Agilent U1461A Insulation Multimeter/ U1453A Insulation Tester

User's Guide

Agilent Technologies

Notices

Manual Part Number

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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. The descriptions and instructions in this manual apply to the Agilent U1461A Insulation Multimeter and the U1453A Insulation Tester.

Model U1461A appears in all illustrations. The word *tester* is used to represent both models.

WARNING

- **Do not exceed any of the measurement limits defined in the specifications to avoid instrument damage and the risk of electric shock.**
- **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.**

WARNING

- **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.**

For model U1461A only:

- **When measuring current, turn off the circuit power before connecting the tester in the circuit. Remember to place the tester in series with the circuit.**
- **Be aware of the presence of hazardous voltage before using the Low Pass Filter (LPF) function for voltage measurement. Voltages measured are usually greater than the values indicated on the tester as the voltages with higher frequencies have been filtered through the LPF function.**

CAUTION

- Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes, 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.

For model U1461A only:

- Never measure voltage when current measurement is selected.

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**
	  • –40 °C to 55 °C, 0% to 80% RH (using lithium batteries), >1 hour operating time[1]
	  • –20 °C to 55 °C, 0% to 80% RH (using alkaline batteries), 20 minutes operating time[1]
	• **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

[1] The operating time is defined when the tester stays at a temperature of 20°C, and then it is moved to colder environment of –40°C for short period of time. The operating temperature of the battery should be allowed from –20°C or –40°C. You should monitor the ambient temperature sensed by the tester. The tester is operational if the temperature display is no less than –20°C or –40°C, according to battery type.

NOTE

The U1461A Insulation Multimeter and U1453A 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.
C SA US	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.

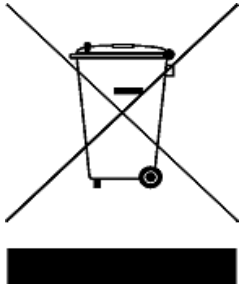
Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

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.

To return this unwanted instrument, contact your nearest Agilent Service Center, or visit

www.agilent.com/environment/product

for more information.

Declaration of Conformity (DoC)

The Declaration of Conformity (DoC) for this instrument is available on the Agilent Web site. 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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2 Making Measurements

5 Characteristics and Specifications

List of Figures

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List of Tables

1 Introduction

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

About This Manual

Documentation map

The following manuals and software related to the *U1461A Insulation Multimeter* and the *U1453A Insulation Tester* are available for download. Please visit our website at http://www.agilent.com/find/hhTechLib for the latest version.

Check the manual edition on the first page of each manual.

User's Guide. This manual.

Quick Start Guide. Printed copy for outdoor use, included with shipment.

Service Guide. Downloadable from http://www.agilent.com/find/hhTechLib

Agilent Handheld Meter Logger Software, Help, and Quick Start Guide. Downloadable from http://www.agilent.com/hhmeterlogger

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 *U1461A/U1453A 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

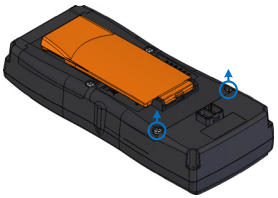
Your tester is powered by four 1.5 V AA lithium batteries (included in the shipment). When you receive your tester, the batteries are not installed.

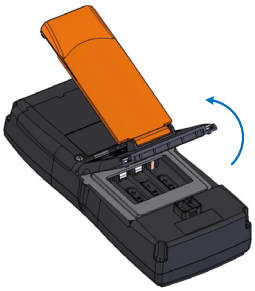
Use the following procedure to install or change the batteries.

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 144.

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.

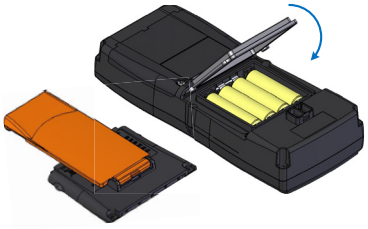


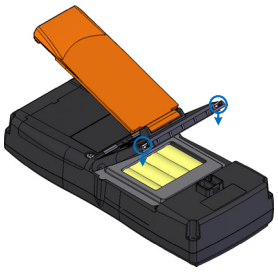


3 Lift and remove the battery cover as shown on the left.

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

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



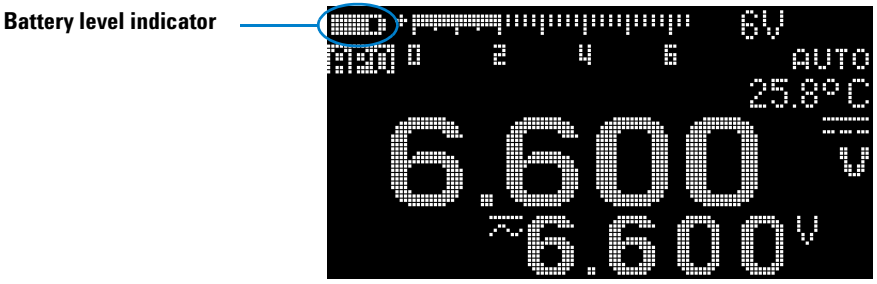


6 Ensure that the inner rubber cover is positioned properly.

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 (↔) flashes.

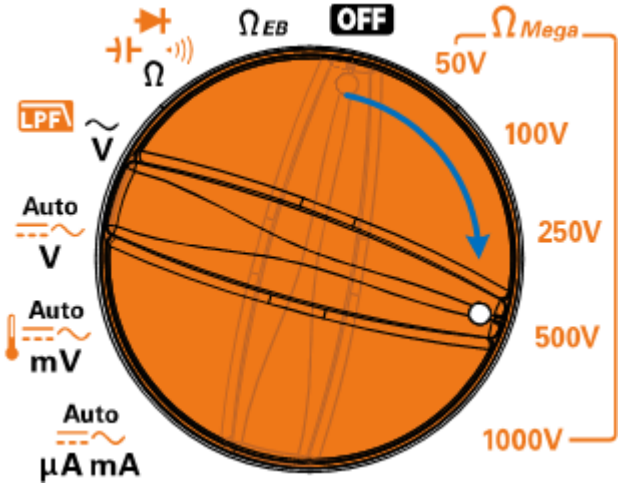
WARNING **To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the low battery indicator appears. Do not discharge the battery by shorting the battery or reversing the battery polarity in any of the batteries.**

CAUTION To avoid testers being damaged 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.

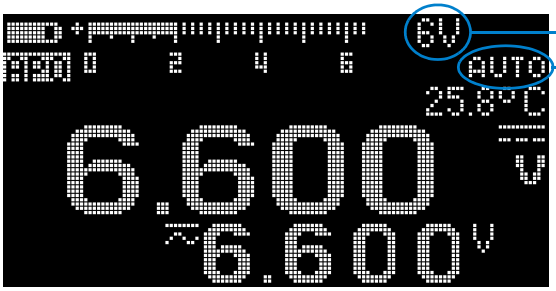
Turn on your tester

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.



Selected range
Autoranging indicator

Pressing Range changes the tester range (and disables auto-ranging). Each additional presses 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.

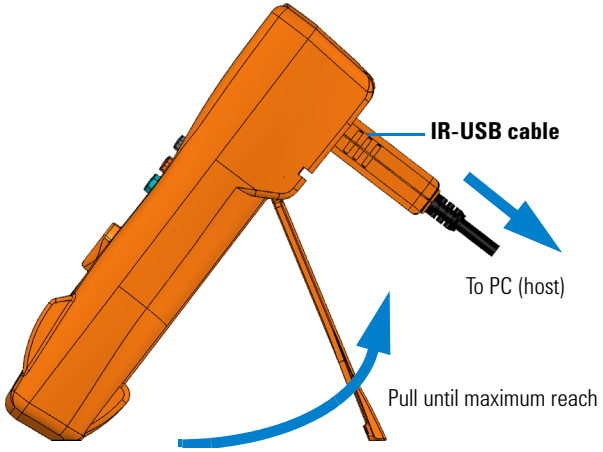
Press and hold Range to switch the tester to **auto-ranging.** Auto-ranging is convenient because the tester automatically selects an appropriate range for sensing and displaying each measurement.

NOTE

- Changing the tester range (and disabling auto-ranging) is not allowed for earth-bond resistance tests and insulation resistance tests.
- The range is fixed for diode tests and temperature measurements.
- 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.

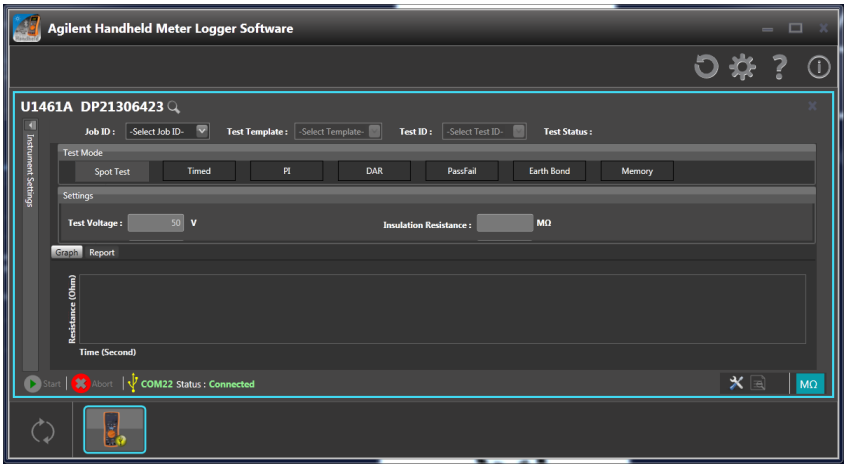


Figure 1-1 Agilent Handheld Meter Logger Software

The Agilent Handheld Meter Logger Software and its supporting documents (Quick Start Guide and Help) are available for download from http://www.agilent.com/hhmeterlogger.

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).

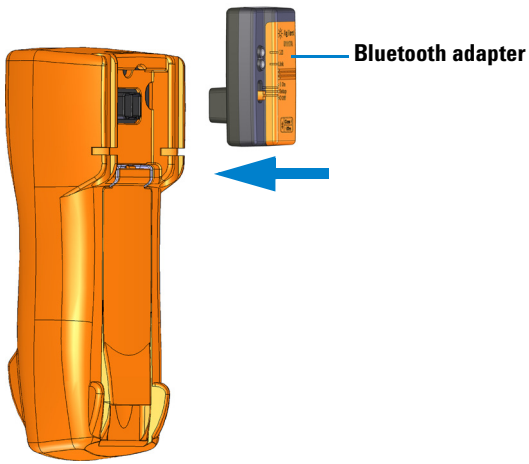


Figure 1-2 Bluetooth adapter connection

Refer to the *Agilent U1117A IR- to- Bluetooth Adapter Operating Instructions* (download from http://www.agilent.com/find/U1117A) for more information on how to set up the U1117A to a Windows PC, Android device, or iOS device.

Your Tester in Brief

Dimensions

Front view

Figure 1-3 Width dimensions

Rear and side view

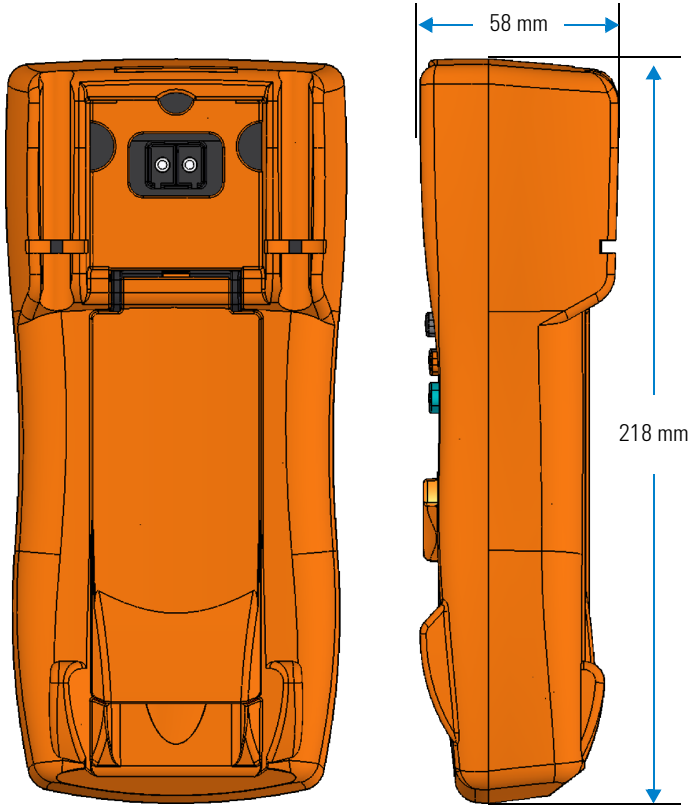


Figure 1-4 Height and depth dimensions

Overview

Front panel

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

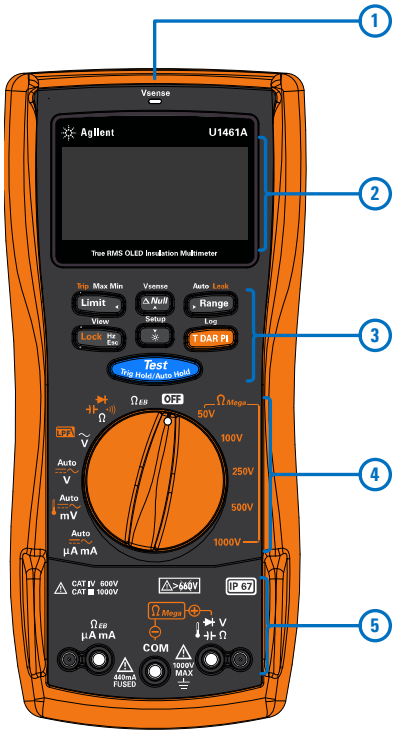


Table 1-1 Front panel part descriptions

Legend	Description	Learn more on:
1	Vsense detector (model U1461A only)/Red LED indicator	page 84
2	Display screen	page 21
3	Keypad	page 17
4	Rotary switch	page 14
5	Input terminals	page 29

Rear panel

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

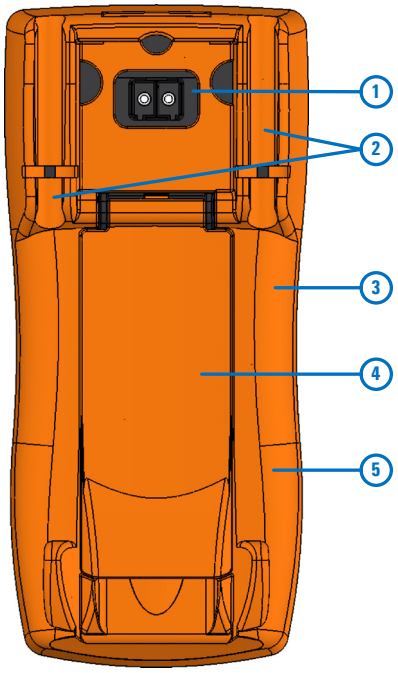


Table 1-2 Rear panel parts

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 17 for more information on the T DAR PI key.

