✔	✔	✔	page 46
	Continuity test	✔	✔	✔	page 48
⊣⊢	Capacitance measurement	✔	✔	✔	page 50
Auto V	Auto voltage measurement	✔	✔	✔	page 30
	DC voltage measurement	✔	✔	✔	
	AC voltage measurement	✔	✔	✔	

Keypad

The operation of each key is explained in Table 1-4 below. Pressing a key enables a function, displays a related symbol, and emits a beep. Turning the rotary switch to another position resets the current operation of the key.

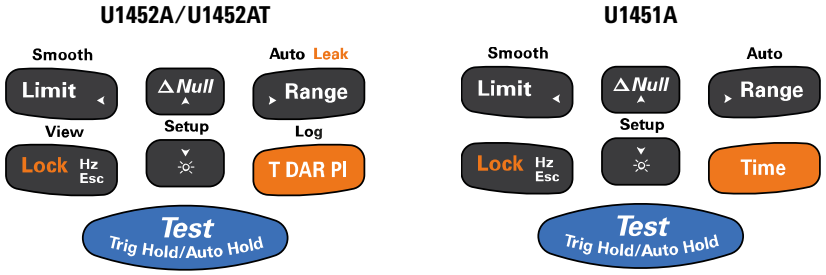


Table 1-4 U1452A/U1452AT/U1451A keypad functions

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
	Insulation Resistance (IR) Test: Initiates an IR test (when the rotary switch is in one of the Ω Mega positions) as long as Test Trig Hold/Auto Hold is held — the tester sources (outputs) a high voltage and measures insulation resistance and TEST is shown on the display.	
	Earth-Bond Resistance (EBR) Test: Initiates an EBR test (when the rotary switch is in the Ω EB position) as long as Test Trig Hold/Auto Hold is held — the tester measures earth-bond resistance and TEST is shown on the display.	
Test Trig Hold/Auto Hold	**Trig Hold:** Freezes the present reading in the display (except when the rotary switch is in one of the Ω Mega positions or in the Ω EB position). • In TrigHold mode, press Test Trig Hold/Auto Hold to manually trigger the holding of the next measured value. • Press and hold Test Trig Hold/Auto Hold again to exit this mode.	**Auto Hold:** Automatically freezes the present reading once the reading is stable (except when the rotary switch is in one of the Ω Mega positions or in the Ω EB position). • In AutoHold mode, the reading is updated automatically once the reading is stable and the count setting is exceeded. • Press and hold Test Trig Hold/Auto Hold again to exit this mode.

Table 1-4 U1452A/U1452AT/U1451A keypad functions (continued)

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
U1451A 	**Lock:** Press Lock Hz Esc to lock the insulation test or earth-bond resistance test (when the rotary switch is in the appropriate position). Press Lock Hz Esc > Test Trig Hold/Auto Hold to initiate an IR or EBR test. The test will remain active until you press Lock Hz Esc or Test Trig Hold/Auto Hold again to release the lock.	**View:** Press and hold Lock Hz Esc to enter the Log Review menu. • Press Lock Hz Esc to cycle through the previously recorded manual (**VIEW H**), interval (**VIEW A**), or event (**VIEW E**) logging data. • Press Limit . or . Range to view first or last logged data respectively. • Press Δ Null ^ or ˅ to scroll through the logged data. • Press T DAR PI to delete the last logged data. • Press and hold T DAR PI to clear all the logged data for the selected logging mode. • Press and hold Lock Hz Esc again to exit this mode.
U1452A/U1452AT View 	**Hz:** Press Lock Hz Esc to display the frequency for voltage or current measurements. Press Lock Hz Esc again to disable the frequency display.	
	Esc: Press Lock Hz Esc in the Setup menu to discard your changes.	
U1451A 	Press T DAR PI to switch or cycle between the default and **alternate** measurement function(s). **T**: Configures the tester for a timed test (when the rotary switch is in one of the Ω Mega positions or the Ω EB position). The test will start when you press Test Trig Hold/Auto Hold.	**Log:** The recording option (HAND, AUTO, or TRIG) must first be selected in the Setup menu (see page 80). • HAND (manual data logging) — Press and hold T DAR PI to log the present reading into the memory. The display will return to normal after a short while (≈ 1 second). To manually log another reading, press and hold T DAR PI again. • AUTO (automatic data logging) — Press and hold T DAR PI to enable the automatic data logging mode, where data is logged at the interval defined in the Setup menu (see page 79). Press and hold T DAR PI again to exit this mode. • TRIG (event data logging) — Press and hold T DAR PI to enable the event data logging mode, where data is logged each time a triggering condition is satisfied (see page 62). Press and hold T DAR PI again to exit this mode.
U1452A/U1452AT Log 	**DAR**: Configures the tester for a dielectric absorption ratio test (when the rotary switch is in one of the Ω Mega positions). The test will start when you press Test Trig Hold/Auto Hold.	
	PI: Configures the tester for a polarization index test (when the rotary switch is in one of the Ω Mega positions). The test will start when you press Test Trig Hold/Auto Hold.	

Table 1-4 U1452A/U1452AT/U1451A keypad functions (continued)

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
Smooth Limit	**Limit:** Press Limit to enable the comparison for limit mode. • Press Limit again to set the comparison value. Use the arrow keys to change the value shown and press T.DAR/# to save your changes. • Press and hold Limit to exit this mode.	**Smooth:** Press and hold Limit to smoothen the refresh rate of the readings. Press and hold Limit again to exit this mode.
U1451A Auto Range	**Range:** Press Range to set a manual range and disable auto-ranging. Press Range again to cycle through each available measurement range.	**Auto:** Press and hold Range to enable auto-ranging.
U1452A/U1452AT Auto Leak Range	**Leak:** Press Range to display the leakage current.	
△Null	**Null:** Press △Null to enable the relative function. • The displayed value is saved as a reference to be subtracted from subsequent measurements. • Press △Null again to view the stored reference value that has been saved. The display will return to normal after a brief period of time (approx. 3 seconds). • Pressing △Null while the stored reference value is being displayed will cancel the relative function.	-

Table 1-4 U1452A/U1452AT/U1451A keypad functions (continued)

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
Setup 	☼: Press ☼ to enable or disable the LCD backlight.	**Setup:** Press and hold ☼ to enter the Setup menu. • In the Setup menu, press Limit or Range to navigate through the menu pages. Press Δ Null or ☼ at each menu page to move the cursor to a specific menu item. • Press T DAR PI to change the value of the selected menu item. Use the arrow keys to change the value shown. • Press T DAR PI again to save your changes, or press Lock to discard your changes. • Press and hold ☼ again to exit the Setup menu.

Display screen

The display annunciators of your tester are described in this section. See also "Measurement units" on page 22 for a list of available measurement signs and notations and "Analog bar graph" on page 23 for a tutorial on the analog bar graph located at the bottom of your display screen.

Display annunciators

The display annunciators of your tester are described in the Table 1-5.

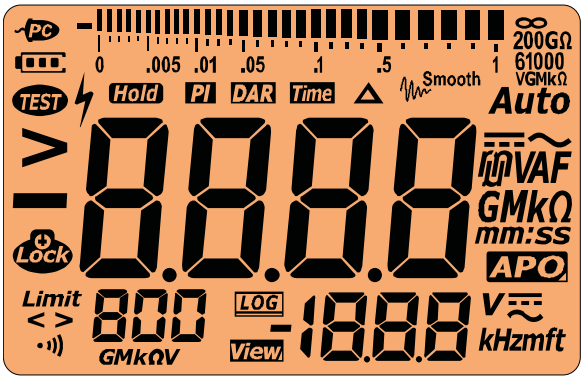


Figure 1-5 Display screen allocation example

Table 1-5 General annunciators

Legend	Description
PC	Remote control enabled
	Battery capacity indication
	Analog bar graph
TEST	Test indication for insulation resistance and earth-bond resistance tests
	Hazardous voltage sign for measuring voltage ≥30 V or OL (overload)

Table 1-5 General annunciators (continued)

Legend	Description
Hold	Auto hold/Trigger hold enabled
PI	Polarization Index test enabled
DAR	Dielectric Absorption Ratio test enabled
Time	Timed test enabled
Δ	Relative (Null) enabled
Smooth	Smooth mode enabled
Auto	Auto-ranging enabled or Auto signal indicator enabled
>	Greater than range (for insulation resistance and earth-bond resistance tests)
Lock	Test and Test Lock indication for insulation resistance and earth-bond resistance tests
-8.8.8.8	Primary display
⎓ ~	AC or DC indication
nVAF GMkΩ	Measuring units for primary display
mm:ss	Test time indication for earth-bond resistance and insulation resistance tests
APO	APO (Auto Power-Off) enabled
Limit < >	Limit comparison enabled
LOG	Data logging in progress

Table 1-5 General annunciators (continued)

Legend	Description
View	View mode for reviewing previously logged data
•))	Audible continuity test selected
-1888	Secondary display
V kHzmft	Measuring units and AC+DC indication for secondary display
800	Tertiary display
GMkΩV	Measuring units for tertiary display

Measurement units

The available signs and notations for each measurement function in your tester are described in Table 1-6. The units listed below are applicable to the primary display and secondary display measurements of your tester.

Table 1-6 Measurement units display

Sign/Notation	Description	
G	Giga	1E+09 (1000000000)
M	Mega	1E+06 (1000000)
k	kilo	1E+03 (1000)
n	nano	1E–09 (0.000000001)
µ	micro	1E–06 (0.000001)
m	milli	1E–03 (0.001)
mV, V	Voltage, units for voltage measurement	
nF, µF, mF	Farad, units for capacitance measurement	

Table 1-6 Measurement units display (continued)

Sign/Notation	Description
Ω, kΩ, MΩ, GΩ,	Ohm, units for resistance measurement
kHz, Hz	Hertz, units for frequency measurement
m	Meter, unit for length
ft	Feet, unit for length

Analog bar graph

The analog bar emulates the needle on an analog tester, without displaying the overshoot.

NOTE

For frequency measurements, the bar graph does not represent the primary display value.

For example, when frequency is displayed on the primary display during voltage measurement, the bar graph represents the voltage value (not the frequency value).

The "–" sign indicates that the measured or calculated value is negative. Each segment is presented as a ratio to the range value indicated on the peak bar-graph. The unit and range will be indicated according to various measurements (see Table 1-7).

Table 1-7 Analog bar graph display

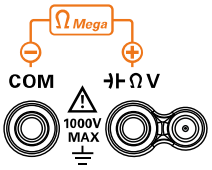
Function	Bar graph
V	
Ω , Ω EB , Ω Mega	
⊣⊢	

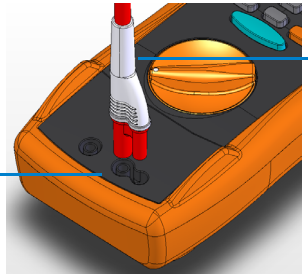
Input terminals

WARNING **To avoid damaging this device, do not exceed the input limit.**

The terminal connections for the different measurement functions of your tester are described in the table below.

Table 1-8 Terminal connections for different measuring functions

Rotary switch position	Input terminals	Overload protection
Auto V		1000 Vrms
Ω ⊣⊢		1000 Vrms for short circuit <0.3 A
ΩEB ΩMega 50V ΩMega 100V ΩMega 250V ΩMega 500V ΩMega 1000V		440 mA/1000 V, 30 kA fast-acting fuse



Remote switch probe terminal for IR and EBR tests

The remote switch probe is used for insulation resistance (IR) and earth-bond resistance (EBR) tests.

Figure 1-6 Connecting the remote switch probe

Cleaning Your Tester

WARNING **To avoid electrical shock or damage to the tester, ensure that the insides of the casing stay dry at all times.**

Dirt or moisture in the terminals can distort readings. Follow the steps below to clean your tester.

1 Turn the tester off, and remove the test leads.

2 Turn the tester over, and shake out any dirt that may have accumulated in the terminals.

Wipe the case with a damp cloth and mild detergent – do not use abrasives or solvents. Wipe the contacts in each terminal with a clean swab dipped in alcohol.

Additional Features

Automatic power-off

Your tester automatically turns off if the rotary switch is not moved or a key is not pressed for 10 minutes (default). Pressing any key will turn the tester back on after it is powered off automatically.

To change the timer period or completely disable the automatic power-off, refer to "Changing the auto power-off (APO) timer" on page 73.

Hazardous voltage indication

The tester will display the hazardous voltage (ϟ) symbol as an early precaution when the measured voltage is equal to or greater than ±DC 30 V or AC 30 V, or when the measured voltage is over the measurement range, **OL** (overload).

Power-on options

Some options can be selected only while you turn the tester on. These power-on options are listed in the table below. To select a power-on option, press and hold the specified key while turning the rotary switch from the OFF position to any other position. Power-on options remain selected until the tester is turned off.

Table 1-9 Power-on options

Key	Description
Limit	Simulates the Auto Power-Off (APO) mode. Press any key to turn the tester back on and resume normal operation.
Range	Checks firmware version. The tester's firmware version will be shown on the primary display. Press any key to exit this mode.

Table 1-9 Power-on options (continued)

Key	Description
	Toggles the red LED indicator alert for insulation resistance tests. If enabled, the red LED indicator will blink every two seconds during an insulation resistance test. The red LED indicator alert is disabled when the Limit feature (see page 57) is enabled.
U1451A  **U1452A/U1452AT** Log 	Change the resolution count to high. To permanently enable change the resolution count. See "Changing the display count" on page 76.
	Tests the LCD. All LCD annunciators are lighted. Press any key to exit this mode.

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2
Making Measurements

The following sections describe how to take measurements with your tester.

Insulation Resistance Test

Set up your tester as shown in Figure 2-1. Set the rotary switch to a test voltage value that does not exceed the maximum voltage limitation of the circuit under test. Ensure that the device-under-test (DUT) is de-energized before performing any resistance measurement.

Table 2-1 Rotary switch position for insulation resistance tests

Legend	Default function		Function when T DAR PI is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
Ω Mega 50V	50 V insulation resistance test	AC+DC V or DC V (during test)	**1** Timed (T) test **2** Dielectric Absorption Ratio (DAR) test **3** Polarization Index (PI) test	AC+DC V or DC V (during test)
Ω Mega 100V	100 V insulation resistance test			
Ω Mega 250V	250 V insulation resistance test			
Ω Mega 500V	500 V insulation resistance test			
Ω Mega 1000V	1000 V insulation resistance test			

CAUTION

- **DO NOT** perform insulation resistance test in distribution systems with voltages higher than 600 V.
- The tester automatically detects if the circuit is energized. If the external voltage is detected to be greater than 30 V (or 50 V or 75 V; depending on selected option in Setup), the test is inhibited. The symbol ϟ is shown on the display when either the external voltage or the test voltage is greater than 30 V. Disconnect the tester and remove the power of the circuit before proceeding.

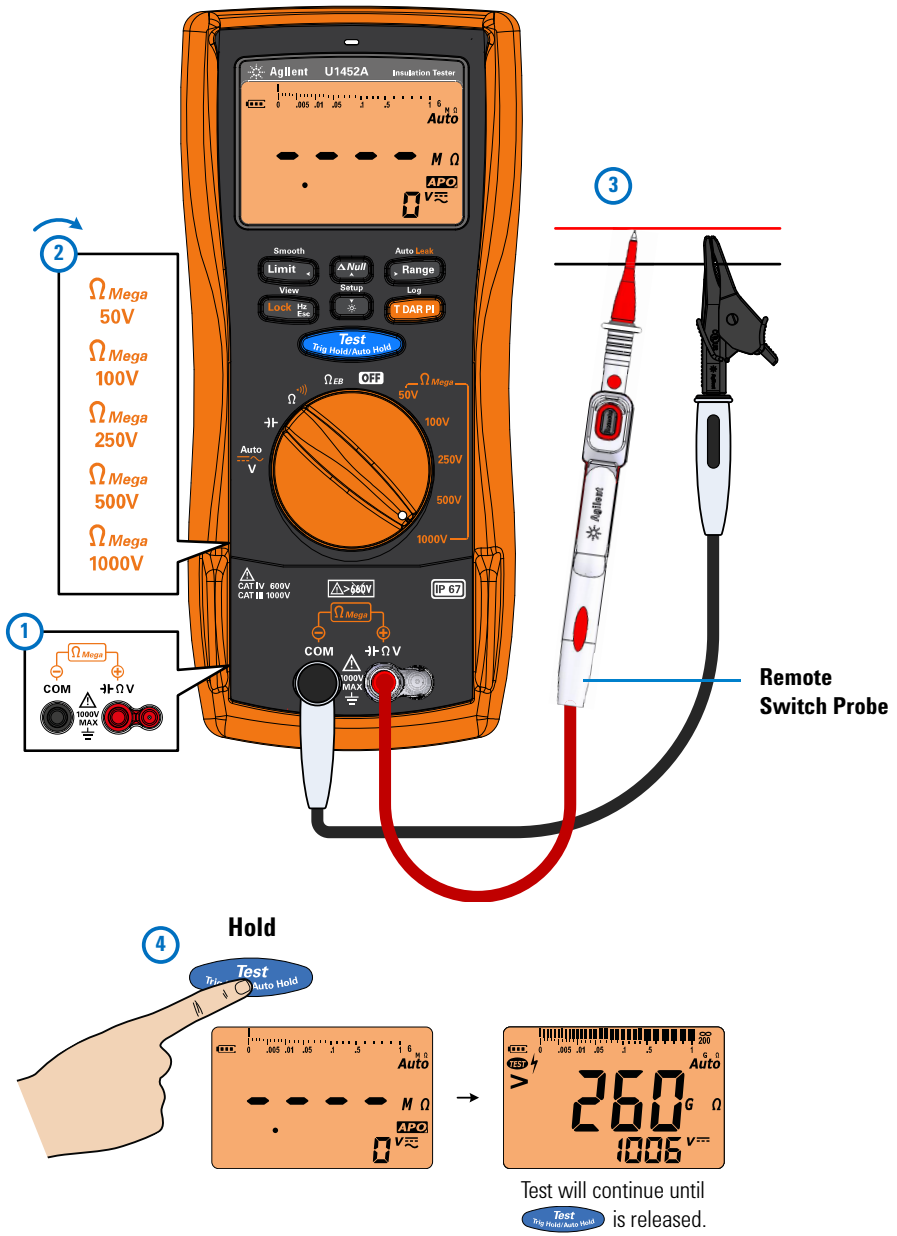


Figure 2-1 Insulation resistance test example

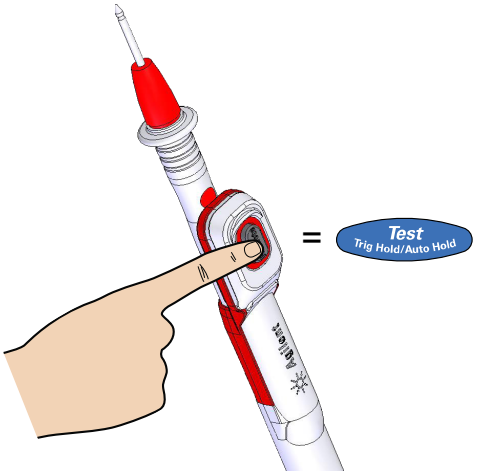
CAUTION The insulation meter will auto-discharge the DUT when the test complete. However, the DUT will not be auto-discharged when you disconnect the probe before the test is complete. Avoid touching the DUT when the DUT is not fully discharged as it may lead to possible electric shock.

NOTE When an insulation test is in progress, the red LED indicator at the top of the tester will blink every 2 seconds (if the Limit function is not enabled). To disable this feature see "Power-on options" on page 26.

Using the Remote Switch Probe

The Remote Switch Probe (included in shipment) is used with insulation resistance tests and earth-bond resistance tests, enabling the tester to be controlled remotely from the button on the Remote Switch Probe.

By default the button on the Remote Switch Probe emulates the Test Trig Hold/Auto Hold button on the tester.

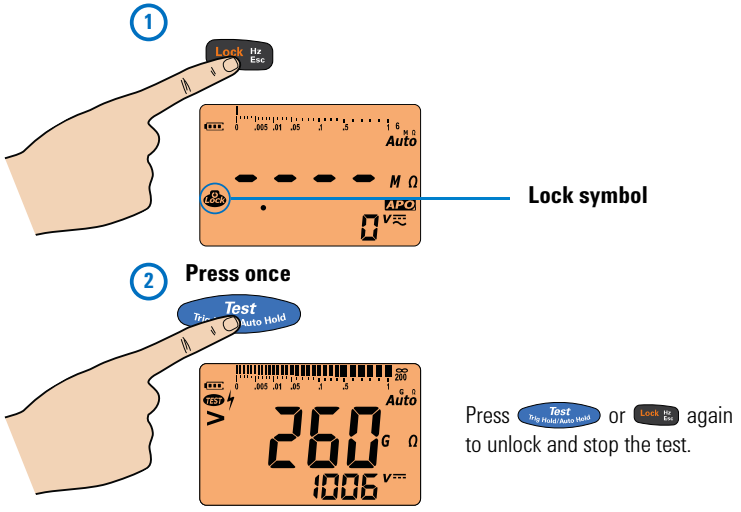


To change the default button operation, see "Changing the button operation on the remote switch probe" on page 82

Locking the test

You can lock the insulation resistance tests or earth-bond resistance tests temporarily.

Press Lock to enable the *lock once* feature. The Lock symbol will be shown on the display. The test will start when you press Test, and it remain active until Test or Lock is pressed again.



By default, the tester will reset the locked status when the test is stopped by pressing Test or Lock. See "Changing the Dielectric Absorption Ratio (DAR) for IR tests" on page 83 to disable this feature.

If you disable this feature, you will need to press Lock to unlock the tester, even if the test has already stopped.

Timed insulation resistance/earth-bond resistance test

Use the timed test to obtain measurement results with consistent test times — for later comparisons. Set up your tester as shown in Figure 2-1, and follow the steps shown below.

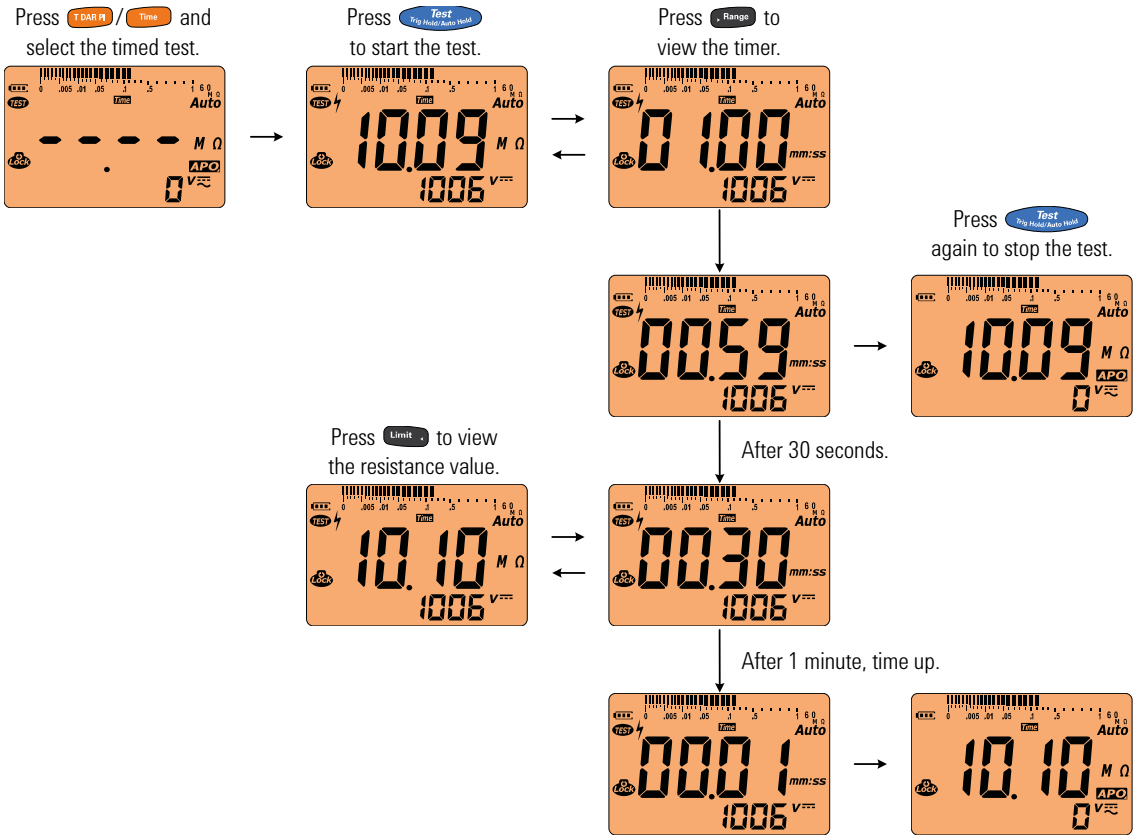


Figure 2-2 T/Time operation

Measuring the Dielectric Absorption Ratio (DAR)

Dielectric Absorption Ratio (DAR) is the ratio of the insulation resistance tested at 60 seconds to the insulation resistance tested at 30 seconds. Set up your tester as shown in Figure 2-1, and follow the steps shown below.