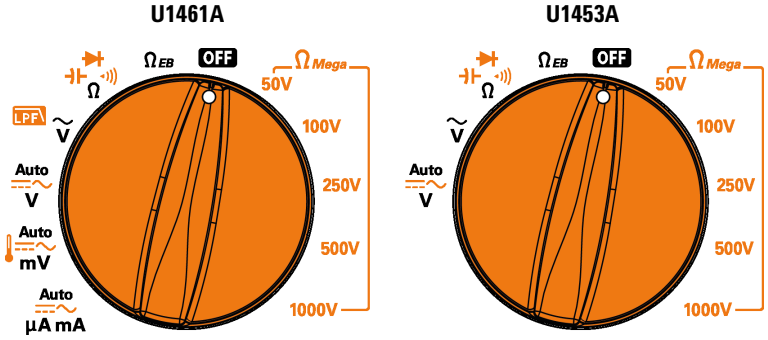


Table 1-3 U1461A/U1453A rotary switch functions

Legend	Measurement function	U1461A	U1453A	Learn more on:
ΩMega 50V	50 V Insulation resistance test	✔	✔	page 51
	T - Timed test	✔	✔	
	DAR - Dielectric Absorption Ratio test	✔	✔	
	PI - Polarization Index Test	✔	✔	

Table 1-3 U1461A/U1453A rotary switch functions (continued)

Legend	Measurement function	U1461A	U1453A	Learn more on:
Ω Mega 100V	100 V Insulation resistance test	✔	✔	page 51
	T - Timed test	✔	✔	
	DAR - Dielectric Absorption Ratio test	✔	✔	
	PI - Polarization Index Test	✔	✔	
Ω Mega 250V	250 V Insulation resistance test	✔	✔	page 51
	T - Timed test	✔	✔	
	DAR - Dielectric Absorption Ratio test	✔	✔	
	PI - Polarization Index Test	✔	✔	
Ω Mega 500V	500 V Insulation resistance test	✔	✔	page 51
	T - Timed test	✔	✔	
	DAR - Dielectric Absorption Ratio test	✔	✔	
	PI - Polarization Index Test	✔	✔	
Ω Mega 1000V	1000 V Insulation resistance test	✔	✔	page 51
	T - Timed test	✔	✔	
	DAR - Dielectric Absorption Ratio test	✔	✔	
	PI - Polarization Index Test	✔	✔	
Ω EB	Earth-bond resistance test	✔	✔	page 51
	T - Timed test	✔	✔	
Ω	Resistance measurement	✔	✔	page 66
	Continuity test	✔	✔	page 68
	Diode test	✔	✔	page 70
	Capacitance measurement	✔	✔	page 75

Table 1-3 U1461A/U1453A rotary switch functions (continued)

Legend	Measurement function	U1461A	U1453A	Learn more on:
LPF ~ V	AC voltage measurement	✔	✔	page 36
	AC voltage measurement with Low Pass Filter (LPF)	✔	-	page 57
Auto V	Auto voltage measurement	✔	✔	page 36
	DC voltage measurement	✔	✔	
	AC voltage measurement	✔	✔	
Auto mV	Auto voltage measurement (mV)	✔	-	
	DC voltage measurement (mV)	✔	-	
	AC voltage measurement (mV)	✔	-	
	Temperature measurement	✔	-	page 78
Auto µA mA	Auto current measurement (µA mA)	✔	-	page 60
	DC current measurement (µA mA)	✔	-	
	AC current measurement (µA mA)	✔	-	
	% Scale of 4-20 mA	✔	-	

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.

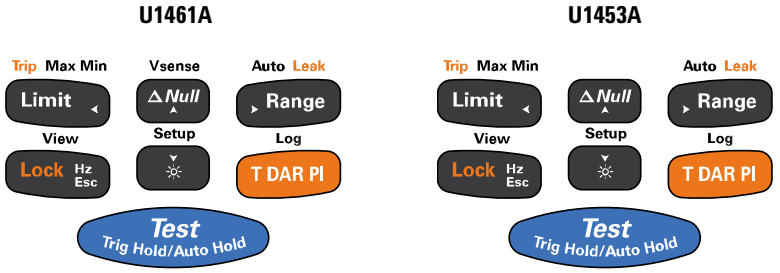


Table 1-4 U1461A/U1453A keypad functions

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 is held — the tester sources (outputs) a high voltage and measures insulation resistance and 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 is held — the tester measures earth-bond resistance and 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 to manually trigger the holding of the next measured value. • Press and hold Test 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 again to exit this mode.

Table 1-4 U1461A/U1453A keypad functions (continued)

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
View Lock Hz Esc	**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 remains active until you press Lock Hz Esc or Test Trig Hold/Auto Hold again to release the lock. • Press Lock Hz Esc during capacitance measurements to view the cable length of the circuit under test. **Hz:** Press Lock Hz Esc to display the frequency for voltage or current measurements. • **Model U1461A only**: Press Lock Hz Esc again to scroll through the frequency (**Hz**), pulse width (**ms**), and duty cycle (**%**) measurements. This option must first be enabled in the Setup menu (see page 141). • Press Lock Hz Esc again to disable the frequency display. **Esc:** Press Lock Hz Esc in the Setup menu to discard your changes.	**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.

Table 1-4 U1461A/U1453A keypad functions (continued)

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
Log T DAR PI	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. **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. **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.	**Log:** The recording option (HAND, AUTO, or TRIG) must first be selected in the Setup menu (see page 110). • 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 110). 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 96). Press and hold T DAR PI again to exit this mode.
Trip Max Min Limit	**Limit:** Press Limit to enable the comparison for limit mode. • Press Limit again to set the comparison value. Use the arrow keys (page 100) to change the value shown and press T DAR PI to save your changes. • Press and hold Limit to exit this mode. **Trip:** When the rotary switch is in one of the Ω Mega positions, first press Range to display the leakage current. Then, press Limit to cycle through the various Trip tests for insulation resistance measurement. The test will start when you press Test. • Trip by leakage current • Trip by stepped voltage (Scan) • Trip by stepped voltage (Ramp)	**Max Min:** Press and hold Limit to start the Max Min recording. • Press Limit again to cycle through maximum (**REC MAX**), minimum (**REC MIN**), average (**REC AVG**), and present (**REC NOW**) readings. • Press and hold Limit again to exit this mode. • Max Min is disabled when Trip tests are enabled.

Table 1-4 U1461A/U1453A keypad functions (continued)

Legend	Function when pressed for:	
	Less than 1 second	**More than 1 second**
Auto Leak Range	**Range:** Press Range to set a manual range and disable auto-ranging. • Press Range again to cycle through each available measurement range. • Press Range during temperature measurements to change the temperature measurement unit between Celsius (°C) and Fahrenheit (°F). This option must first be enabled in the Setup menu (see page 139). **Leak:** Press Range to display the leakage current.	**Auto:** Press and hold Range to enable auto-ranging. **Auto:** Press and hold Range during diode tests to enable the Auto-diode feature. Press and hold Range again to exit this mode.
Vsense Δ Null	**Null:** Press Δ Null to enable the relative function. • The displayed value is saved as a reference to be subtracted from subsequent measurements. • Press Δ 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 Δ Null while the stored reference value is being displayed will cancel the relative function.	**Vsense (model U1461A only):** Press and hold Δ Null to enable the non-contact voltage presence indicator. • Press Range to change the Vsense detector's sensitivity from **HIGH SENSE** to **LOW SENSE**. • Press and hold Δ Null again to exit this mode.
Setup ☼	☼: Press ☼ to increase or decrease the OLED brightness. This option must first be enabled in the Setup menu (see page 116).	**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 (page 100) to change the value shown. • Press T.DAR PI again to save your changes, or press Lock Hz 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 26 for a list of available measurement signs and notations and "Analog bar graph" on page 27 for a tutorial on the analog bar graph located at the bottom of your display screen.

General display annunciators

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

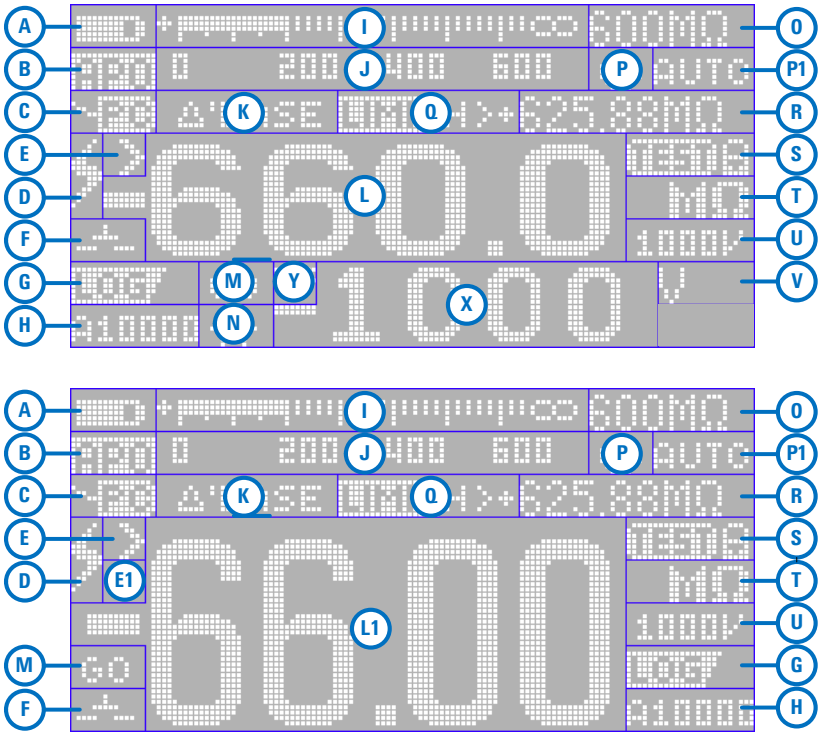


Figure 1-5 Display screen allocation example

Table 1-5 General annunciators

Area	Legend	Description
A		Battery capacity indication
B		APO (Auto Power-Off) enabled
C		Remote control enabled
D		Hazardous voltage sign for measuring voltage ≥30 V or OL (overload)
E		Greater than range (for insulation resistance and earth-bond resistance tests)
		Type-J/Type-K thermocouple selected
E1		Polarity (for dual displays)
F		• Capacitor is charging (during capacitance measurement) • Positive slope for pulse width (**ms**) and duty cycle (**%**) measurements
		• Capacitor is discharging (during capacitance measurement) • Negative slope for pulse width (**ms**) and duty cycle (**%**) measurements
		Short continuity indication
		Open continuity indication
G		Data logging in progress
		View mode for reviewing previously logged data

Table 1-5 General annunciators (continued)

Area	Legend	Description
H	A:Full A:Void H001 H100 A1000 E1000	Index for AUTO (automatic), HAND (manual), and TRIG (event) data logging
I		Analog bar graph
J	0 200 400 600	Scale of analog bar graph
K	Δ NULL	Relative (Null) enabled
	Δ'BASE	Relative value when Null is enabled
L	-660.0	Primary measurement display (medium)
L1	-66.00	Primary measurement display (large)
M	GO HG HI LO	Comparison result for Limit mode
N		Reverse diode indication for Auto-diode test
O	1000mV 600MΩ	Range indication
P		Smooth mode enabled
P1	AUTO	Auto-ranging enabled, Auto-diode enabled, or Auto signal indicator enabled

Table 1-5 General annunciators (continued)

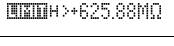
Area	Legend	Description
Q		Maximum reading shown on primary display
		Minimum reading shown on primary display
		Averaged reading shown on primary display
		Present reading shown on primary display
		Auto hold enabled
		Trigger hold enabled
		Timed test enabled
		Dielectric Absorption Ratio test enabled
		Polarization Index test enabled
		Limit comparison enabled
		Overcurrent indication
		Trip enabled
R		Ambient temperature indication
		Elapsed time for Recording mode
		Timer display for T, DAR, and PI tests
R+S		Limit value indication for comparison

Table 1-5 General annunciators (continued)

Area	Legend	Description
S		AC, DC, and AC+DC indication for primary display
		Low-pass filter enabled for AC measurement
		Diode test enabled
		Temperature measurement without ambient compensation selected
		Test and Test Lock indication for insulation resistance and earth-bond resistance tests
T		Measuring units for primary display
U		Test voltage for insulation resistance
		% Scale of 4-20 mA or 0-20 mA
		Audible continuity test selected
		Audible disabled
		Tone enabled
V		Measuring units for secondary display

Table 1-5 General annunciators (continued)

Area	Legend	Description
X	-66.00	Secondary measurement display
Y		AC, DC, and AC+DC indication for secondary 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	
T	Tera	1E+12 (1000000000000)
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	
A, mA, µA, nA	Ampere, units for current measurement	
nF, µF, mF	Farad, units for capacitance measurement	
Ω, kΩ, MΩ, GΩ,	Ohm, units for resistance measurement	
kHz, Hz	Hertz, units for frequency measurement	
ms	Millisecond, unit for pulse width measurement	

Table 1-6 Measurement units display (continued)

Sign/Notation	Description
%	Percent, unit for duty cycle measurement
°C	Degree Celsius, unit for temperature measurement
°F	Degree Fahrenheit, unit for temperature measurement
m, km	Meter, units for length
ft	Feet, unit for length
s	Seconds, unit for Recording mode elapsed time

Analog bar graph

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

NOTE

For frequency, duty cycle, pulse width, 4-20 mA % scale, 0-20 mA % scale, and temperature measurements, the bar graph does not represent the primary display value.

For example, when frequency, duty cycle, or pulse width is displayed on the primary display during voltage or current measurement, the bar graph represents the voltage or current value (not the frequency, duty cycle, or pulse width value). Another example is when 4-20 mA % scale or 0-20 mA % scale is displayed on the primary display, the bar graph represents the current value and not the percentage value.

The "+" or "–" sign indicates whether the measured or calculated value is positive or negative. Each bar represents 10 to 100 counts depending on the display count and range selected.

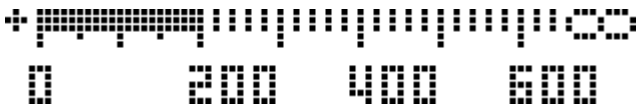


Figure 1-6 Analog bar graph example

See Table 1-7 for the relevant display counts, span, and counts per bar.

Table 1-7 Analog bar graph display counts/bar

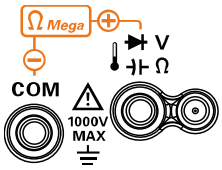
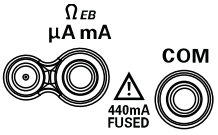
Display counts	Span 1	Counts/bar	Span 2	Counts/bar
6000	0 to 200	10	>200	20
1000	0 to 200	10	>200	40
2000	0 to 400	20	>400	80

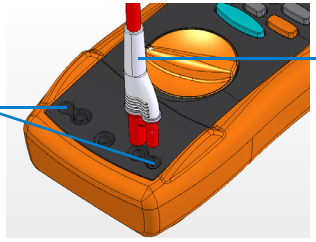
Input terminals

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
V ~ LPF V ~ Auto V		1000 Vrms
Ω Auto mV Ω Mega 50V Ω Mega 100V Ω Mega 250V Ω Mega 500V Ω Mega 1000V		1000 Vrms for short circuit <0.3 A
Ω EB Auto μA mA		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 1-7 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 116.

OLED Auto Dim function

Your tester's OLED automatically dims if the rotary switch is not moved or a key is not pressed for 90 seconds (default). This auto dim behavior is enabled by default. Pressing any key or changing the rotary switch position will cancel this effect and reset the auto dim timer.

To disable the auto dim, refer to "Changing the OLED behavior" on page 116.

Change the OLED brightness

NOTE The auto dim function is enabled by default. Refer to "Changing the OLED behavior" on page 116 to disable the auto dim function before you can manually change the OLED brightness.

If viewing the display becomes difficult in low-light conditions, press  to change the OLED brightness (this option must first be enabled in the Setup, see "Changing the OLED behavior" on page 116 for more information.

The **LOW**, **MEDIUM**, or **HIGH** setting must be selected in the tester's Setup (browse to **Menu 3 > BACKLIT**) prior to this action. Pressing repeatedly will cycle the OLED brightness from low to medium to high (and back to low again).

You are advised to select an suitable brightness level based on your needs to conserve battery life if you wish to control the OLED brightness level manually.

Hazardous voltage indication

The tester will display the hazardous voltage ( ) 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
△Null	Displays the power-on greeting. Press any key to exit this mode.
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 and serial number. The tester's firmware version and serial number 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 90) is enabled.
	Smooth is enabled until the tester is turned off. To permanently enable Smooth, see "Enabling smooth mode" on page 112.
	Tests the OLED. All OLED pixels are lighted. Use this mode to verify that there are no dead OLED pixels. 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 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.

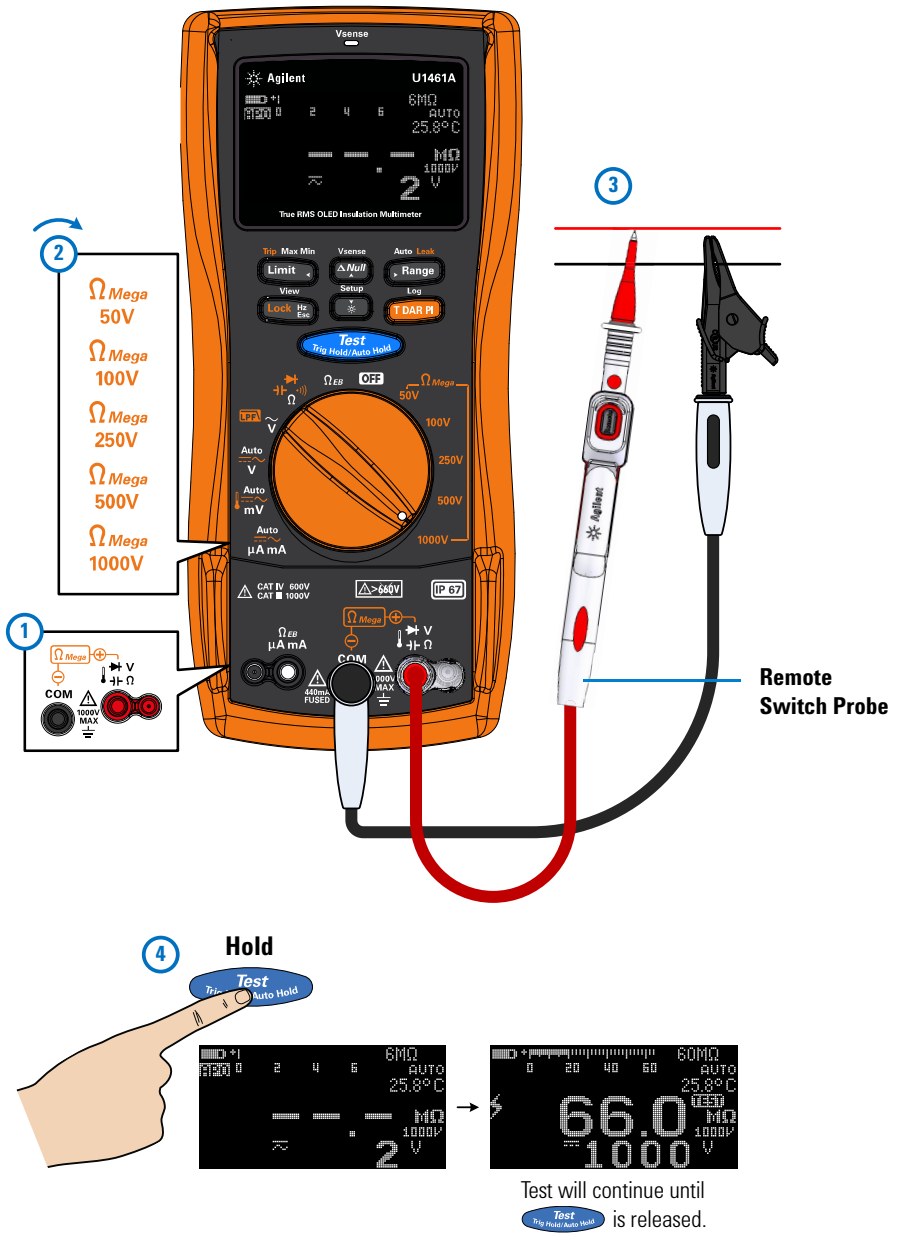


Figure 2-1 Insulation resistance test example

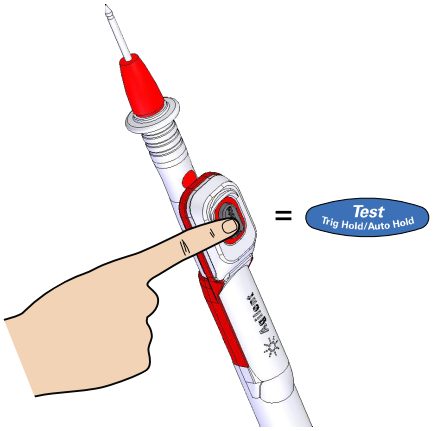
CAUTION The insulation meter will auto-discharge the DUT when the test is complete. However, the DUT will not be auto-discharged when you disconnect the probe before the test is complete. Avoid touching the DUT when the DUT is not fully discharged as it may lead to possible electric shock.

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 32.

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.

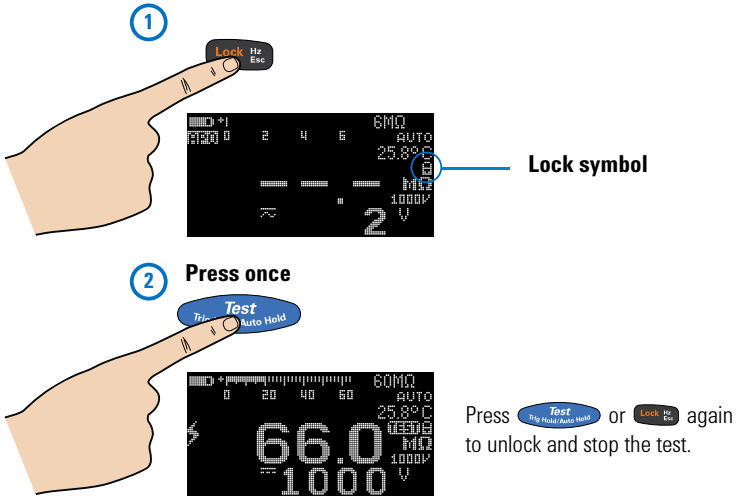


To change the default button operation, see "Changing the button operation on the remote switch probe" on page 130

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 symbol will be shown on the display. The test will start when you press Test and it remains 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 “Disabling the lock once feature” on page 131 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 (T) 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 operation

NOTE

- Because of the time required to perform the T, PI, and DAR tests, the use of alligator test clips is recommended.
- The length of the timer is 1 minute by default. To change this value, see "Changing the insulation resistance and earth-bond resistance test period" on page 135 for more information.

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.

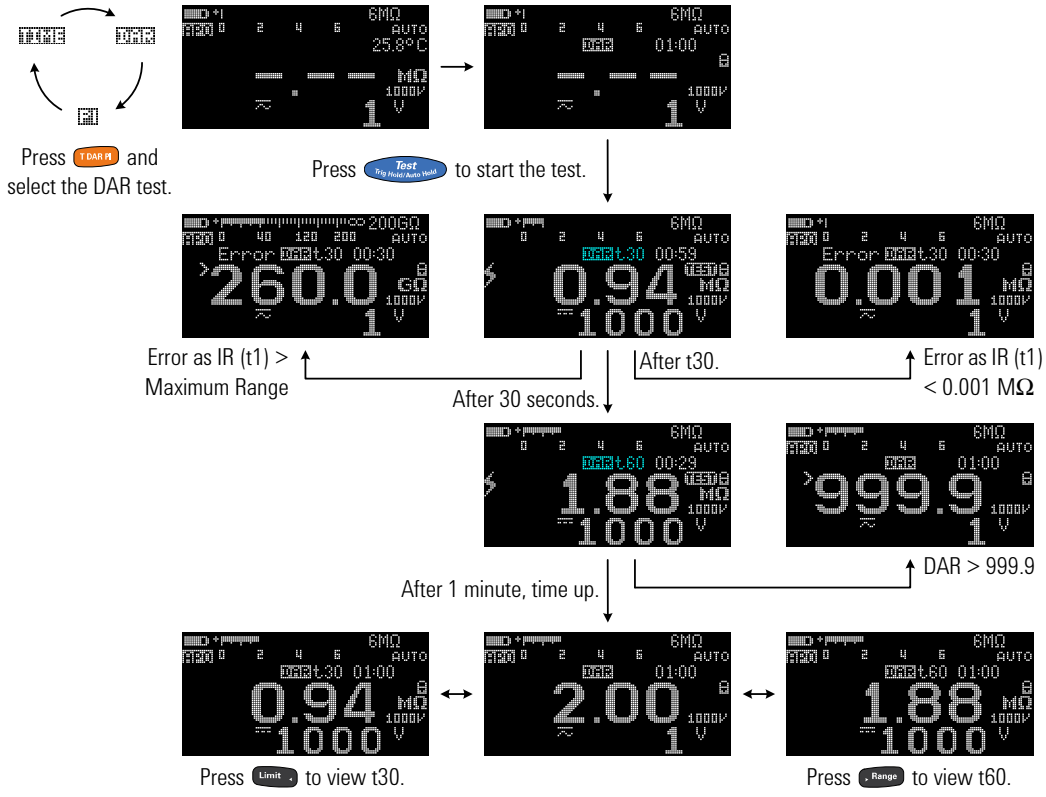


Figure 2-3 DAR operation

NOTE You can change the DAR from 60:30 to 60:15 in the Setup. See "Changing the Dielectric Absorption Ratio (DAR) for insulation resistance tests" on page 132 for more information. **Error** is shown on the display if the IR is greater than the maximum range or less than 0.001 MΩ after t1/t15/t30; if the test is interrupted by the user; or if the tester's battery is low.

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.

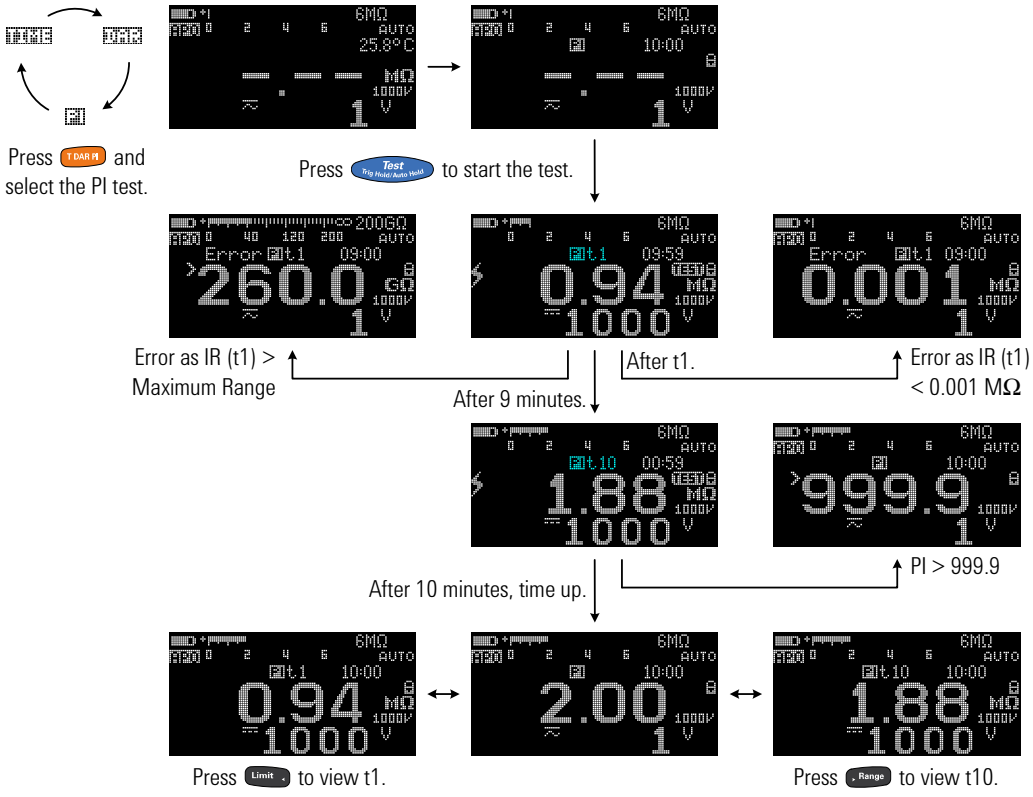
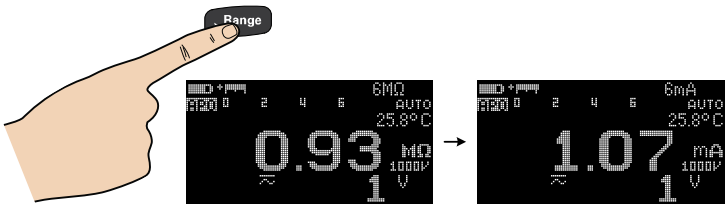


Figure 2-4 PI operation

NOTE **Error** is shown on the display if the IR is greater than the maximum range or less than 0.001 MΩ after t1/t15/t30; 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.