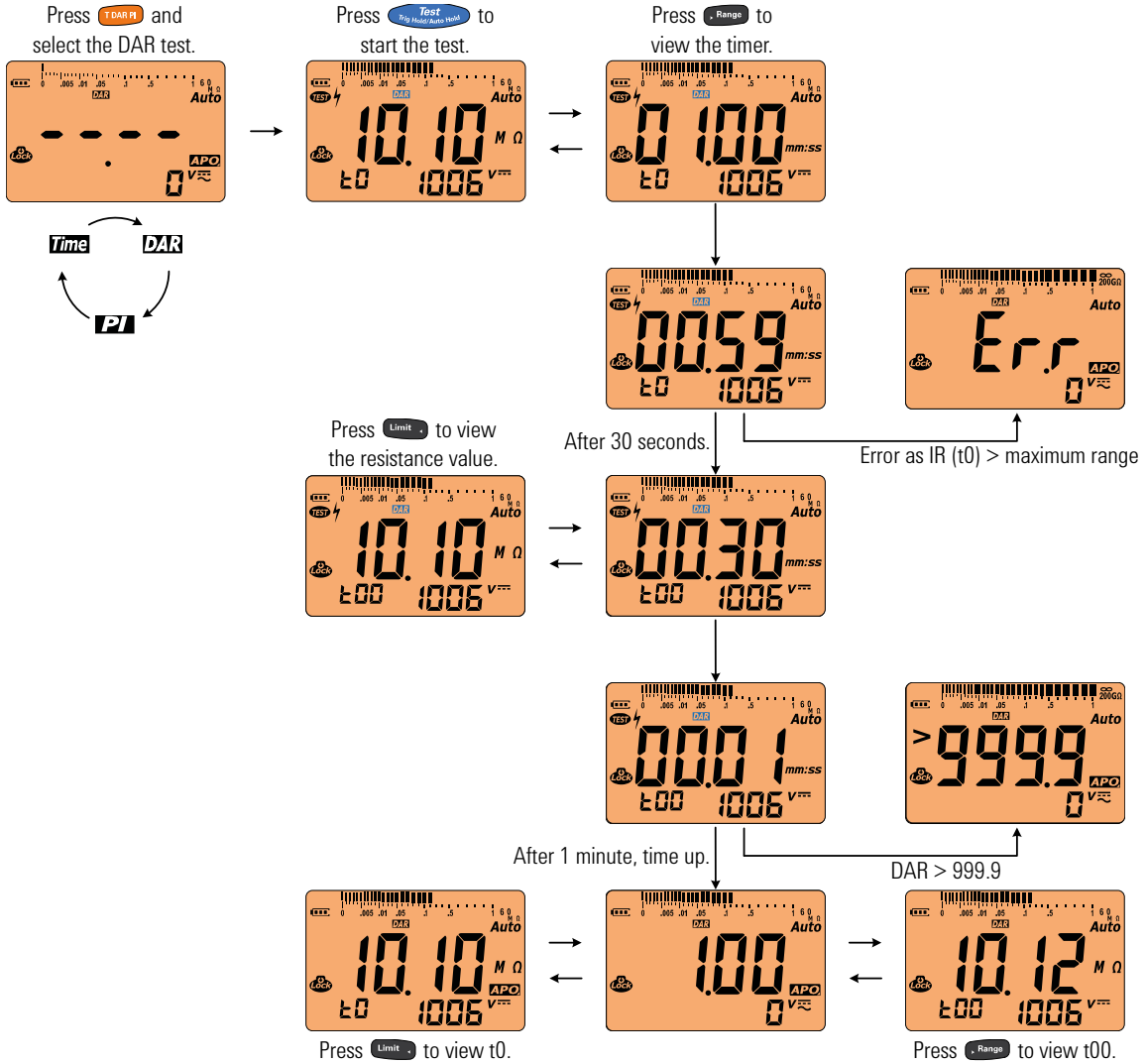


Figure 2-3 DAR operation

Measuring the Polarization Index (PI)

Polarization Index (PI) is the ratio of the insulation resistance tested at 10 minutes to the insulation resistance tested at 1 minute. Set up your tester as shown in Figure 2-1, and follow the steps shown below.

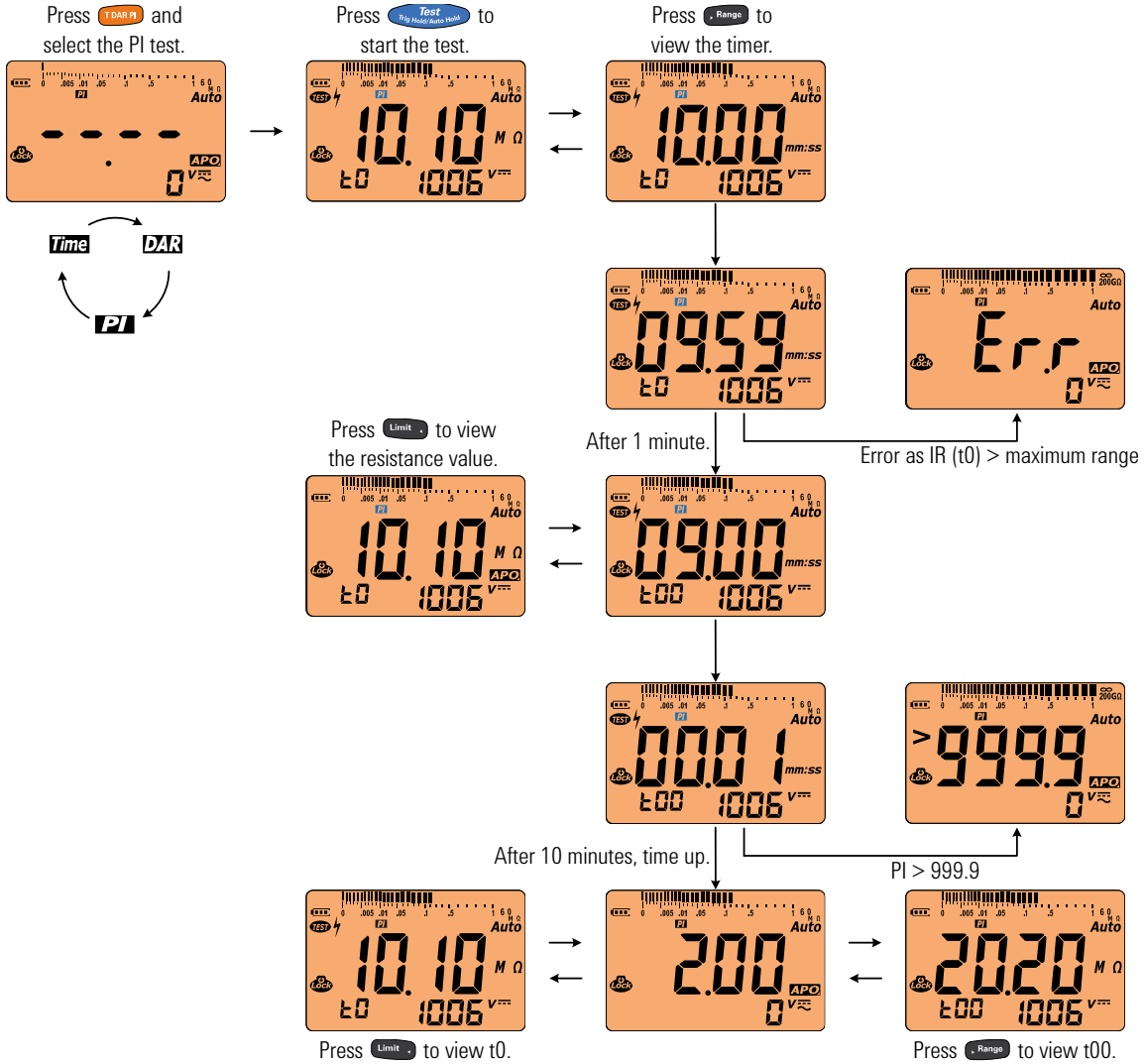


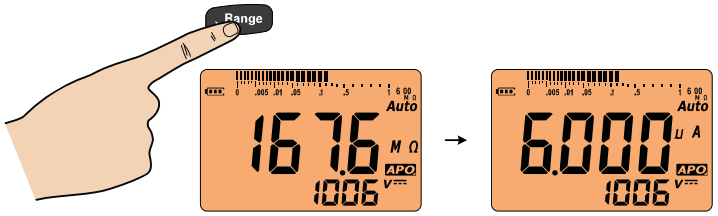
Figure 2-4 PI operation

NOTE

- Because of the time required to perform the T, PI, and DAR tests, the use of alligator test clips is recommended.
- For timed (page 34) tests, The length of the timer is 1 minute by default. To change this value, see "Changing the IR and EBR test period" on page 80 for more information.
- For DAR (page 35) tests, you can change the DAR from 60:30 to 60:15 in the Setup. See "Changing the Dielectric Absorption Ratio (DAR) for IR tests" on page 83 for more information.
- For DAR (page 35) and PI (page 36) tests, **Err** is shown on the display if the IR is greater than the maximum range or less than 0.001 MΩ; if the test is interrupted by the user; or if the tester's battery is low.

Viewing the leakage current

Press Range to view the leakage current display. The leakage current display is related to the insulation resistance. The higher the resistance tested, the lower the current is to be measured.



Earth-Bond Resistance Test

Set up your tester to perform earth-bond resistance tests as shown in Figure 2-5.

Table 2-2 Earth-bond resistance test position

Legend	Default function		Function when T DAR PI is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
Ω_{EB}	Earth-bond resistance test	AC+DC V or DC V (during test)	Timed (T) test	AC+DC V or DC V (during test)

CAUTION

- To avoid possible damage to your tester or to the equipment under test, disconnect the circuit power and discharge all high-voltage capacitors before measuring resistance.
- The tester automatically detects if the circuit is energized. If the external voltage is detected to be greater than 2 V, the test will not start. Disconnect the tester and remove power before proceeding.

NOTE

- The earth-bond resistance function is used to measure the resistance between earth conductors, protective earth conductors, and conductors for equipotential bonding; including their connections and terminals; with an indication of the measured value or indication of limits.
- The voltage source is <6.8 V, and the current is >200 mA when the resistance of ≤2 Ω is to be measured. When the source voltage is <4.7 V, the tester will inhibit the test automatically. The secondary display indicates the voltage (with auto-ranging enabled).
- The APO (auto power-off) function is disabled during the test.
- See also "Timed insulation resistance/earth-bond resistance test" on page 34.