Performing leakage current trip tests

This function may be used to test MOVs (Metal Oxide Varistors), gas discharge tubes, voltage arresters, or sparking gaps. The voltage source will be stopped when the current is greater than the trip current set.

You can select the test voltage and set the current for tripping the test. The trip or breakdown current can be adjusted from 0.001 mA to 1.500 mA from the Setup (see page 137) or by pressing Null before starting the test.

NOTE T/DAR/PI tests, Null, Limit, and test lock is disabled when leakage current trip tests or stepped voltage trip tests are enabled.

Set up your tester as shown in Figure 2-1, and follow the steps shown in Figure 2-5.

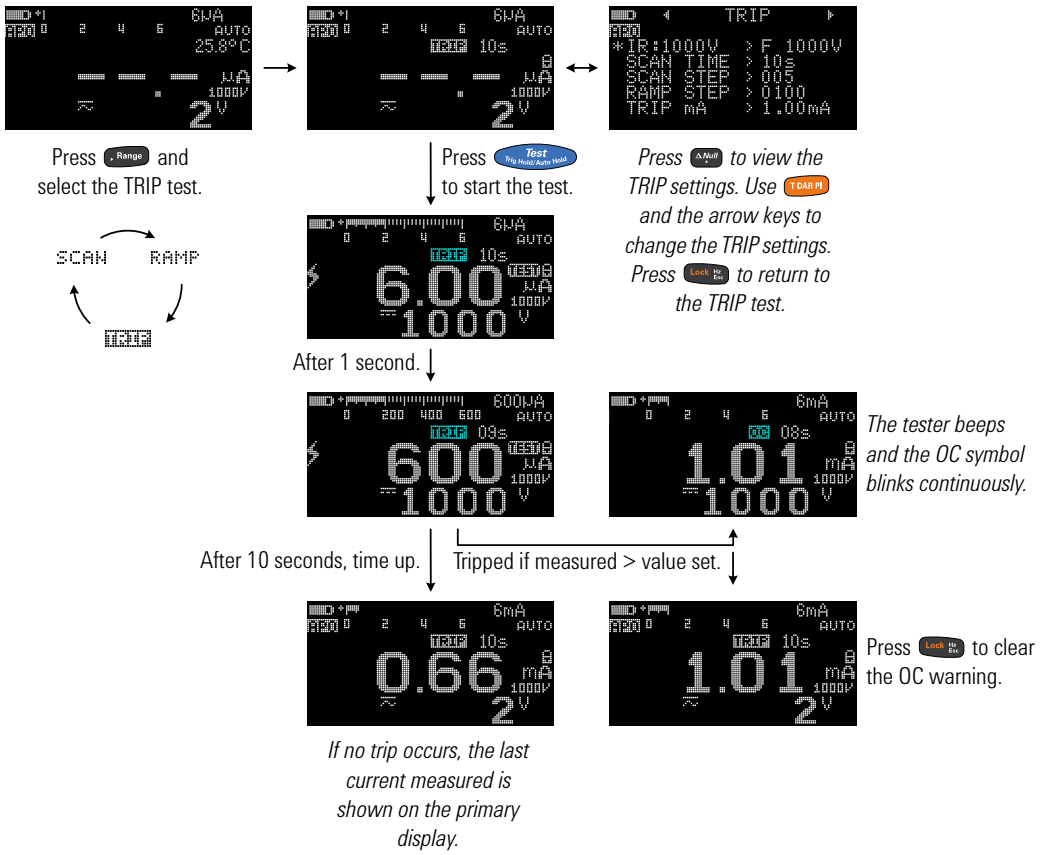


Figure 2-5 TRIP operation

Performing stepped voltage trip tests

Scan

A typical scan signal length is based on the following parameters:

- **IR TEST VOLTAGE** - the amplitude end position
- **SCAN STEP** - the number of steps required to reach the amplitude end position
- **SCAN TIME** - the dwelling time length for each step

NOTE

- The TRIP test method involves the application of high direct voltage in a series of uniform voltage steps at regular time intervals. The minimum voltage step is 10 V. Each step should be set to greater than 10 V and the last step is equal to or less than the test voltage setting.
- As an example, if the SCAN STEP is set to 5; for the 1000 V test voltage setting, the test voltage is sent out at the following intervals: 200 V, 400 V, 600 V, 800 V, and 1000 V.

You can configure the scan signal amplitude end position, number of steps (1 to 100 steps), and dwelling time length (1 to 99 seconds) in the Setup (see page 135 and page 136) or by pressing △Null before starting the test.

The total dwell time will increase with respect to the number of steps and the scan dwell time per step selected. The scan dwell time is defined as the length of time the scan signal will “dwell” in the present step before incrementing to the next step.

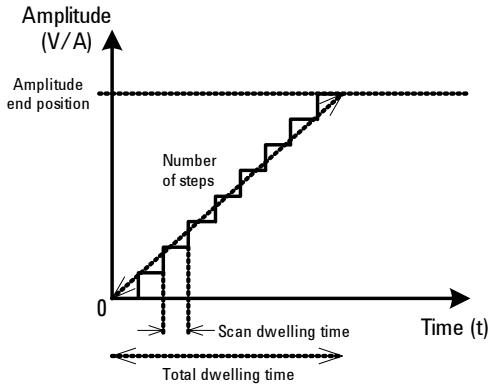


Figure 2-6 Scan signal

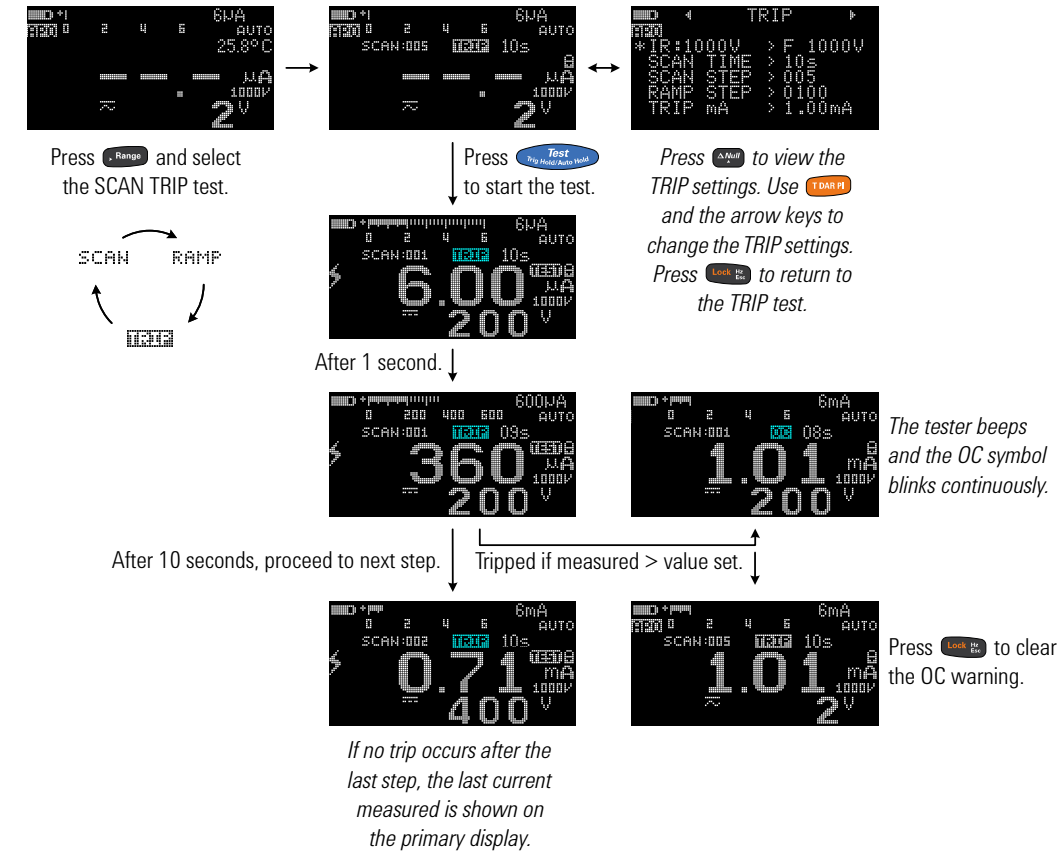


Figure 2-7 SCAN TRIP operation

Ramp

A typical ramp signal length is based on the following parameters:

- **IR TEST VOLTAGE** - the amplitude end position, and
- **RAMP STEP** - the number of steps required to reach the amplitude end position.

NOTE The principal advantages of the ramped voltage test over the conventional stepped voltage methods are that it gives better control and improved warning of impending failure to avoid damage to the insulation. Elimination of the human variable from the time, voltage, and current parameters yields overall test results which are much more accurate and repeatable.

You can configure the ramp signal amplitude end position and number of steps in the Setup (see page 137) or by pressing Δ Null before starting the test.

The ramp dwelling time will be set to the fastest of the instrument capability. A higher number of steps provides a more linear ramp signal. This however will result in an increase in the total dwelling time.

A lower number of steps will result in a shorter total dwelling time and a more stepped ramp signal.

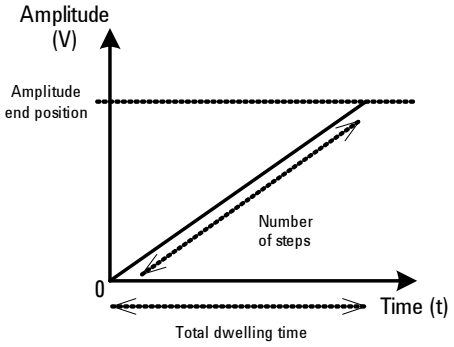


Figure 2-8 Ramp signal

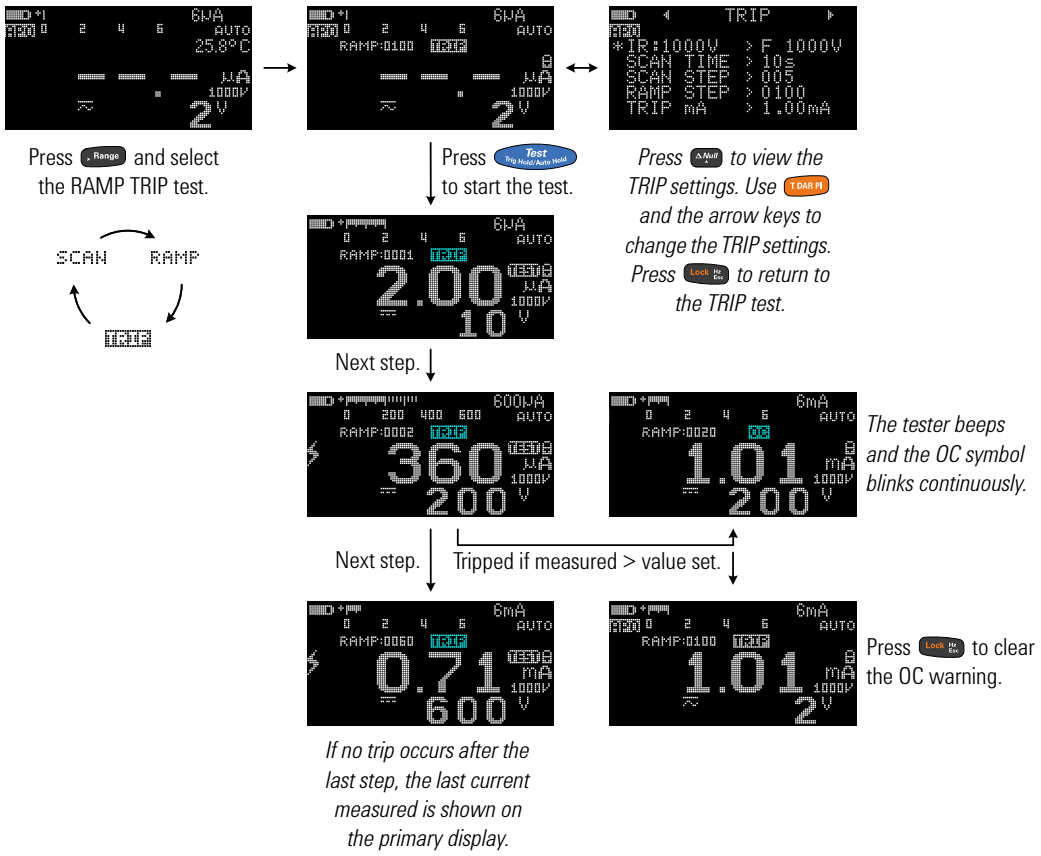


Figure 2-9 RAMP TRIP operation

Changing the insulation resistance test voltage

You can adjust the test voltage value of each test voltage position (see Table 2-1) from the Setup menu ("Menu 8").

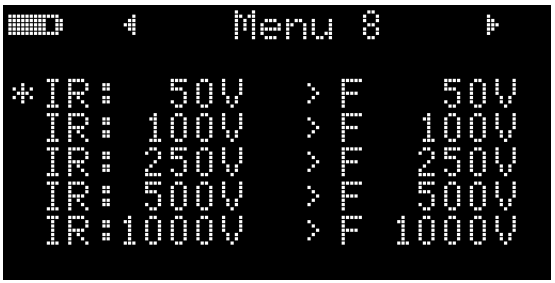


Table 2-2 lists the available range for each test voltage position. See "Changing the insulation resistance test voltage" on page 133 for more information.

Table 2-2 User test voltage range for insulation resistance

Rotary switch position	Parameter	Range	
		F(actory) default	Available U(ser) range[1]
Ω Mega 50V	IR: 50 V	50 V	10 V to 60 V
Ω Mega 100V	IR: 100 V	100 V	10 V to 120 V
Ω Mega 250V	IR: 250 V	250 V	10 V to 300 V
Ω Mega 500V	IR: 500 V	500 V	10 V to 600 V
Ω Mega 1000V	IR: 1000 V	1000 V	10 V to 1100 V

[1] Minimum increment of 1 V between each subsequent value.

Earth-Bond Resistance Test

Set up your tester to perform earth-bond resistance tests as shown in Figure 2-10.

Table 2-3 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 is inhibited and ⚠Ve > 2V is shown on the display. 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. The function includes 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 (T) insulation resistance/earth-bond resistance test" on page 40.

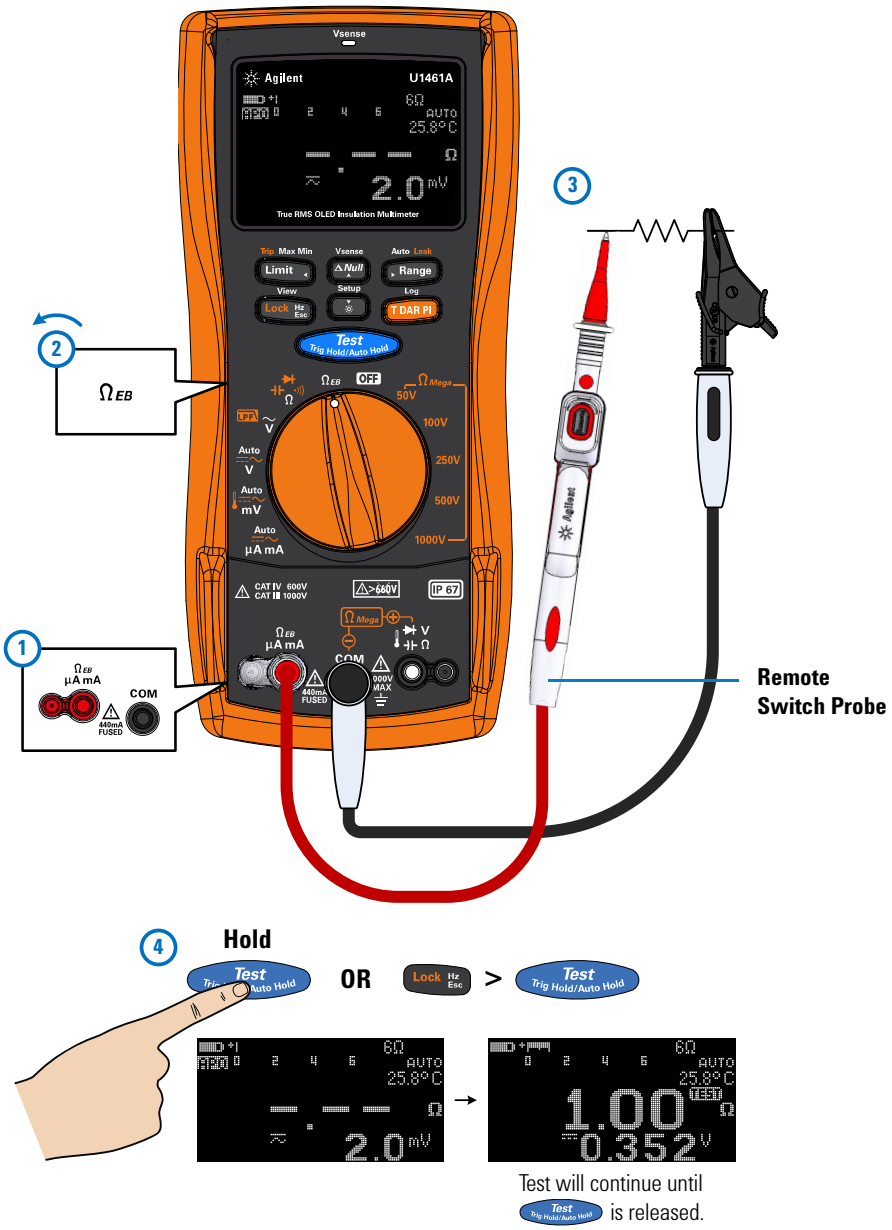


Figure 2-10 Earth-bond resistance test example

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 OPEN** will be shown on the display. Follow the instructions in the *U1461A/U1453A Service Guide* to replace the fuse.

Fuse blown; replace fuse.

Measuring AC or DC Voltage

Set up your tester to measure AC or DC voltage as shown in Figure 2-11.

Table 2-4 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**
LPF ~V	AC V	-	AC V with LPF	-
~V	AC V	-	-	-
Auto ~V	Auto (V)	AC+DC V	*Cycles between* **1** DC V **2** AC V **3** Auto (V)	 **1** AC+DC V **2** AC+DC V **3** AC+DC V
Auto mV	Auto (mV)	AC+DC mV	*Cycles between* **1** DC mV **2** AC mV **3** Temperature **4** Auto (mV)	 **1** AC+DC mV **2** AC+DC mV **3** -, °C, or °F **4** AC+DC mV

NOTE

- AC voltage measurements measured with this tester are returned as true RMS (root mean square) readings. These readings are accurate for sinusoidal waves and other waveforms with no DC offset, such as square waves, triangle waves, and staircase waves.
- 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 Duty to measure the frequency of the voltage source. See "Measuring Frequency" on page 63 to learn more.

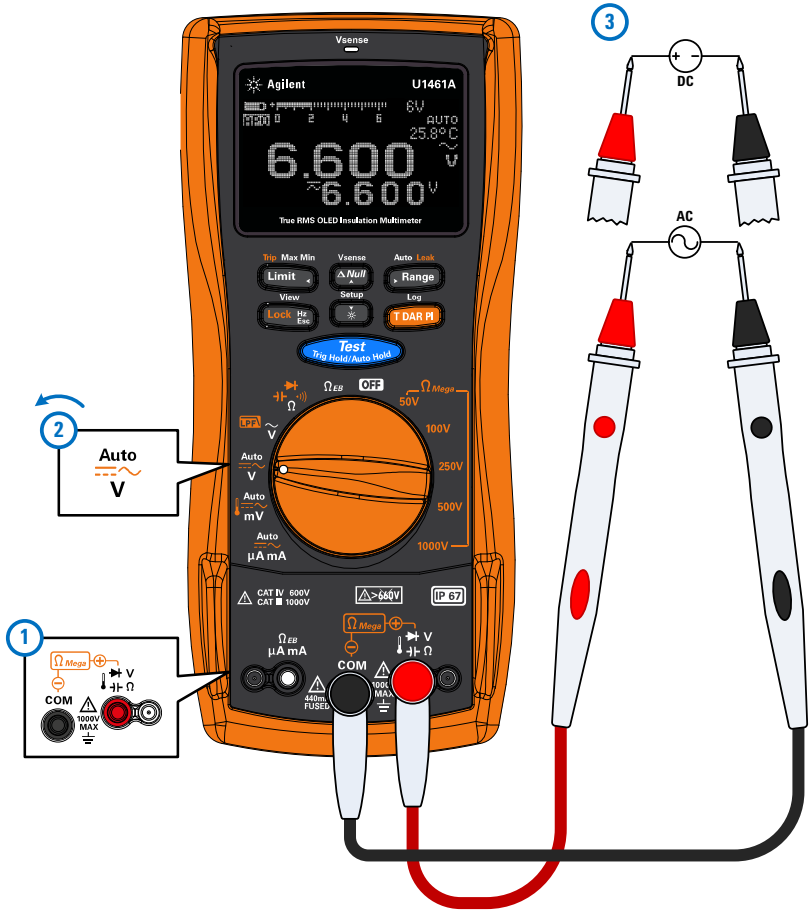
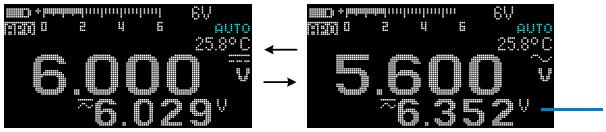


Figure 2-11 AC or DC voltage measurement example

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 AC+DC value is shown in the secondary display.

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).

Using the LPF (Low Pass Filter) feature for AC signals

For model U1461A only: Your tester is equipped with an AC low-pass filter to help reduce unwanted electronic noise when measuring AC voltage or AC frequency.

Set up your tester to measure AC voltage as shown in Figure 2-11. Turn the rotary knob to LPF ~V and press T DAR PI to activate the LPF option. Your tester continues measuring in the chosen AC mode, but now the signal diverts through a filter that blocks unwanted voltages above 1 kHz. Probe the test points, and read the display.

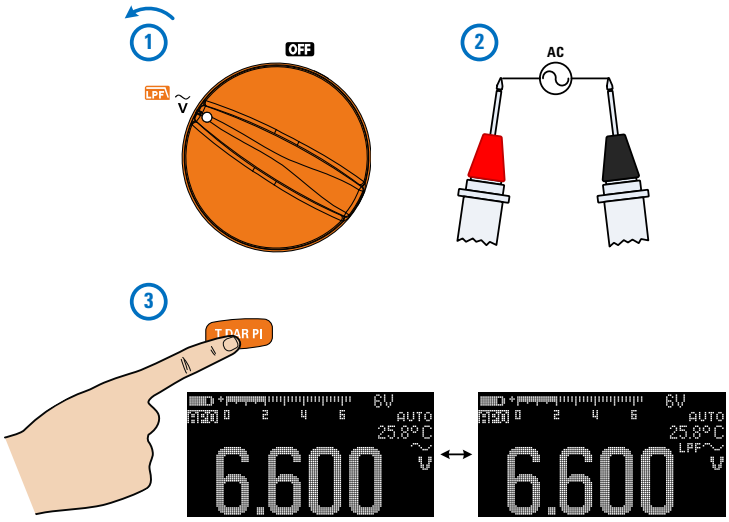


Figure 2-12 AC voltage with LPF measurement example

WARNING

- **To avoid possible electric shock or personal injury, do not use the LPF option to verify the presence of hazardous voltages. Voltages greater than what is indicated may be present. First, make a voltage measurement without the filter to detect the possible presence of hazardous voltages. Then, select the filter option.**
- **When the LPF option is selected, the measurement function will switch to the manual range mode (defaults to 600 V) for variable speed drive (VSD) applications. It is recommended only to use 600 V and 1000 V in the manual range for VSD testing.**

The low-pass filter can improve measurement performance on composite sine waves that are typically generated by inverters and variable frequency motor drives.

Enabling the LPF in the Setup

You can also enable the low-pass filter to block and attenuate AC signals above 1 kHz for the AC or DC paths of V, mV, and µA mA measurements. See “Enabling the low-pass filter” on page 140 for more information.

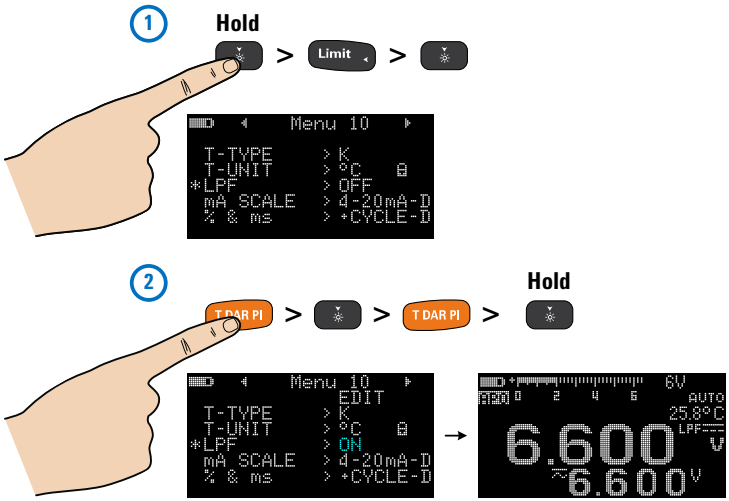


Figure 2-13 Enabling the low-pass filter

Measuring AC or DC Current

Set up your tester to measure AC or DC current as shown in Figure 2-14. Open the circuit path to be tested.

Table 2-5 AC and DC current measurement positions

Legend	Default function		Function when REL Δ/TARE is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
Auto ⎓~ µA mA	Auto (µA mA)	AC+DC (µA mA)	**1** DC (µA mA) **2** AC (µA mA) **3** % Scale of 4-20 mA **4** Auto (µA mA)	**1** AC+DC (µA mA) **2** AC+DC (µA mA) **3** DC mA **4** AC+DC (µA mA)

WARNING **Never measure voltage by the current measurement terminals and never attempt an in-circuit current measurement where the open-circuit potential to earth is greater than 1000 V. Doing so will cause damage to the tester and possible electric shock or personal injury.**

CAUTION To measure current, you must turn off power to the circuit and discharge all high-voltage capacitors. Then, open the circuit under test, and place the tester in series with the circuit. Insert the black test lead into the **COM** terminal and insert the red test lead to the **µA mA** terminal. Never place the probes across (in parallel with) any circuit or component when the leads are plugged into the current terminals.

NOTE Reversing the leads will produce a negative reading, but it will not damage the tester. Check the tester's fuses when no current is measured.