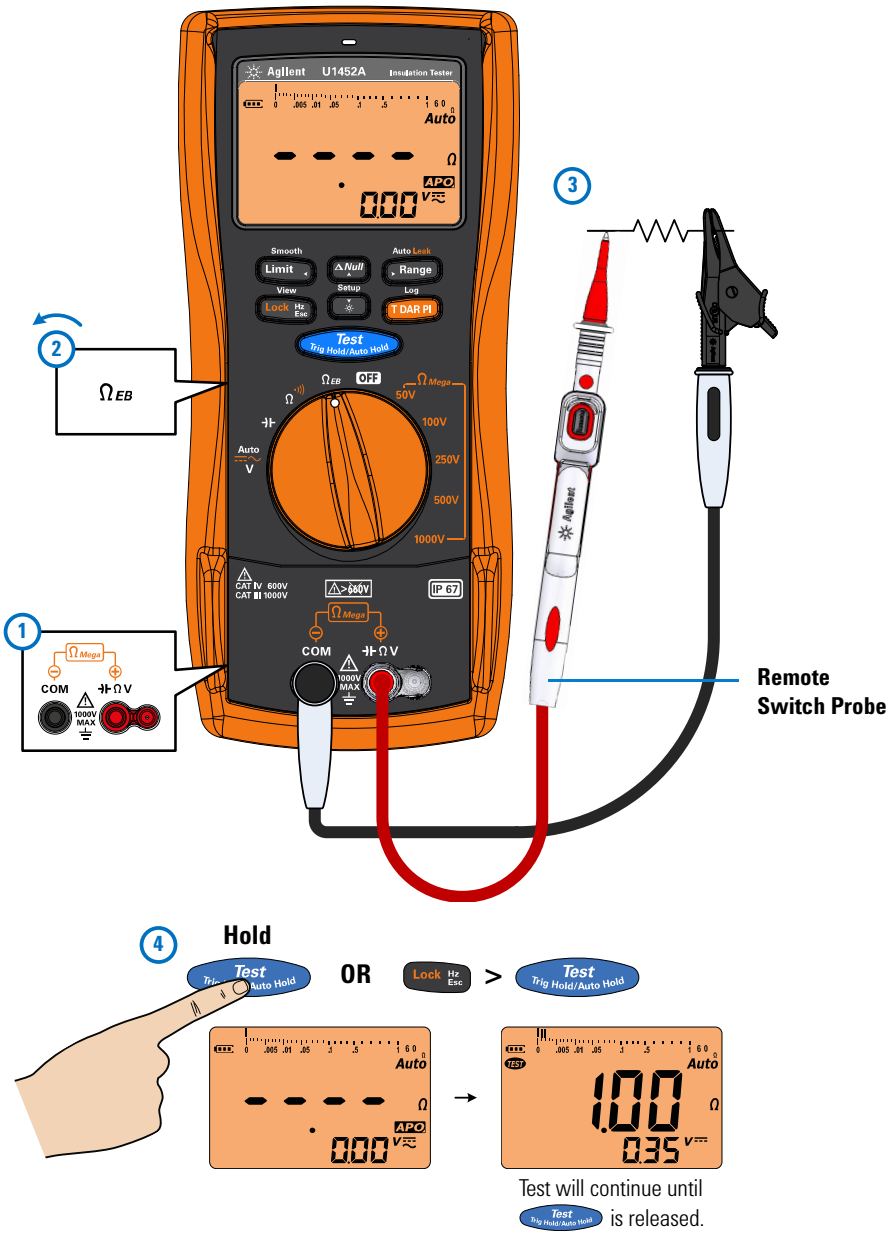
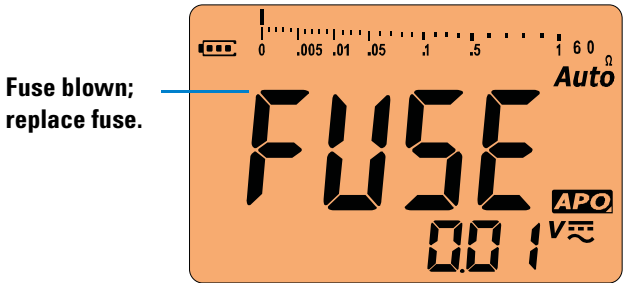


Figure 2-5 Earth-bond resistance test example

Using the earth-bond resistance test to verify the fuse condition

1. Keep the test leads open, and ensure that no voltage is applied to the terminals.
2. Press and hold Test (Trig Hold/Auto Hold) to verify the fuse condition.
3. If the fuse has been blown, **FUSE** will be shown on the display. Follow the instructions in the *U1452A/U1452AT/U1451A Service Guide* to replace the fuse.



Measuring AC or DC Voltage

Set up your tester to measure AC or DC voltage as shown in Figure 2-6.

Table 2-3 AC and DC voltage measurement positions

Legend	Default function		Function when T DAR PI is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
Auto V	Auto (V)	AC+DC V	**1** DC V **2** AC V **3** Auto (V)	**1** AC+DC V **2** AC+DC V **3** AC+DC V

NOTE

- This tester displays DC voltage values as well as their polarity. Negative DC voltages will return a negative sign on the left of the display.
- Press Lock Hz Esc to measure the frequency of the voltage source. See "Measuring Frequency" on page 44 to learn more.

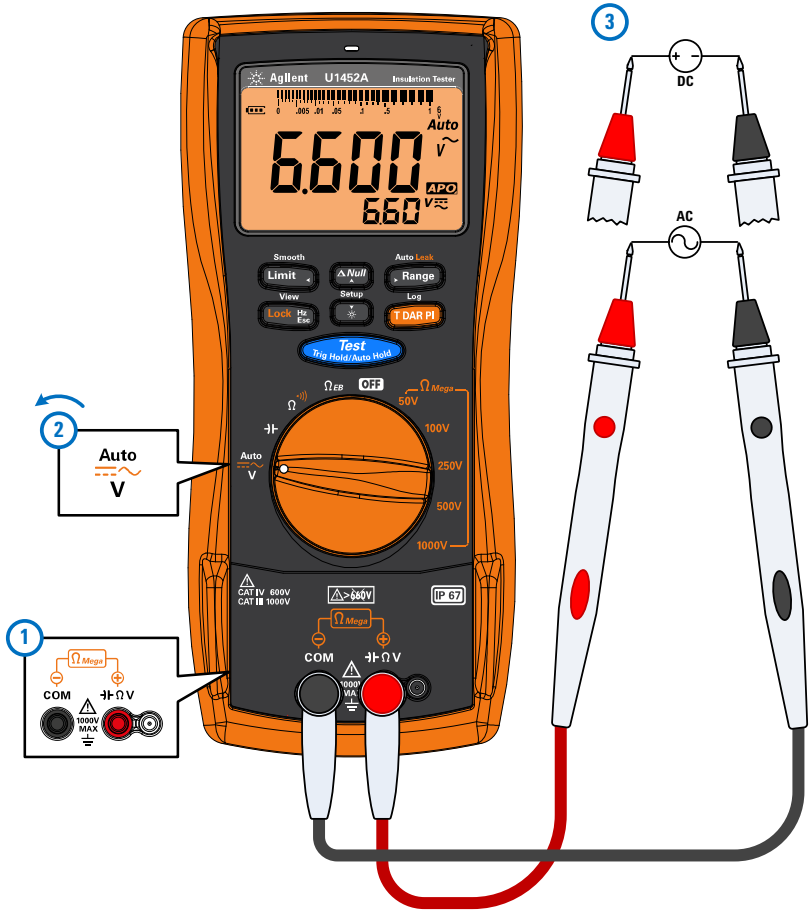
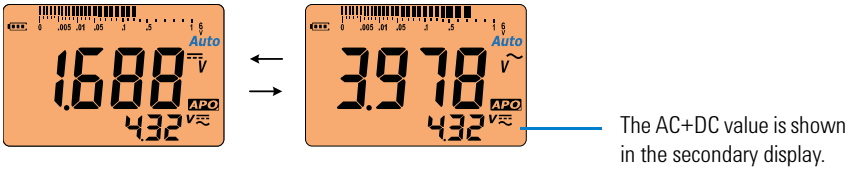


Figure 2-6 AC or DC voltage measurement example

Auto AC or DC signal identification

The **Auto** function is able to automatically identify the signal component (AC or DC) of an electrical source and select a suitable measurement range according to the AC+DC reading.

The symbol *Auto* blinks during the identification.



The **Auto** function identifies the signal component using the following rules:

- It will consider which component value is greater between the AC or DC.
- The AC value should be greater than a minimum value of 50 counts (based on 6000 counts) of range to prevent residual value due to range changing.
- The frequency measured is greater than 10 Hz for the AC mode.

While the signal is being identified, you can press T DAR PI to lock the (AC or DC) signal on the primary display.

At any time, you can press Range to stop the **Auto** function and lock the identified signal component (AC or DC).

Measuring Frequency

Your tester allows simultaneous monitoring of real-time voltage with frequency measurements. To measure frequency, rotate the switch to measure voltage (see Figure 2-6) and set up the tester accordingly.

Press Lock Hz Esc. Probe the test points, and read the display.

WARNING **Never measure the frequency where the voltage level exceeds the specified range. Manually set the voltage range if you want to measure frequencies below 20 Hz.**

NOTE

- Pressing Range controls the input range of the voltage function and not the frequency range.
- To obtain the best measuring results for frequency measurements, please use the AC measuring path.

Frequency measurement techniques

- Measuring the frequency of a signal helps detect the presence of harmonic currents in neutral conductors and determines whether these neutral currents are the result of unbalanced phases or non-linear loads.
- Frequency is the number of cycles a signal completes each second. Frequency is defined as 1/Period. Period is defined as the time between the middle threshold crossings of two consecutive, like-polarity edges, as shown in Figure 2-7.
- The tester measures the frequency of a voltage signal by counting the number of times the signal crosses a threshold level within a specified period of time.
- If a reading shows as 0 Hz or is unstable, the input signal may be below or near the trigger level. You can usually correct these problems by manually selecting a lower input range, which increases the sensitivity of the tester.

- If a reading seems to be a multiple of what you expect, the input signal may be distorted. Distortion can cause multiple triggerings of the frequency counter. Selecting a higher voltage range might solve this problem by decreasing the sensitivity of the tester. In general, the lowest frequency displayed is the correct one.
- The frequency of the input signal is shown in the primary display. The voltage value of the signal is shown in the secondary display. The bar graph does not indicate frequency but indicates the voltage value of the input signal.

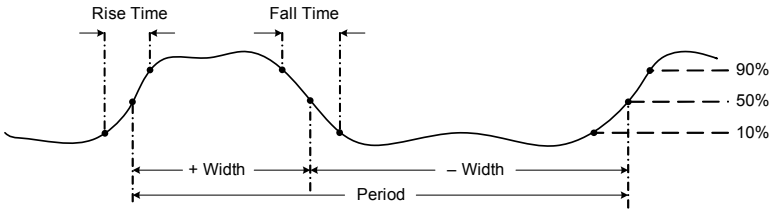


Figure 2-7 Definition of frequency

Measuring Resistance

Set up your tester to measure resistance as shown in Figure 2-8.

Table 2-4 Resistance measurement position

Legend	Default function		Function when T DAR PI is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
Ω)))	Resistance	-	Continuity	-

CAUTION To avoid possible damage to your tester or to the equipment under test, disconnect the circuit power and discharge all high-voltage capacitors before measuring resistance.

NOTE Resistance (opposition to the current flow) is measured by sending a small current out through the test leads to the circuit under test. Because this current flows through all possible paths between the leads, the resistance reading represents the total resistance of all paths between the leads. Resistance is measured in ohms (Ω).

Keep the following in mind when measuring resistance.

- The test leads can add 0.1 Ω to 0.2 Ω of error to resistance measurements. To test the leads, touch the probe tips together and read the resistance of the leads. To remove lead resistance from the measurement, hold the test lead tips together and press Δ Null. Now the resistance at the probe tips will be subtracted from all future display readings.
- Because the tester's test current flows through all possible paths between the probe tips, the measured value of a resistor in a circuit is often different from the resistor's rated value.

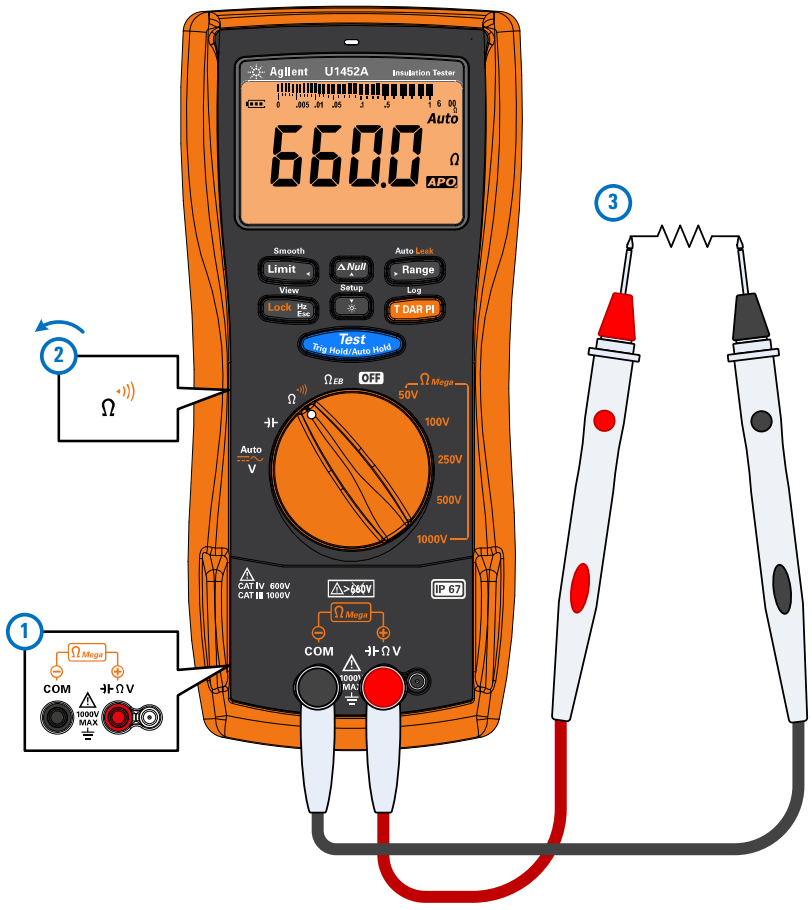


Figure 2-8 Resistance measurement example

Continuity Test

Set up your tester to perform continuity tests as shown in Figure 2-9. The beeper will sound and the red will light LED up as a continuity indication.