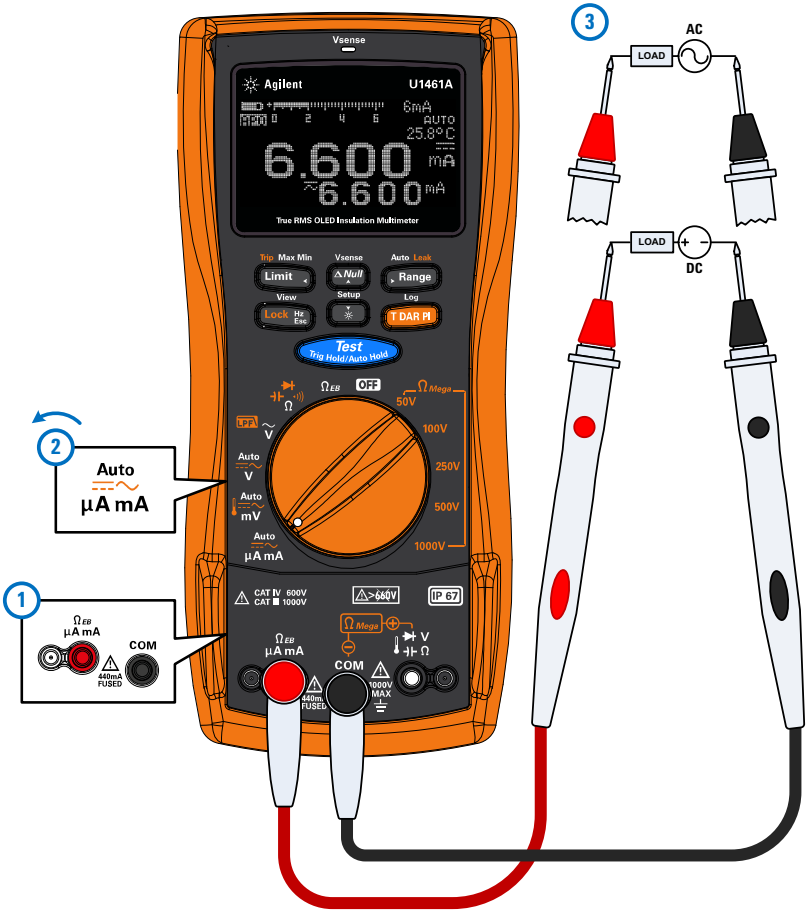


Figure 2-14 AC or DC current measurement example

CAUTION Placing the probes across (in parallel with) a powered circuit when a lead is plugged into a current terminal can damage the circuit you are testing and blow the tester's fuse. This happens because the resistance through the tester's current terminals are very low, resulting in a short circuit.

NOTE

- Press Lock Hz Esc to measure the frequency of the AC or DC current source. See "Measuring Frequency" on page 63 to learn more.
- The **Auto** function is able to automatically identify the signal component (AC or DC) of an electrical source. See "Auto AC or DC signal identification" on page 56 to learn more.

% Scale of 4-20 mA or 0-20 mA

To display the current measurement in % scale, set up your tester to measure DC current as shown in Figure 2-14, then press T DAR PI until the % scale is shown.

NOTE

- The 4-20 mA current loop output from a transmitter is a type of electrical signal that is used in a series circuit to provide a robust measurement signal that is proportional to the applied pressure, temperature, or flow in process control. The signal is a current loop where 4 mA represents the zero percent signal and 20 mA represents the 100 percent signal.
- The % scale for 4-20 mA or 0-20 mA in this tester is calculated using its corresponding DC mA measurement. The tester will automatically optimize the best resolution for the selected measurement. Two ranges are available for the % scale as shown in Table 2-6.

The analog bar graph displays the current measurement value. (In the example above, 24 mA is represented as 125% in the 4-20 mA % scale.)

Table 2-6 % Scale measurement range

% Scale of 4-20 mA or 0-20 mA	DC mA measurement range
999.99%	6 µA or 600 mA[1]
9999.9%	

[1] Applies to both autoranging and manual range selection.

You can change the % scale range (4-20 mA or 0-20 mA) in the Setup (page 141). Use the % scale with a pressure transmitter, a valve positioner, or other output actuators to measure pressure, temperature, flow, pH, or other process variables.

Measuring Frequency

Your tester allows simultaneous monitoring of real-time voltage or current with frequency measurements. To measure frequency, rotate the switch to one of the positions highlighted in Table 2-7 and set up the tester accordingly. Press Lock Hz Esc. Probe the test points, and read the display.

Table 2-7 Measurement positions allowing frequency measurements

Legend	Default function	
Rotary switch position	**Primary display**	**Secondary display**
LPF ~ V	AC V	-
~ V	AC V	-
Auto ~ V	Auto (V)	AC+DC V
Auto ~ mV	Auto (mV)	AC+DC mV
Auto ~ µA mA	Auto (µA mA)	AC+DC (µA mA)

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

NOTE

- Pressing Range controls the input range of the primary function (voltage or ampere) 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 2-15.
- The tester measures the frequency of a voltage or current 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 or ampere value of the signal is shown in the secondary display. The bar graph does not indicate frequency but indicates the voltage or ampere value of the input signal.

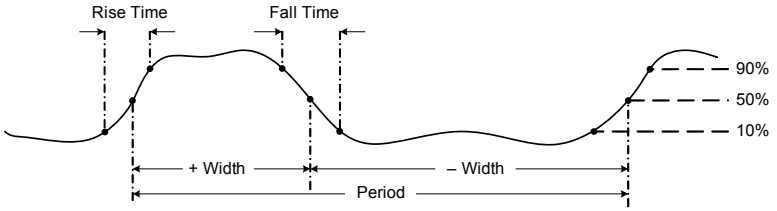


Figure 2-15 Definition of frequency

Measuring duty cycle and pulse width

You must first enable the duty cycle and pulse width display in the Setup menu. See "Enabling the (+ or –) duty cycle and pulse width display" on page 141 for more information.

While displaying voltage or current frequency, press Lock Hz Esc to select the measurement as a percentage (**%**) for duty cycle or in the millisecond (**ms**) unit for pulse width.

NOTE

- The duty cycle (or duty factor) of a repetitive pulse train is the ratio of the positive or negative pulse width to the period expressed as a percentage. The duty-cycle function is optimized for measuring the on or off time of logic and switching signals. Systems such as electronic fuel injection systems and switching power supplies are controlled by pulses of varying width, which can be checked by measuring the duty cycle.
- The pulse width function measures the amount of time a signal is high or low. It is the time from the middle threshold of the rising edge to the middle threshold of the next falling edge. The measured waveform must be periodic; its pattern must repeat at equal time intervals.
- The bar graph does not indicate duty cycle or pulse width value but indicates the voltage or ampere value of the input signal.
- The duty cycle polarity is displayed to the left of the duty cycle value. + indicates a positive pulse width and – indicates a negative pulse width. Change the polarity in the Setup (see page 141).

Measuring Resistance

Set up your tester to measure resistance as shown in Figure 2-16.

Table 2-8 Resistance measurement position

Legend	Default function		Function when T DAR H is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
	Resistance	-	**1** Continuity **2** Diode **3** Capacitance **4** Resistance	**1** - **2** - **3** Cable length **4** -

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.
- The resistance function can produce enough voltage to forward-bias silicon diode or transistor junctions, causing them to conduct. If this is suspected, press Range to apply a lower current in the next higher range.

Figure 2-16 Resistance measurement example

Continuity Test

Set up your tester to perform continuity tests as shown in Figure 2-17. The beeper will sound and the red LED lights up as a continuity indication.

Table 2-9 Continuity test position

Legend	Default function		Function when T DAR PI is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
	Resistance	-	**1** Continuity **2** Diode **3** Capacitance **4** Resistance	**1** - **2** - **3** Cable length **4** -

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 lasting as short as 1 ms. 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 124 for more information on the audible alert option.

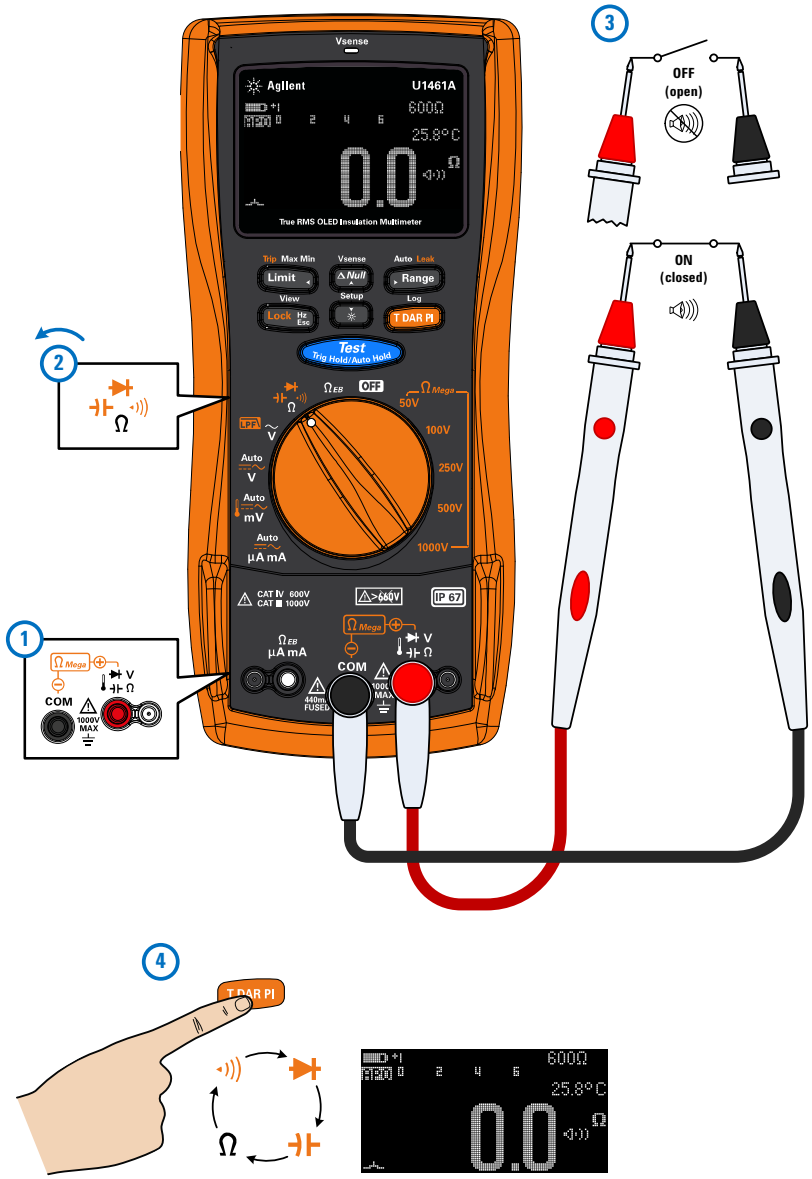


Figure 2-17 Continuity test example

Diode Test

Set up your tester to perform diode tests as shown in Figure 2-18.

Table 2-10 Diode test position

Legend	Default function		Function when T DAR is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
	Resistance	-	**1** Continuity **2** Diode **3** Capacitance **4** Resistance	**1** - **2** - **3** Cable length **4** -

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 diodes.

NOTE

- This test sends a current through a semiconductor junction, and then measures the junction's voltage drop. A typical junction drops 0.3 V to 0.8 V.
- Connect the red test lead to the positive terminal (anode) of the diode and the black test lead to the negative terminal (cathode). The cathode of a diode is indicated with a band.
- Your tester can display diode forward-bias of up to approximately 1 V. The forward-bias of a typical diode is within the range of 0.3 V to 0.8 V; however, the reading can vary depending on the resistance of other pathways between the probe tips.
- If the beeper is enabled during diode test, the tester will beep briefly for a normal junction and sound continuously for a shorted junction, below 0.04 ± 0.02 V approx. See "Changing the beep frequency" on page 115 to disable the beeper.

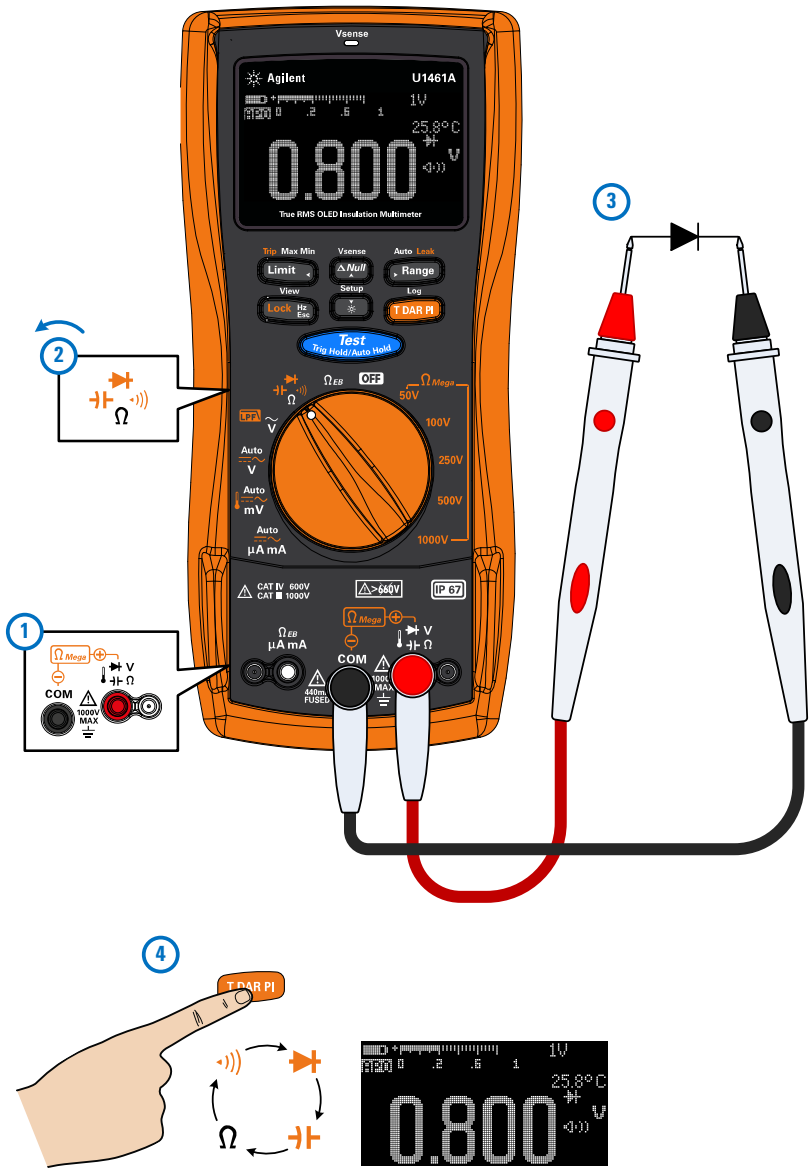


Figure 2-18 Forward-bias diode test example

Reverse the probes (as shown in Figure 2-19) and measure the voltage across the diode again.

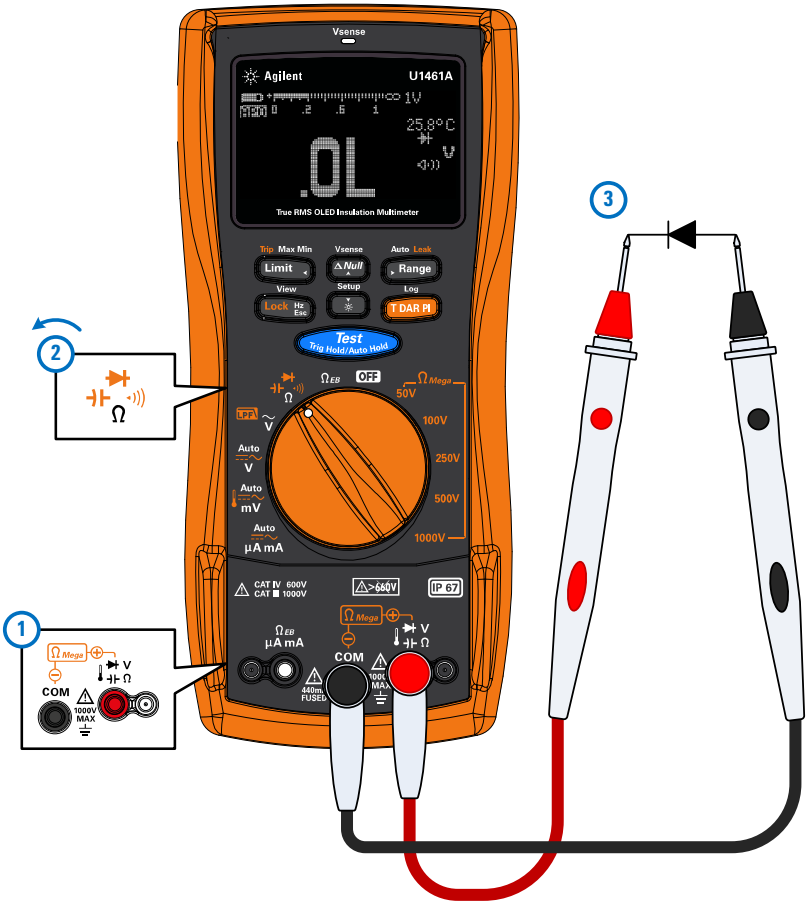


Figure 2-19 Reverse-bias diode test example

Assessing the diode condition

Assess the diode according to the following guidelines:

- A diode is considered good if the tester displays **OL** in reverse-bias mode.
- A diode is considered shorted if the tester displays approximately 0 V in both forward- and reverse-bias modes, and the tester beeps continuously.
- A diode is considered open if the tester displays **OL** in both forward- and reverse-bias modes.

Use the diode test to check diodes, transistors, silicon controlled rectifiers (SCRs), and other semiconductor devices. A good diode allows current to flow in one direction only.

Using the Auto-diode feature

Set up your tester to test diodes as shown in Figure 2-18 or Figure 2-19. Press and hold Range to toggle the Auto-diode feature. Probe the test points, and read the display.

NOTE The auto-diode function will help you test both forward- and reverse-bias directions simultaneously. You do not need to change the measuring direction to identify the diode's condition.

Table 2-11 Auto-diode voltage thresholds

Forward voltage	Reverse voltage	Diode status	
Primary display	Secondary display	GO	NG
OL or <0.3 V or >0.8 V	–OL or >–0.3 V or <–0.8 V		✘
Within 0.3 V to 0.8 V	–OL	✔	
OL	Within –0.3 V to –0.8 V	✔	

NOTE The open condition will not be alerted as **OL** on both directions if the auto-diode function is used.

The primary display shows the forward-bias voltage value. The reverse-bias voltage value is shown in the secondary display.

- **GO** is shown briefly (along with a single beep) if the diode is in a good condition.
- **NG** is shown briefly (along with two beeps) if the diode is out of the thresholds.

Figure 2-20 Auto-diode operation

Measuring Capacitance

Set up your tester to measure capacitance as shown in Figure 2-21.

Table 2-12 Capacitance measurement position

Legend	Default function		Function when T DAR is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
	Resistance	-	**1** Continuity **2** Diode **3** Capacitance **4** Resistance	**1** - **2** - **3** Cable length **4** -

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 charging the capacitor with a known current for a known period of time, measuring the resulting voltage, and then calculating the capacitance.
- is shown on the bottom left of the display when the capacitor is charging, and is shown when the capacitor is discharging.
- To improve measurement accuracy of small value capacitors, press Δ/Null with the test leads open to subtract the residual capacitance of the tester and leads.
- For measuring capacitance values greater than 1000 µF, discharge the capacitor first, then select a suitable range for measurement. This will speed up the measurement time and also ensure that the correct capacitance value is obtained.

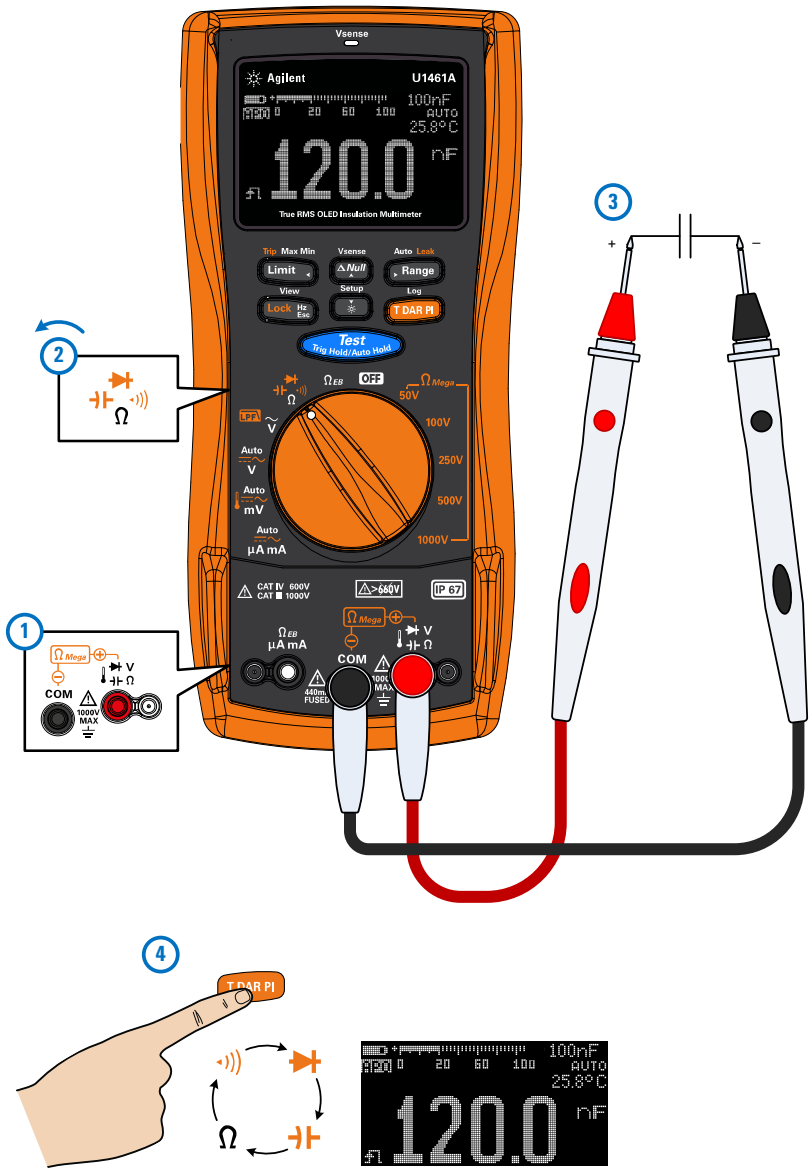
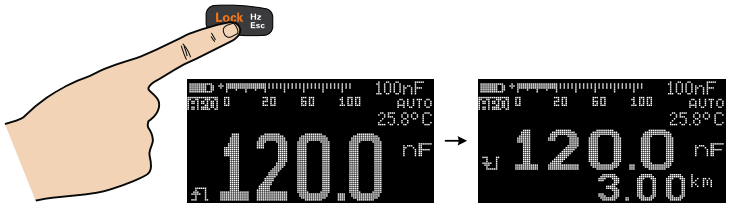


Figure 2-21 Capacitance measurement example

Viewing the cable length value

Press Lock Hz Esc to temporarily display the cable length of the circuit under test 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 127.

You can also change the cable length unit (Meter or Feet). To change this value, see "Changing the cable length unit" on page 128.

Measuring Temperature

The tester uses a type-K (default setting) temperature probe for measuring temperature. To measure temperature, set up your tester as shown in Figure 2-22.

Table 2-13 Temperature measurement position

Legend	Default function		Function when T DAR H is pressed	
Rotary switch position	**Primary display**	**Secondary display**	**Primary display**	**Secondary display**
			Cycles between	
Auto mV	Auto (mV)	AC+DC mV	**1** DC mV **2** AC mV **3** Temperature **4** Auto (mV)	**1** AC+DC mV **2** AC+DC mV **3** -, °C, or °F **4** AC+DC mV

WARNING **Do not connect the thermocouple to electrically live circuits. Doing so will potentially cause fire or electric shock.**

CAUTION Do not bend the thermocouple leads at sharp angles. Repeated bending over a period of time can break the leads.

NOTE

- Shorting the terminal to the **COM** terminal will display the temperature at the tester's terminals.
- To change the default thermocouple type from type-K to type-J, see "Changing the thermocouple type" on page 139 for more information.

The primary display normally shows temperature or the message **OL** (open thermocouple). The open thermocouple message may be due to a broken (open) probe or because no probe is installed into the input jacks of the tester.

NOTE

The bead-type thermocouple probe is suitable for measuring temperatures from –40 °C to 204 °C (399 °F) in PTFE-compatible environments. Do not immerse this thermocouple probe in any liquid. For best results, use a thermocouple probe designed for each specific application — an immersion probe for liquid or gel, and an air probe for air measurement.

Observe the following measurement techniques:

- Clean the surface to be measured, and ensure that the probe is securely touching the surface. Remember to disable the applied power.
- When measuring above ambient temperatures, move the thermocouple along the surface until you get the highest temperature reading.
- When measuring below ambient temperatures, move the thermocouple along the surface until you get the lowest temperature reading.
- Place the tester in the operating environment for at least 1 hour as the tester is using a non-compensation transfer adapter with miniature thermal probe.

For quick measurement, use the compensation to view the temperature variation of the thermocouple sensor. The compensation assists you in measuring relative temperature immediately.

Changing the temperature unit

Press Range to change the temperature units between °C or °F (you must first change the temperature unit to switch between °C and °F or °F and °C). See "Changing the temperature unit" on page 139 for more information.

CAUTION

The option to change the temperature unit is locked for certain regions. Always set the temperature unit display per the official requirements and in compliance with the National laws of your region.

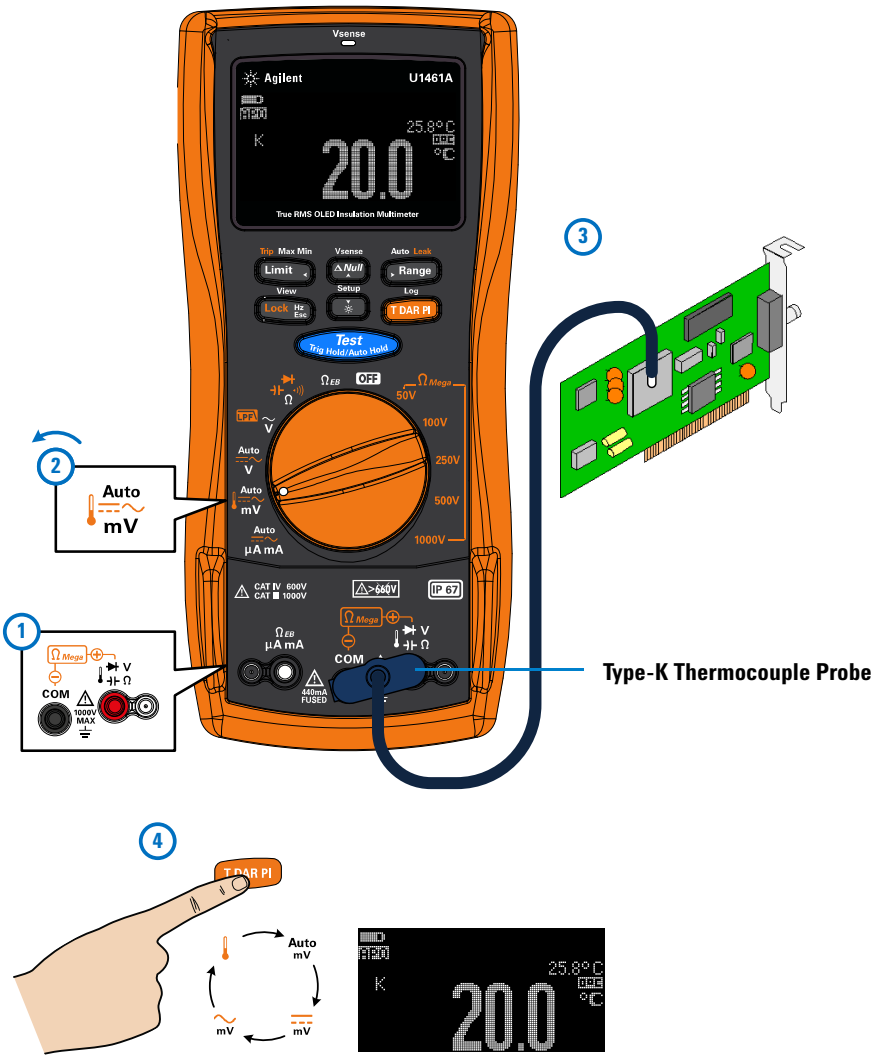


Figure 2-22 Surface temperature measurement example

Temperature measurement without ambient compensation

If you are working in a constantly varying environment, where ambient temperatures are not constant, do the following:

1. Press Range for more than 1 second to select compensation. This allows a quick measurement of the relative temperature.
2. Avoid contact between the thermocouple probe and the surface to be measured.
3. After a constant reading is obtained, press Δ Null to set the reading as the relative reference temperature.
4. Touch the surface to be measured with the thermocouple probe and read the display.