Table 2-5 Continuity test position

Legend	Default function		Function when T DAR H is pressed	
Rotary switch position	Primary display	Secondary display	Primary display	Secondary display
Ω)))	Resistance	-	Continuity	-

CAUTION To avoid possible damage to your tester or to the equipment under test, disconnect the circuit power and discharge all high-voltage capacitors before testing for continuity.

NOTE

- Continuity is the presence of circuit continuities. The beeper sounds as the resistance falls down to the threshold, and the red LED indicator will be lit (if enabled in the Setup). The audible and visual alert allows you to perform quick continuity tests without having to watch the display.
- The continuity function detects intermittent shorts and opens. A brief short causes the tester to emit a short beep.
- You can enable or disable the audible alert via the Setup. See "Changing the continuity alert" on page 74 for more information on the audible alert option.

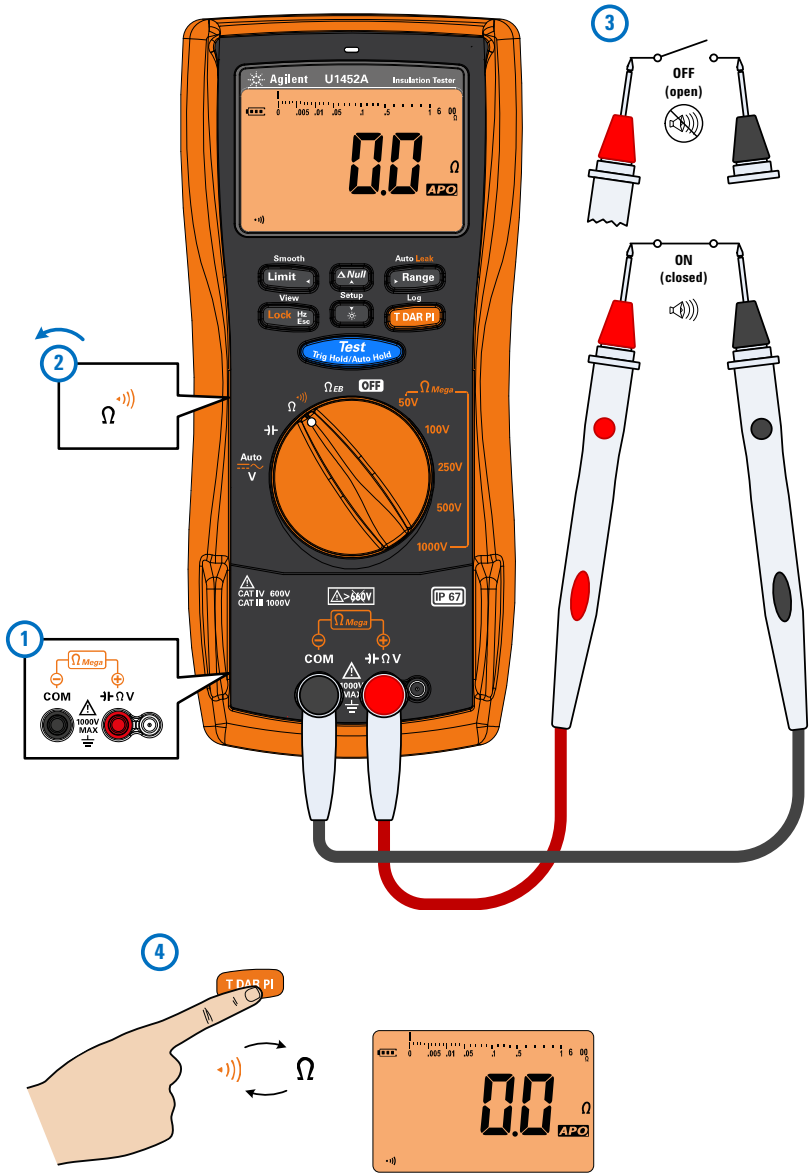


Figure 2-9 Continuity test example

Measuring Capacitance

Set up your tester to measure capacitance as shown in Figure 2-10. The cable length of the circuit under test in shown in the secondary display.

- The default cable length scale is 1 km per 40 nF (km/C). To change this value, see "Changing the cable length scale" on page 78.
- You can also change the cable length unit (Meter or Feet). To change this value, see "Changing the cable length unit" on page 77.

Table 2-6 Capacitance measurement position

Legend	Default function		Function when T-DAR is pressed	
Rotary switch position	Primary display	Secondary display	Primary display	Secondary display
⊣⊢	Capacitance	Cable length	-	-

CAUTION To avoid possible damage to the tester or to the equipment under test, disconnect circuit power and discharge all high-voltage capacitors before measuring capacitance. Use the DC voltage function to confirm that the capacitor is fully discharged.

NOTE

- The tester measures capacitance by using an AC sine wave.
- The resistance of the test leads will impact the accuracy of the measurement. It is recommended to use short leads to measure capacitance.
- The test frequency is 54.5 Hz.

Figure 2-10 Capacitance measurement example

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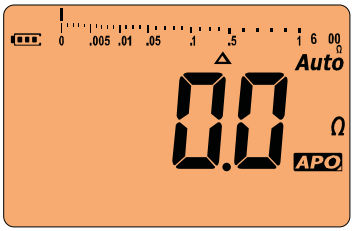
3
Tester Features

The following sections describe the additional features available in your tester.

Making Relative Measurements (Null)

When making null measurements, also called relative, each reading is the difference between a stored (selected or measured) null value and the input signal.

One possible application is to increase the accuracy of a resistance measurement by nulling the test lead resistance.



NOTE Null can be set for both auto and manual range settings, but not in the case of an overload.

1. To activate Null, press Δ Null. The measurement value at the time that when Null (Δ) is enabled, is stored as the reference value.
2. Press Δ Null again to view the stored reference value (the Δ annunciator blinks). The display will return to normal after 3 seconds.
3. To disable Null, press Δ Null while the stored reference value is shown (step 2).

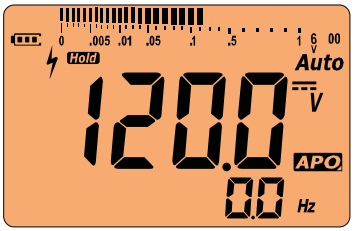
For any measurement function, you can directly measure and store the null value by pressing Δ Null with the test leads open (nulls the test lead capacitance), shorted (nulls the test lead resistance), or across a desired null value circuit.

NOTE

- In resistance measurement, the tester will read a non-zero value even when the two test leads are in direct contact, because of the resistance of these leads. Press Δ Null to zero-adjust the display.
- For DC voltage measurements, the thermal effect will influence the accuracy of the measurements. Short the test leads and press Δ Null when the displayed value is stable to zero-adjust the display.

Freezing the Display (TrigHold and AutoHold)

TrigHold operation



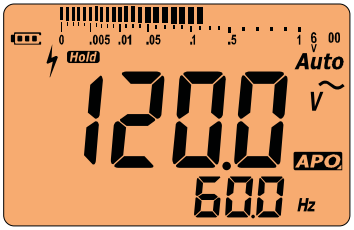
Press Test Trig Hold/Auto Hold to freeze the display for any function, except for the Ω Mega or the Ω EB function.

Press Test Trig Hold/Auto Hold again to trigger a new reading. The Hold annunciator blinks while waiting for the reading to be stable.

Press and hold Test Trig Hold/Auto Hold to exit this mode.

NOTE Pressing Test Trig Hold/Auto Hold when the rotary switch is in one of the Ω Mega or the Ω EB position will result in a test being performed instead.

AutoHold operation



Press and hold Test Trig Hold/Auto Hold to activate AutoHold for any function, except for the Ω Mega or the Ω EB function.

AutoHold monitors the input signal and updates the display and, if enabled, emits a beep, whenever a new stable measurement is detected. The Hold annunciator blinks while waiting for the reading to be stable.

Press and hold Test Trig Hold/Auto Hold to exit this mode.

NOTE Pressing and holding Test Trig Hold/Auto Hold when the rotary switch is in one of the Ω Mega or the Ω EB position will result in a test being performed instead.

A trigger point is one that varies more than a selected adjustable (AutoHold threshold) variation count (default 500 counts). The following conditions are not included in the update.

Function	None updated counts
Voltage	50
Resistance	OL or Open
Capacitance	50

To change the default AutoHold threshold count see "Changing the variation count" on page 71 for more information.

NOTE If the reading value is unable to reach a stable state, the reading value will not be updated.

Performing Limit Comparisons (Limit)

Limit is used to compare the test result with the chosen settling value. The default settling values are shown in the table below.

You can set pass condition to be > or < the value measured.

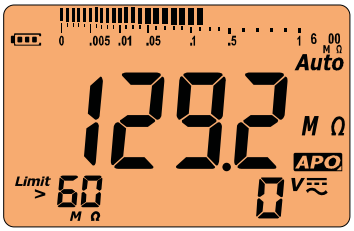


Table 3-1 Limit settling default values

Function	Default value	Range	Limit settling range
Voltage measurement[1]	>30 V	Auto or Manual	1 V < LS < 900 V
Resistance measurement	<10 Ω	Auto or Manual	1 Ω < LS < 90 MΩ
Capacitance measurement[2]	>10	Range locked	10 < LS < 900
Earth-bond resistance test	<10 Ω	Auto	1 Ω < LS < 90 kΩ
Insulation resistance test	>10 MΩ	Auto	1 kΩ < LS < 90 GΩ

[1] Absolute value comparison, regardless of polarity.

[2] Limit for capacitance is represented without a unit.

1 Press Limit to activate Limit.

2 Press Limit again to set the comparison value. Use the arrow keys to position the cursor and to change the value shown.

The most significant digit can be set to a value from 1 to 9. The remaining two digits can be set to 0, 00, or left blank along with any unit combination (see Table 3-1).

3 Position the cursor on the **>** annunciator to change the Limit pass condition (< or >).

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 If the new value is passed:
- PAS is shown
- A short beep tone is heard
- The red LED blinks once

6 If the new value is failed:
- FAı is shown
- Three short beep tones are heard
- The red LED blinks thrice

NOTE When the Limit feature is enabled for insulation resistance tests, the red LED indicator lights up accordingly to the changes in the limit values instead of blinking every 2 seconds.

Recording Measurement Data (Log)

Log provides you with the convenience of recording test data for future review or analysis. Since data is stored in the nonvolatile memory, the data remains saved even when the tester is turned OFF or if the battery is replaced.

Log collects measurement information over a user-specified duration. There are three Log options that can be used to capture measurement data: manual (**HAND**), interval (**AUTO**), or event (**TRIG**).

- A manual log stores an instance of the measured signal each time you press and hold 

(see page 60).
- An interval log stores a record of the measured signal at a user-specified interval (see page 60).
- An event log stores a record of the measured signal each time a trigger condition is satisfied (see page 61).

Table 3-2 Log maximum capacity

Log option	Maximum capacity for saving
Manual (**HAND**)	H00 to H99 (100 entries)
Interval (**AUTO**)	A00 to A99 (100 entries)
Event (**TRIG**)	E00 to E99 (100 entries)

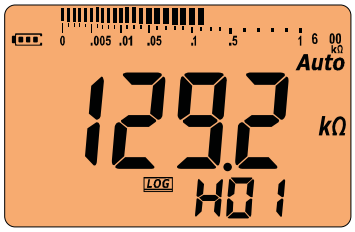
NOTE Each recorded index includes two parameters: the primary display and the secondary display. Examples include IR-V or V-Hz.

Before starting a recording session, set up the tester for the measurements to be recorded.

To change the Log option see “Changing the recording option” on page 80 for more information.

See “Reviewing Previously Recorded Data (View)” on page 63 to review or erase the recorded entries.

Performing manual logs (HAND)



Ensure that HAnd is selected as the Log option in the Setup.

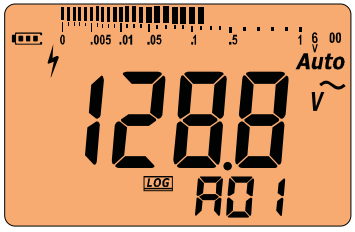
1 Press and hold Log T DAR PI to store the present input signal value.

LOG and the log entry number are displayed. The display will return to normal after a short while (around 1 second).

2 Repeat step 1 again to save the next input signal value.

The maximum number of readings that can be stored for the manual log is 100 entries. When all entries are occupied, HFU will be shown when you press and hold Log T DAR PI.

Performing interval logs (AUTO)



Ensure that AUto is selected as the Log option in the Setup.

The default recording interval duration is 1 second. To change the recording interval duration, see "Changing the sample interval duration" on page 79 for more information.

The duration set in the Setup will determine how long each recording interval takes. The input signal value at the end of each interval will be recorded and saved into the tester's memory.

Start the interval log mode

1 Press and hold Log T DAR PI to start interval log mode.

LOG and the log entry number are displayed. Subsequent readings are automatically recorded into the tester's memory at the interval specified in the Setup.

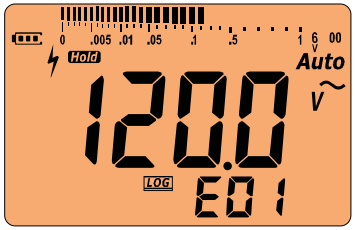
2 Press and hold Log T DAR PI again to exit the interval log mode.

The maximum number of readings that can be stored for the interval log is 100 entries. When all entries are occupied, AFU will be shown when you press and hold Log T DAR PI.

NOTE When the interval log recording session is running, all other keypad operations are disabled; the exception is Log T DAR PI, which, when pressed for more than 1 second, will stop and exit the recording session. Furthermore, APO (auto power-off) is disabled during the recording session.

Performing event logs (TRIG)

Ensure that trig is selected as the Log option in the Setup.



Event logs are used only with the following modes:

- TrigHold and AutoHold (page 55)
- Earth-bond resistance tests (page 38)
- Insulation resistance tests (page 38)
- T/DAR/PI tests (page 30)

Event records are triggered by the measured signal satisfying a trigger condition set by the measurement function used in the following modes:

Table 3-3 Event log trigger conditions

Modes	Trigger condition *The input signal value is recorded:*	Primary display recorded	Secondary display recorded
TrigHold	Each time you press Test Trig Hold/Auto Hold and the reading update is stable.	Voltage, resistance, or capacitance	Voltage, frequency, capacitance cable length, or output source voltage
AutoHold	When the input signal varies more than the variation count and the reading update is stable.	Voltage, resistance, or capacitance	Voltage, frequency, capacitance cable length, or output source voltage

Table 3-3 Event log trigger conditions (continued)

Modes	Trigger condition *The input signal value is recorded:*	Primary display recorded	Secondary display recorded
Earth-bond resistance test Insulation resistance test	Each time you press Test (Trig Hold/Auto Hold) to stop the test output source.	Resistance or leak current value	Test output source voltage
T/Time	When the time is up (Timer = 00:00), the final value is recorded before the test output source is stopped.	Resistance or leak current value	Test output source voltage

NOTE The values of DAR t30 (or DAR t15), DAR t60, PI t1, and PI t10 will be recorded in every IR rotary switch location. For more information on DAR and PI tests, see page 35 and page 36 respectively.

Start the event log mode

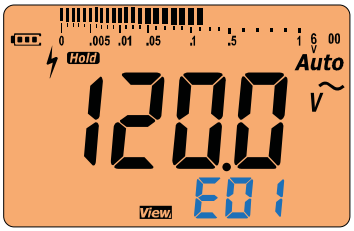
1. Select one of the modes listed in Table 3-3.
2. Press and hold Log (T DAR PI) to start event log mode.

   LOG and the log entry number are displayed. The primary display and secondary display readings will be recorded into the memory. Subsequent readings are automatically recorded into the tester's memory every time the trigger condition specified in Table 3-3 is satisfied.
3. Press and hold Log (T DAR PI) again to exit the event log mode.

The maximum number of readings that can be stored for the event log is 100 entries. When all entries are occupied, EFU will be shown when you press and hold Log (T DAR PI).

NOTE APO (auto power-off) is disabled during the recording session.

Reviewing Previously Recorded Data (View)



Viewing data stored in the tester's memory is performed through the View Lock Hz Esc key.

1 Press and hold View Lock Hz Esc to View the previously recorded data. Press View Lock Hz Esc again to cycle through the manual (H), interval (A), or event (E) records.

   If nothing has been recorded, H--, A--, or E-- will be displayed instead.

2 Select the desired recording category to view its entries.

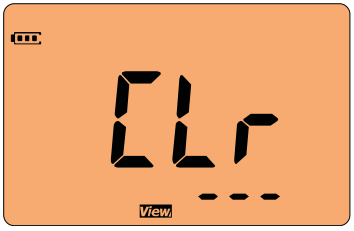
   i Press Limit to jump to the first stored entry. Press Range to jump to the last stored entry.

   ii Press ✳ to view the next stored entry. The index number increases by one. Press △Null to view the previous stored entry. The index number decreases by one.

   iii Press T DAR PI to clear the last stored entry for the selected log type. Press and hold T DAR PI to clear all entries for the selected log type.

3 Press and hold View Lock Hz Esc again to exit the View mode.

Sanitizing the Log Memories



You have the option to sanitize the log memories of your tester. This operation erases the log memories of your tester thoroughly. The data stored in the tester's memory will not be able to be reconstructed in any way after the data sanitization operation.

Prior to sanitizing the log memories, ensure that all manual (H), interval (A), or event (E) records have been cleared (see step iii). When all entries are cleared (H--, A--, and E--), press and hold △Null to sanitize the log memories.

CAUTION The data sanitization operation may take up to 30 seconds to complete. Do not press any keys or turn the rotary switch until the data sanitization operation is completed.

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4 Setup Options

The following sections describe how to change the preset features of your tester.

Using the Setup Menu

The Setup menu allows you to change a number of nonvolatile preset features. Modifying these settings affects the general operation of your tester across several functions. Select a setting to edit in order to perform one of the following actions:

- Switch between two values, such as on or off.
- Cycle through multiple values from a predefined list.
- Decrease or increase a numerical value within a fixed range.

The contents of the Setup menu are summarized in Table 4-2 on page 68.

Table 4-1 Setup menu key functions

Legend	Description
	• Press for more than 1 second to access the Setup menu. • Press and hold until the tester restarts to exit the Setup menu.
	• Press Limit or Range to browse each menu page.
	• Press Null or at each menu page to move the cursor to a specific menu item.
U1451A  **U1452A/U1452AT** Log 	• Press T DAR PI to edit the selected menu item. The menu item's value will flash to indicate that you can now change the value shown. • Press Null or again to switch between two values, to cycle through multiple values from a list, or to decrease or increase a numerical value. • Press T DAR PI to save your changes.
	• While the menu item's value is flashing, press Lock Hz Esc to discard your changes.

NOTE The tester will automatically exit the Setup menu after 30 seconds of inactivity.

Editing numerical values

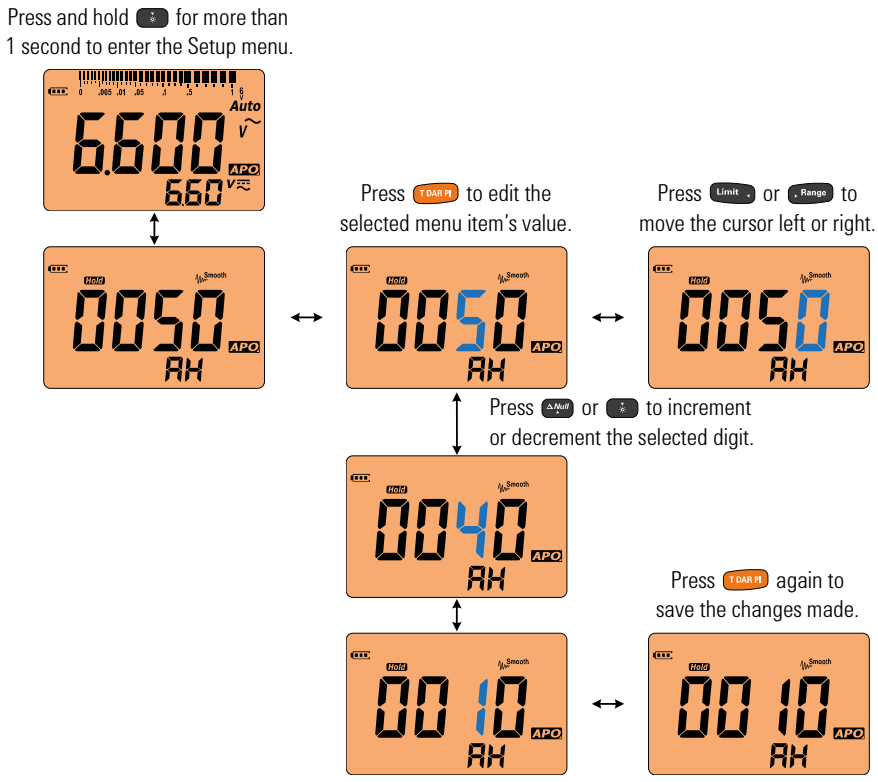
When editing numerical values, use the Limit and Range to position the cursor on a numerical digit.

- Press Limit to move the cursor to the left, and
- Press Range to move the cursor to the right.

When the cursor is positioned over a digit, use the Δ Null and ☼ keys to change the numerical digit.

- Press Δ Null to increment the digit, and
- Press ☼ to decrement the digit.

When you have completed your changes, save the new numerical value by pressing T DAR PI. (Or alternatively, if you wish to discard the changes you made, press Lock Hz Esc.)



Setup Menu Summary

The Setup menu items are summarized in the table below. Click the respective “Learn more” pages for more information on each menu item.

Table 4-2 Setup menu item descriptions

Legend	Available settings	Description	Learn more on:
Smooth Hold AH	0001 to 9999 counts	Set the AutoHold and Smooth threshold count from 1 to 9999 counts. Default is 0050 counts.	page 71
Smooth SMo	0001 to 9999 (d or E)	Set the settling value from 0001 to 9999. You can also disable this feature (d). Default is disabled (0009_d).	page 71
bEE	3200 Hz to 4267 Hz, or oFF	Set the beep frequency from 3200 Hz to 4267 Hz. You can also disable this feature (oFF). Default is 3840 Hz.	page 72
APo	01 to 99 minutes (d or E)	Set the auto power-off timer period from 1 to 99 minutes (1 hour, 39 minutes). You can also disable this feature (d). Default is 15 minutes (15_E).	page 73
bLt	01 to 99 seconds (d or E)	Set the backlight timer period from 1 to 99 seconds (1 minute, 39 seconds). You can also disable this feature (d). Default is 15 seconds (15_E).	page 73
typ	SHor or tonE	Set the tester to sound a single beep (SHor) or a tone (tonE) during continuity alerts for short circuits. Default is a single beep for short circuits (SHor).	page 74
Snd	MELo, USEr, bEEE, or oFF	Set the power-on melody to the factory default (MELO), a beep (bEEE), or disable this feature (oFF). Default is a beep (bEEE).	page 75
bAt	Pr 1 or SEC	Change the battery selection from primary (Pr 1) to secondary (SEC). Default is primary (Pr 1).	page 75
rSt	YES or no	Reset the tester to its factory default settings.	page 76

Table 4-2 Setup menu item descriptions (continued)

Legend	Available settings	Description	Learn more on:
CnE	Hi or Lo	Set the display count to High (Hi) or Low (Lo). Default is Low (Lo).	page 76
CAb ftm	mEtE (m) or Foot (ft)	Set the cable length unit to Meter (mEtE) or Foot (Foot) for capacitance measurements. Default is mEtE (m).	page 77
CAb	01 to 99 nF/km	Set the capacitance measurement versus cable length scale from 1 to 99 nF/km. Default is 40 nF/km.	page 78
Limit ALE	bE.rL, --.rL, bE.--, or --.--	Set the tester to beep momentarily and light up the red LED indicator for limit and continuity alerts. You can also disable either or both alerts (off). Default is to beep momentarily and light up the red LED indicator (bE.rL).	page 78
LOG tIm	0001 to 9999 seconds	Set the logging duration for interval logs from 1 to 9999 seconds (2 hours, 46 minutes, 39 seconds). Default is 1 second.	page 79
LOG tYP	Hand, AUto, or tr ig	Set the data logging option (Hand: manual log, AUto: interval log, or tr ig: event log). Default is manual log (Hand).	page 80
t mi	00.05 to 59.59 mm:ss	Set the insulation resistance or earth-bond resistance test period. Default is 10 seconds (00. 10 mm:ss)	page 80
inH	30 V, 50 V, or 75 V	Set the maximum inhibit voltage for insulation resistance test. Default is 30 V.	page 81
onE	YES or no	Enable or disable the lock once feature. Default is enabled (YES).	page 82

Table 4-2 Setup menu item descriptions (continued)

Legend	Available settings	Description	Learn more on:
rEn	bt- 1 to bt-7 (d or E)	Change or disable the button operation on the remote probe. Default is Test (bt-7E).	page 82
DAR t 1n	60.30 or 60. 15 seconds	Set the Dielectric Absorption Ratio in seconds (60:30 or 60:15). Default is 60:30 (seconds).	page 83

Setup Menu Items

Changing the variation count

This setting is used with the AutoHold feature (see page 55). When the variation of the measured value exceeds the value of the variation count, the AutoHold feature will be ready to trigger.

Legend	Range	Default setting
AH	(0001 to 9999) counts	0050

To change the variation count:

1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to AH (Smooth and Hold are shown on the display), and press T DAR PI to edit the value.
3. Use the arrow keys to change the variation count.
4. Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).
5. Press and hold ✳ until the tester restarts to return to normal operation.

Enabling smooth mode

Smooth is used to smoothen the refresh rate of the readings in order to reduce the impact of unexpected noise and to help you achieve a stable reading.

The smooth refresh rate can be set from 0001 to 9999. The smooth time is defined as the set value +1. Smooth will be restarted when the variation count is exceeded, when the range is changed, or after a tester function or feature is enabled. The variation count is set to the value used for the AutoHold feature (see "Changing the variation count" on page 71).

Legend	Range	Default setting
SMo	• 0001 to 9999 • d(isabled) or E(nabled)	0009$_d$

To change the smooth refresh rate:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to SMo (Smooth is shown on the display), and press T DAR PI to edit the value.

3 Use the arrow keys to change the smooth refresh rate. Select E to enable the Smooth feature.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Changing the beep frequency

The beeper alerts users to the presence of circuit continuities and newly sensed values for Max Min recordings.

Legend	Range	Default setting
bEE	(4267, 4151, 4042, 3938, 3840, 3746, 3675, 3572, 3491, 3413, 3339, 3268, 3200) Hz, or oFF	3840

To change the beep frequency:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to bEE, and press T DAR PI to edit the value.

3 Use the arrow keys to change the beep frequency. Select oFF to disable the beeper.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ☼ until the tester restarts to return to normal operation.

Changing the auto power-off (APO) timer

The APO (see page 6) feature uses a timer to determine when to automatically turn the tester off.

Legend	Range	Default setting
APo	• (01 to 99) minutes • E(nabled) or d(isabled)	15E

To change the APO timer period:

1 Press ☼ for more than 1 second to enter the Setup menu.

2 Browse to APo, and press T DAR PI to edit the value.

3 Use the arrow keys to change the APO timer period. Select d to disable the APO feature.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ☼ until the tester restarts to return to normal operation.

Changing the LCD backlight timeout

The tester's LCD backlight uses a timer to determine when to turn off the LCD backlight.

Legend	Range	Default setting
bLt	• (01 to 99) seconds • E(nabled) or d(isabled)	15E

To change the LCD backlight timer period:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to bLt, and press T DAR PI to edit the value.

3 Use the arrow keys to change the backlight timer period. Select d to disable the backlight timer.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Changing the continuity alert

This setting is used with continuity tests (see page 48). The tester will beep to alert users to the presence of circuit continuities for short circuits. If tone is selected, the tester will sound different tones according to the bar graph display.

Legend	Range	Default setting
tyP	SHor (t) or tonE	SHor

To change the continuity alert:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to tyP (is shown on the display), and press T DAR PI to edit the value.

3 Use the arrow keys to change the continuity alert.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Disabling the power-on melody

The tester plays a melody or a beep when it is powered on.

Legend	Range	Default setting
Snd	MELo(dy), USEr, bEEE, or oFF	bEEE

To disable the power-on melody:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to Snd, and press T DAR PI to edit the value.

3 Use the arrow keys to change the power-on melody. Select oFF to disable the power-on melody.

NOTE The USEr option is for Agilent internal use.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Changing the battery type

If you are using rechargeable batteries to power your tester, change the battery type from Pr I to SEC for the tester to accurately reflect the battery capacity indication.

Legend	Range	Default setting
bAt	Pr I(mary) or SEC(ondary)	Pr I

To change the battery type:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to bAt, and press T DAR PI to edit the value.

3 Use the arrow keys to change the battery type.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Resetting the tester's Setup options

The tester's Setup options can be reset to its default values through the Setup menu.

Legend	Range	Default setting
rSt	YES or no	no

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to rSt, and press T DAR PI to edit the value.

3 Use the arrow keys to select YES.

4 Press and hold T DAR PI for more than 1 second to perform the reset. The tester will beep once and return to the first Setup menu page. Or, alternatively press Lock Hz Esc to discard your changes.

Changing the display count

Use these settings to change the display count for the following measurements/tests. The low resolution count is a tenth of the original display count. As an example, if the original display count is 6000 counts, then the low resolution display count is 600 counts.

Legend	Range	Default setting
Cnt	High(gh) or Low(w)	Lo

NOTE

- Voltage and capacitance measurements are fixed at 6000 counts.
- DAR and PI tests are fixed at 9999 counts.

To change the display count:

1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to Cnt, and press T DAR PI to edit the value.
3. Use the arrow keys to change the display count.
4. Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).
5. Press and hold ✳ until the tester restarts to return to normal operation.

Changing the cable length unit

This setting is used with capacitance measurements (see page 50). Change the unit (Meter or Feet) of the cable length display.

Legend	Range	Default setting
CAb mFt	mEtEr(r) or Foot	mEtEr

To change the cable length unit:

1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to CAb mFt, and press T DAR PI to edit the value.
3. Use the arrow keys to change the cable length unit.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Changing the cable length scale

This setting is used with capacitance measurements (see page 50). Change the scale from 1 nF to 99 nF per kilometer for capacitance transfers to cable length.

Legend	Range	Default setting
CAb	(01 to 99) nF	40

To change the cable length scale:

1 Press ✳ for more than 1 second to enter the Setup menu.

2 Browse to CAb, and press T DAR PI to edit the value.

3 Use the arrow keys to change the cable length scale.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ✳ until the tester restarts to return to normal operation.

Changing the alert indicators

The tester's audible and visual alerts users to the presence of circuit continuities (see page 48) and values exceeding the Limit values set (see page 48).

Legend	Range	Default setting
ALE	bE.rL, --.rL, bE.--, or --.--	bE.rL

To change the alert indicators:

1 Press ⚙ for more than 1 second to enter the Setup menu.

2 Browse to ALE (**Limit** and •)) is shown on the display), and press T DAR PI to edit the value.

3 Use the arrow keys to change the alert indicators. Select -- to disable either the beeper, the red LED, or both the alert indicators.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ⚙ until the tester restarts to return to normal operation.

Changing the sample interval duration

This setting is used with the Interval Data Logging feature (see page 60). The tester will record a measurement value at the beginning of every sample interval.

Legend	Range	Default setting
t int	(0001 to 9999) seconds	0001

To change the sample interval duration:

1 Press ⚙ for more than 1 second to enter the Setup menu.

2 Browse to t int (LOG is shown on the display), and press T DAR PI to edit the value.

3 Use the arrow keys to change the sample interval duration.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ⚙ until the tester restarts to return to normal operation.

Changing the recording option

This setting is used with the Data Logging feature (see page 59). There are three available recording options for the Data Logging feature.

- HAnd: Manual log
- AUto: Interval log
- tr 19: Event log

Legend	Range	Default setting
tYP	HAnd, AUtO, or tr 19	HAnd

To change the recording option:

1. Press ☼ for more than 1 second to enter the Setup menu.
2. Browse to tYP (LOG is shown on the display), and press T DAR PI to edit the value.
3. Use the arrow keys to change the recording option.
4. Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).
5. Press and hold ☼ until the tester restarts to return to normal operation.

Changing the IR and EBR test period

This setting is used with insulation resistance tests (see page 38) or earth-bond resistance measurements (see page 38). The tester performs the test over the timed period defined in this setting.

Legend	Range	Default setting
t mT	(00.05 to 59.59) mm:ss	00. 10

To change the insulation resistance and earth-bond resistance test period:

1 Press for more than 1 second to enter the Setup menu.
2 Browse to t in, and press T DAR PI to edit the value.
3 Use the arrow keys to change the test period.
4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).
5 Press and hold until the tester restarts to return to normal operation.

Changing the maximum inhibit voltage for IR tests

This setting is used with insulation resistance tests (see page 38). The tester will not perform the insulation resistance test if it detects that the external voltage exceeds the inhibit voltage value set here.

Legend	Range	Default setting
inH	(30, 50, or 75) V	30

To change the maximum inhibit voltage:

1 Press for more than 1 second to enter the Setup menu.
2 Browse to inH, and press T DAR PI to edit the value.
3 Use the arrow keys to change the value of the inhibit voltage.
4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).
5 Press and hold until the tester restarts to return to normal operation.

Disabling the lock once feature

This setting is used with insulation resistance tests (see page 38) and earth-bond resistance measurements (see page 38). By default, the tester will reset the locked status when the test is stopped by pressing Test Trig Hold/Auto Hold.

If you disable this feature, you will need to press Lock Hz Esc to unlock the tester, even if the test has already stopped.

Legend	Range	Default setting
onE	YES or no	YES

To disable the lock once feature:

1. Press ☼ for more than 1 second to enter the Setup menu.
2. Browse to onE, and press T DAR PI to edit the value.
3. Use the arrow keys to select YES.
4. Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).
5. Press and hold ☼ until the tester restarts to return to normal operation.

Changing the button operation on the remote switch probe

This setting is used with the remote switch probe. The button operation on the remote switch probe will emulate the function selected in this setting.

Legend	Range	Default setting
rEm	• bt-1 - Limit • bt-2 - Δ/Null • bt-3 - Range • bt-4 - Lock Hz Esc • bt-5 - ☼ • bt-6 - T DAR PI • bt-7 - Test Trig Hold/Auto Hold • d(isable) or E(nable)	bt-7E

To change the button operation on the remote switch probe:

1 Press ☼ for more than 1 second to enter the Setup menu.

2 Browse to rEm, and press T DAR PI to edit the value.

3 Use the arrow keys to change the function of the remote switch probe button. Select d to disable the remote switch probe button.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ☼ until the tester restarts to return to normal operation.

Changing the Dielectric Absorption Ratio (DAR) for IR tests

This setting is used with insulation resistance tests (see page 38). The tester perform the DAR test using the ratio set here.

Legend	Range	Default setting
t m	(60.30 or 60. 15) seconds	60.30

To change the DAR ratio:

1 Press ☼ for more than 1 second to enter the Setup menu.

2 Browse to t m (DAR is shown on the display), and press T DAR PI to edit the value.

3 Use the arrow keys to change the value of the DAR ratio.

4 Press T DAR PI to save your changes (or press Lock Hz Esc to discard your changes).

5 Press and hold ☀ until the tester restarts to return to normal operation.

5 Characteristics and Specifications

This chapter lists the characteristics, considerations, and specifications of the U1452A/U1452AT/U1451A tester.

Product Characteristics

POWER SUPPLY

Battery type:

- 4 × 1.5 V AA Alkaline batteries (ANSI/NEDA 15A or IEC LR6)
- 4 × 1.5 V AA Zinc Chloride batteries (ANSI/NEDA 15D or IEC R6)

Battery life:

- 270 hours typical, based on new alkaline batteries for DC voltage measurement at room temperature.
- Insulation Resistance (IR) test: 1000 times of standard test with new alkaline batteries at room temperature. The standard test is 1000 V into 1 MΩ with a cycling of 5 seconds ON and 25 or 55 seconds OFF without backlight.
- Earth-Bond Resistance (EBR) test: 2800 or 2500 times of standard test with new alkaline batteries at room temperature. The standard test is 1 Ω with a cycling of 5 seconds ON and 25 or 55 seconds OFF without backlight.
- Low battery indicator will flash when the battery voltage drops below
  - For normal operation: 3.4 V (approximately)
  - For IR and EBR operation: 4.7 V (approximately)

POWER CONSUMPTION

2.7 VA maximum (with backlight)

FUSE

10 × 35 mm 30 kA fast-acting fuse

DISPLAY

Liquid Crystal Display (LCD), 4 digits with maximum reading of 6600 counts

OPERATING ENVIRONMENT

Refer to "Environmental Conditions" on page VI

STORAGE COMPLIANCE

Refer to "Environmental Conditions" on page VI

SAFETY AND EMC COMPLIANCE

Refer to "Environmental Conditions" on page VI

SURGE PROTECTION

8 kV peak per IEC1010.1-92 (IEC1010-1)

MEASUREMENT CATEGORY

CAT III 1000 V/CAT IV 600 V

IP RATING

IP-67, protected against dust and the effect of immersion between 15 cm and 1 m

DROP TEST

1 meter per EN/IEC 61010-1:2001 and 3 meters, 6 sides drop to oak floor and tester with holster.

TEMPERATURE COEFFICIENT

0.05 × (specified accuracy) / °C (from –20 °C to 18 °C, or 28 °C to 55 °C)

COMMON MODE REJECTION RATIO (CMRR)

>120 dB at DC, 50/60 Hz ± 0.1% (1 kΩ unbalanced)

NORMAL MODE REJECTION RATIO (NMRR)

>60 dB at 50/60 Hz ± 0.1%

DIMENSIONS (W × H × D)

100 × 218 × 58 mm

WEIGHT

728 grams (with alkaline batteries and orange rubber holster)

- Three years for the product
- Three months for the product's standard accessories, unless otherwise specified
- Please take note that for the product, the warranty does not cover:
  - Damage from contamination
  - Normal wear and tear of mechanical components
  - Manuals, fuses, and standard disposable batteries

CALIBRATION CYCLE

One year

Specification Considerations

- Accuracy is given as ± (% of reading + counts of least significant digit) at 23 °C ± 5 °C, with relative humidity less than 80% RH.
- The AC measurement is calibrated for sine waves only.

Measurement Category

The Agilent U1452A/U1452AT/U1451A tester has a safety rating of CAT III, 1000 V and CAT IV, 600 V.

Measurement CAT I are for measurements performed on circuits not directly connected to the AC mains. Examples are measurements on circuits not derived from the AC mains and specially protected (internal) mains-derived circuits.

Measurement CAT II are measurements performed on circuits directly connected to a low-voltage installation. Examples are measurements on household appliances, portable tools, and similar equipment.

Measurement CAT III are measurements performed in the building installation. Examples are measurements on distribution boards, circuit- breakers, wiring, including cables, bus-bars, junction boxes, switches, socket outlets in the fixed installation, and equipment for industrial use, and some other equipment including stationary motors with permanent connection to the fixed installation.

Measurement CAT IV are measurements performed at the source of the low-voltage installation. Examples are electricity meters and measurements on primary over current protection devices and ripple control units.

Electrical Specifications

NOTE Specification considerations are given on page 88.

DC specifications

Table 5-1 DC voltage specifications with accuracy of ± (% of reading + no. of least significant digit)

Function	Range	Resolution	Accuracy		Input impedance
			U1451A	U1452A/U1452AT	
Voltage[1]	6 V	0.001 V	0.5% + 2	0.2% + 2	10 MΩ (nominal)
	60 V	0.01 V	0.5% + 2	0.2% + 2	10 MΩ (nominal)
	600 V	0.1 V	0.5% + 2	0.2% + 2	10 MΩ (nominal)
	1000 V	1 V	0.5% + 2	0.2% + 2	10 MΩ (nominal)

Notes:
1 DC V overload protection: 1000 V_{RMS}.

Table 5-2 Resistance specifications with accuracy of ± (% of reading + no. of least significant digit)

Function	Range	Resolution	Accuracy	
			U1451A	U1452A/U1452AT
Resistance[1]	600 Ω	0.1 Ω	1.5% + 3	1.0% + 3
	6 kΩ	0.001 kΩ	1.5% + 3	1.0% + 3
	60 kΩ	0.01 kΩ	1.5% + 3	1.0% + 3
	600 kΩ	0.1 kΩ	1.5% + 3	1.0% + 3
	6 MΩ	0.001 MΩ	2.0% + 3	1.2% + 3
	60 MΩ	0.01 MΩ	2.5% + 3	2.0% + 3

Notes:

1 The following statements are true for resistance measurements:
- Overload protection: 1000 VRMS for short circuits with <0.3 A current.
- Maximum open voltage is <+2.8 V.
- The built-in buzzer beeps when the resistance measured is less than 30 Ω ± 15 Ω.
- The accuracy is specified after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).

AC specifications

Table 5-3 AC voltage specifications with accuracy of ± (% of reading + no. of least significant digit)

Function	Range	Resolution	Accuracy
			45 Hz to 400 Hz
Voltage[1]	6 V	0.001 V	2.0% + 3
	60 V	0.01 V	2.0% + 3
	600 V	0.1 V	2.0% + 3
	1000 V	1 V	2.0% + 3

Notes:

1 The following statements are true for resistance measurements:
- AC V overload protection: 1000 VRMS.
- AC V input impedance: 10 MΩ in parallel with <100 pF (nominal).
- The input signal is lower than the product of 1,000,000 V×Hz.

Capacitance specifications

Table 5-4 Capacitance specifications with accuracy of ± (% of reading + no. of least significant digit)[1][2][3]

Range	Resolution	Accuracy	Signal
100 nF	0.1 nF	3% + 2	Sine wave: 54.5 Hz, <2 V
1 µF	0.001 µF	3% + 2	
10 µF	0.01 µF	3% + 2	
100 µF	0.1 µF	5% + 2[4] @ <50 µF	

Notes:

1. Overload protection: 1000 VRMS for short circuits with <0.3 A current
2. The accuracy of for all ranges is specified based on a film capacitor or better, and after the Null function is used to subtract the residual values (by opening the test leads).
3. The maximum display is 1200 counts.
4. Add additional accuracy of 0.1% per µF for values greater than 50 µF — for example 100 µF, additional accuracy of 5% is to be added.

Frequency specifications

Table 5-5 Frequency specifications with accuracy of ± (% of reading + no. of least significant digit)[1][2]

Range	Resolution	Accuracy	Minimum input frequency
19.99 Hz	0.01 Hz	0.2% + 1	2 Hz
199.9 Hz	0.1 Hz	0.2% + 1	
<400 Hz	1 Hz	0.2% + 1 @ ≤400 Hz	

Notes:

1 Overload protection: 1000 V; input signal is <1,000,000 V × Hz (product of voltage and frequency).

2 The frequency measurement is susceptible to error when measuring low-voltage and low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.

Sensitivity for voltage measurements

Table 5-6 Sensitivity for voltage measurements

Input range[1]	Minimum sensitivity (RMS sine wave)
	2 Hz to 400 Hz
6 V	0.5 V
60 V	5 V
600 V	65 V
1000 V	65 V

Notes:

1 Maximum input for specified accuracy, refer to "AC specifications" on page 91.

Insulation resistance specifications

Table 5-7 Insulation resistance specifications with accuracy of ± (% of reading + no. of least significant digit)

Test voltage	Range	Resolution	Accuracy	Test current
50 V	6 MΩ	0.001 MΩ	2% + 5	1 mA @ 50 kΩ
	<50 MΩ	0.01 MΩ	2% + 5	
	~60 GΩ	~0.01 GΩ	2% + 5[7]	
100 V	6 MΩ	0.001 MΩ	2% + 5	1 mA @ 100 kΩ
	60 MΩ	0.01 MΩ	2% + 5	
	<100 MΩ	0.1 MΩ	2% + 5	
	~60 GΩ	~0.01 GΩ	2% + 5[7]	
250 V	6 MΩ	0.001 MΩ	1.5% + 5	1 mA @ 250 kΩ
	60 MΩ	0.01 MΩ	1.5% + 5	
	<250 MΩ	0.1 MΩ	1.5% + 5	
	~200 GΩ	~0.1 GΩ	1.5% + 5[7]	
500 V	6 MΩ	0.001 MΩ	1.5% + 5	1 mA @ 500 kΩ
	60 MΩ	0.01 MΩ	1.5% + 5	
	<500 MΩ	0.1 MΩ	1.5% + 5	
	~200 GΩ	~0.1 GΩ	1.5% + 5[7]	
1000 V	6 MΩ	0.001 MΩ	1.5% + 5	1 mA @ 1 MΩ
	60 MΩ	0.01 MΩ	1.5% + 5	
	600 MΩ	0.1 MΩ	1.5% + 5	
	<1 GΩ	0.001 GΩ	1.5% + 5	
	~200 GΩ	~0.1 GΩ	1.5% + 5[7]	

Notes:

1 The voltage indication on the display refers to the voltage at the DUT (device under test), and the accuracy is according to the DC voltage measurement. The default test voltage is shown in the table below.

Ω_{Mega} position (Mark)	1000 V	500 V	250 V	100 V	50 V
Test voltage	1000 V	500 V	250 V	100 V	50 V
Test accuracy	0% to +20%	0% to +20%	0% to +20%	0% to +20%	0% to +20%

The test voltage across a resistor of a value of $U_N \times (1000\ \Omega/V)$ shall not differ by more than 10% relative to no load (open) voltage, as a result of possibly present AC voltage components in the output voltage, when a capacitor of 1µF is connected in parallel with the insulation resistance to be measured. U_N represents the nominal output test voltage.

2 Live circuit detection: The test will be inhibited if the terminal voltage >30 V/50 V/75 V (AC/DC) prior to initialization of the test.
3 Short-circuit test current: 1.0 mA nominal.
4 Auto discharge time: <0.5 seconds for capacitors less or equal to 1 µF.
5 Maximum capacitive load: Operable with up to 1 µF load.
6 The accuracy of the leakage current may be referred to as the DC current measurement.
7 Additional accuracy is to be added to the basic accuracy as shown in the table below.

Voltage	1000 V	500 V	250 V	100 V	50 V
Above	1 GΩ	500 MΩ	250 MΩ	100 MΩ	50 MΩ
Basic accuracy	1.5% + 5	1.5% + 5	1.5% + 5	2.0% + 5	2.0% + 5
Additional accuracy	0.1%/GΩ	0.2%/GΩ	0.4%/GΩ	1.0%/GΩ	2.0%/GΩ

Earth-bond resistance specifications

Table 5-8 Earth-bond resistance specifications with accuracy of ± (% of reading + no. of least significant digit)[1][2]

Range	Resolution	Accuracy		Open circuit voltage
		U1451A	U1452A/U1452AT	
60 Ω	0.01 Ω	1.5% + 3	1.0% + 3	>4 V and <7 V
600 Ω	0.1 Ω	1.5% + 3	1.0% + 3	
6 kΩ	0.001 kΩ	1.5% + 3	1.0% + 3	
60 kΩ	0.01 kΩ	1.5% + 3	1.0% + 3	

Notes:

1 The following statements are true for earth-bond resistance tests:
- Overload protection: <2 V and 0.44 A/1000 V; 10 × 35 mm 30 kA fast-acting fuse
- Short circuit current: >200.0 mA as resistance < or = 2 Ω

2 The accuracy is specified after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).

EN61557 specifications

The following specifications are a requirement for European labeling.

Measurement	Intrinsic uncertainty		Operating uncertainty[1]
	U1451A	U1452A/U1452AT	
Voltage	± (0.5% + 2)	± (0.2% + 2)	30%

Notes:

1 The maximum resistance to meet the standard of EN61557-1, 5.2.4, which indicates the maximum amount allowed as less than 30%.

Measurement	Intrinsic uncertainty		Operating uncertainty[1]
	U1451A	U1452A/U1452AT	
Earth-bond resistance	± (1.5% + 3)	± (1.0% + 3)	30%
Insulation resistance	Based on the test voltage and range. See "Insulation resistance specifications" on page 95.		30%

Notes:

1 The maximum resistance to meet the standard of EN61557-1, 5.2.4, which indicates the maximum amount allowed as less than 30%.

Test voltage[1][2][3]	IR <	Intrinsic uncertainty (A)	Temperature (E3)	Operating Uncertainty
50 V	12.85 GΩ	27.6%	2%	27.6% + 1.15 × E3
100 V	25.7 GΩ	27.6%	2%	27.6% + 1.15 × E3
250 V	65.5 GΩ	27.6%	2%	27.6% + 1.15 × E3
500 V	131 GΩ	27.6%	2%	27.6% + 1.15 × E3
1000 V	260 GΩ	27.4%	2%	27.4% + 1.15 × E3

Notes:

1 Specification confidence level to 99.73% as coverage factor up to 3.
2 Temperature range is from 0 °C to 35 °C.
3 Test voltage/maximum range for different models:

Test voltage	U1451A	U1452A	U1452AT
50 V	-	60 GΩ	60 GΩ
100 V	-	60 GΩ	60 GΩ
250 V	60 GΩ	200 GΩ	-
500 V	60 GΩ	200 GΩ	-
1000 V	60 GΩ	200 GΩ	-

Display update rate (approximate)

Table 5-9 Display update rate (approximate)

Function	Times/Second
AC V	5
DC V	5
Ω	5
Capacitance	5
EBR	5
IR	5
Frequency	1 (>10 Hz)

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