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3
Tester Features

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

Non-Contact AC Voltage Detection (Vsense)

For model U1461A only: Vsense is a non-contact voltage detector that detects the presence of AC voltages nearby.

WARNING

- **You are advised to test on a known live circuit within the rated AC voltage range of this product before and after each use to ensure that Vsense works.**
- **Voltage could still be present even if there is no Vsense alert indication. Do not rely on Vsense with shielded wires. Never touch live voltage or conductor without the necessary insulation protection or power off the voltage source.**
- **Vsense may be affected by differences in socket design, insulation thickness, and insulation type.**

CAUTION You are advised to measure voltage by using test leads through the voltage measurement function after using Vsense, even if there is no alert indication.

1 Press and hold △Null to enable Vsense (on any position of the rotary switch except OFF).

NOTE If the presence of AC voltage is sensed, the tester will beep and the Vsense red LED at the top of the tester will turn on. The audible and visual alert allows you to easily sense nearby AC voltage presence.

No resolution and accuracy of voltage measurement will be displayed in this mode.

2 Press Range to toggle the Vsense's sensitivity between **HIGH SENSE** (high sensitivity) or **LOW SENSE** (low sensitivity).

3 Press and hold △Null again to disable Vsense.

NOTE

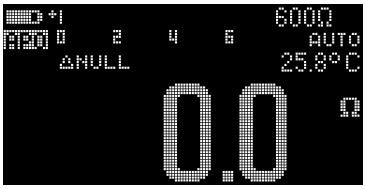
Place the top of the tester close to a conductor when sensing for AC voltages (as low as 24 V in the high sensitivity setting). The high sensitivity setting allows for AC voltage sensing on other styles of recessed power connectors or sockets where the actual AC voltage is recessed within the connector itself. The low sensitivity setting can be used on flush mounted wall sockets or outlets and various power strips or cords.

Figure 3-1 Detecting AC voltage example

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 (ΔNULL) is enabled, is stored as the reference value.
2. Press Δ Null again to view the stored reference value (Δ'BASE). 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.

Capturing Maximum and Minimum Values (Max Min)

The Max Min operation stores the maximum, minimum, and average input values during a series of measurements.

When the input goes below the recorded minimum value or above the recorded maximum value, the tester beeps and records the new value. The elapsed time since the recording session was started is stored and shown on the display at the same time. The tester also calculates an average of all readings taken since Max Min was activated.

From the tester's display, you can view the following statistical data for any set of readings:

- **REC MAX**: highest reading since Max Min was enabled
- **REC MIN**: lowest reading since Max Min was enabled
- **REC AVG**: average or mean of all readings since Max Min was enabled
- **REC NOW**: present reading (actual input signal value)

1 Press and hold Limit to enable Max Min.

2 Press Limit again to cycle through the **MAX**, **MIN**, **AVG**, or **NOW** (present) input values.

3 The elapsed time is shown on the display. Press Test Trig Hold/Auto Hold to restart the recording session.

4 Press and hold Limit again to disable Max Min.

NOTE

- Changing the range manually will also restart the recording session.
- You can also use Max Min while measuring frequency (see "Measuring Frequency" on page 63). If the measured frequency shown is not reflected accurately, press 

again to restart the recording session.
- If an overload is recorded, the averanging function will be stopped. **OL** is shown in place of the average value.
- The APO (auto power-off) function is disabled when Max Min is enabled.
- The maximum recording time is 99999 seconds (1 day, 3 hours, 46 minutes, 39 seconds). **OL** is shown if the recording exceeds the maximum time.

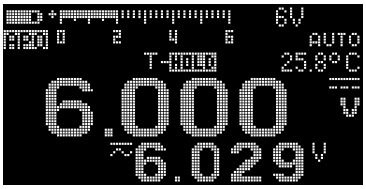
Max Min is useful for capturing intermittent readings, recording minimum and maximum readings unattended, or recording readings while equipment operation keeps you from observing the tester display.

The true average value displayed is the arithmetic mean of all readings taken since the start of recording. The average reading is useful for smoothing out unstable inputs, calculating power consumption, or estimating the percentage of time a circuit is active.

Freezing the Display (TrigHold and AutoHold)

TrigHold operation

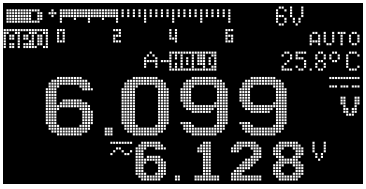
Press Test Trig Hold/Auto Hold to freeze the display for any function, except for the Ω Mega or the Ω EB function.



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.



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.

AutoHold monitors the input signal and updates the display and, if enabled, emits a beep, whenever a new stable measurement is detected. A trigger point is one that varies more than a selected adjustable (AutoHold threshold) variation count (default 500 counts based on **DDDDD** option selected in Setup). Open lead conditions are not included in the update.

To change the default AutoHold threshold count see "Changing the variation count" on page 109 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.

Table 3-1 Hi/Lo default settling values

Function	Limit settling default value		Limit settling range	
	HI	**LO**	**HI**	**LO**
Voltage measurement	>+30 V	<–30 V	**LO** to +9999.9 V	–9999.9 V to **HI**
Voltage measurement (up to millivolts)	>+30 mV	<–30 mV	**LO** to +999.99 mV	–999.99 mV to **HI**
Temperature measurement	>+100°	<–100°	**LO** to +9999.9°	–9999.9° to **HI**
Resistance measurement	>+10 Ω	<+10 Ω	**LO** to +99.999 MΩ	–99.999 MΩ to **HI**
Capacitance measurement	>+10 nF	<+10 nF	**LO** to +9.9999 mF	–9.9999 mF to **HI**
Diode test	>+0.8 V	<+0.3 V	**LO** to +9.9999 V	–9.9999 V to **HI**
Earth-bond resistance test	>+10 Ω	<+10 Ω	**LO** to +99.999 kΩ	–99.999 kΩ to **HI**
Current measurement	>+30 mA	<+0 mA	**LO** to +999.99 mA	–999.99 mA to **HI**
Insulation resistance test	>+10 MΩ	<+10 MΩ	**LO** to +999.99 GΩ	–999.99 GΩ to **HI**
Frequency measurement	>+999.99 Hz	<+0 Hz	**LO** to +999.99 kHz	+000.00 Hz to **HI**
Pulse width measurement	>+000.50 ms	<+0 ms	**LO** to +9999.9 ms	+000.00 ms to **HI**
Duty cycle measurement	>+050.00%	<+0%	**LO** to +999.99%	+000.00% to **HI**

You can select four different modes for Limit:

Limit mode	GO	NG
LIMIT HI or **LIMIT LO**	**LO** limit < Reading < **HI** limit	Reading < **LO** limit, or Reading > **HI** limit
LIMIT H>	Reading > **HI** limit	Reading ≤ **HI** limit
LIMIT L<	Reading < **LO** limit	Reading ≥ **LO** limit

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.

3 Position the cursor on the **HI** symbol to change the Limit mode.

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:

- **GO** is shown briefly
- A short beep tone is heard

6 If the new values is failed:

- For **LIMIT HI** or **LIMIT LO** mode: **HI** or **LO** is shown briefly along with the fail cause
- For **LIMIT H>** or **LIMIT L<** mode: **NG** is shown briefly
- Three short beep tones are heard
- The red LED lights up

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 Log T DAR PI (see page 93).
- An interval log stores a record of the measured signal at a user-specified interval (see page 93).
- An event log stores a record of the measured signal each time a trigger condition is satisfied (see page 94).

Table 3-2 Log maximum capacity

Log option	Maximum capacity for saving
Manual (**HAND**)	100
Interval (**AUTO**)	3000
Event (**TRIG**)	3000

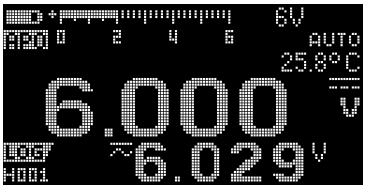
NOTE Each recorded index includes two parameters: the primary display and the secondary display. Examples include IR-V or Hz-V.

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 110 for more information.

See "Reviewing Previously Recorded Data (View)" on page 97 to review or erase the recorded entries.

Performing manual logs (HAND)



Ensure that **HAND** is selected as the Log option in the Setup.

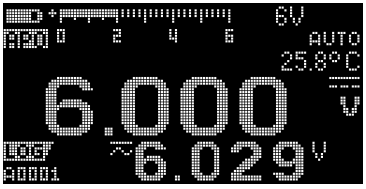
1 Press and hold Log T DAR PI to store the present input signal value.

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, **H : FULL** 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 110 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.

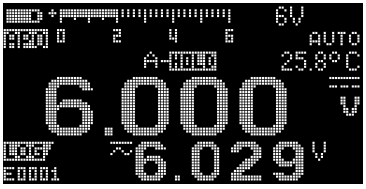
2 Press and hold Log T DAR PI again to exit the interval log mode.

The maximum number of readings that can be stored for the interval log is 3000 entries. When all entries are occupied, **A : FULL** 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; except for 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 89)
- Max Min recordings (page 87)
- Limit comparisons (page 90)
- Earth-bond resistance tests (page 51)
- Insulation resistance tests (page 51)
- T/DAR/PI tests (page 36)

Event records are triggered by the measured signal satisfying a trigger condition set by the measurement function used in the following modes (shown in Table 3-3 on page 95):

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 and the reading update is stable.	Voltage, current, resistance, capacitance, diode, or frequency	Voltage, current, 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, current, resistance, capacitance, diode, or frequency	Voltage, current, capacitance cable length, or output source voltage
Max Min	When a new maximum (or minimum) value is recorded. The average and present readings are not recorded in the Event log.	Voltage, current, resistance, capacitance, diode, or frequency	Voltage, current, capacitance cable length, or output source voltage
Limit	Each time a new value is compared (**GO**/**NG**/**HI**/**LO**).	Voltage, current, resistance, capacitance, diode, or frequency	Voltage, current, capacitance cable length, or output source voltage
Earth-bond resistance test	Each time you press Test to stop the test output source.	Resistance or leak current value	Test output source voltage
Insulation resistance test			
T	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 41 and page 42.

Start the event log mode

1 Select one of the six modes listed in Table 3-3.

2 Press and hold Log T DAR PI to start event log mode.

 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 3000 entries. When all entries are occupied, **E : FULL** 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 : Void**, **A : Void**, or **E : Void** 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 Δ 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 : Void**, **A : Void**, and **E : Void**), press and hold Δ 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 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 102.

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.
	• Arrow keys left and right • Press or to browse each menu page.
	• Arrow keys up and down • Press or at each menu page to move the cursor to a specific menu item.
	• Press to edit the selected menu item. The menu item's value will flash to indicate that you can now change the value shown. • Press or again to switch between two values, to cycle through multiple values from a list, or to decrease or increase a numerical value. • Press to save your changes.
	• While the menu item's value is flashing, press to discard your changes.

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

Editing numerical values

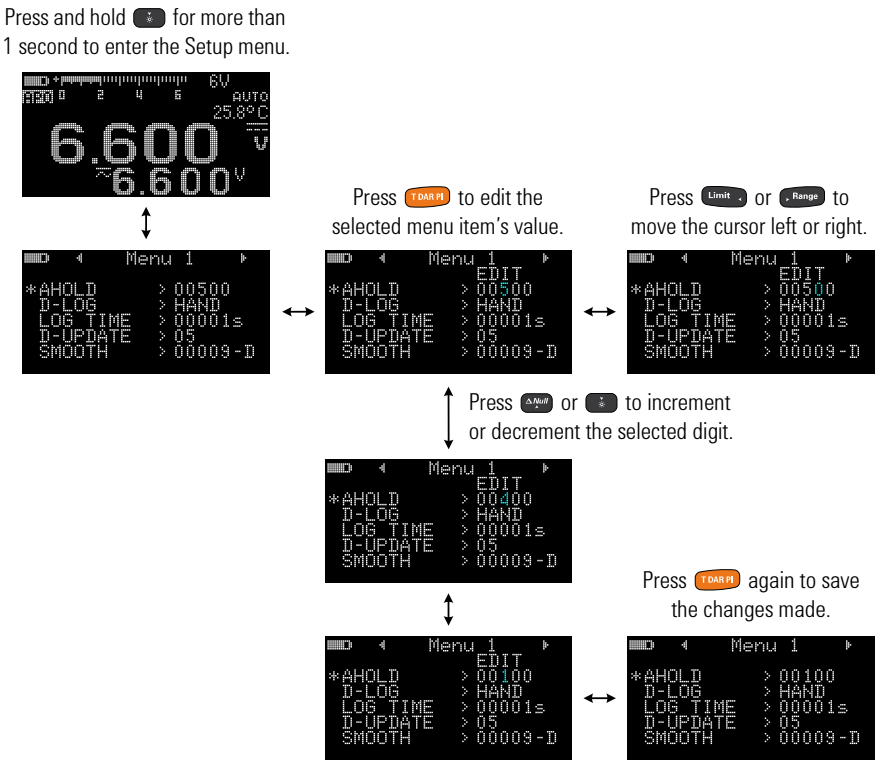
When editing numerical values, use the Limit and Range to position the cursor on a numerical digit.

- 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

Menu	Legend	Available settings	Description	Learn more on:
MENU 1	AHOLD	00500 to 99999	Set the AutoHold threshold count from 5 to 99999 counts (or 9999 counts, depending on the display count selected). Default is 500 counts.	page 109
	D-LOG	HAND, AUTO, or TRIG	Set the data logging option (HAND: manual log, AUTO: interval log, or TRIG: event log). Default is manual log.	page 110
	LOG TIME	00001 S to 99999 S	Set the logging duration for interval logs from 1 to 99999 seconds (1 day, 3 hours, 46 minutes, 39 seconds). Default is 1 second.	page 110
	D-UPDATE	05, 10, 20, or 40 times per second	Set the data update rate for voltage, current, resistance, and diode measurements. Default is 5 times per second.	page 111
	SMOOTH	00001 to 99999 (D or E)	Set the settling value from 00001 to 99999. You can also disable this feature (D). Default is disabled (00009-D).	page 112

Table 4-2 Setup menu item descriptions (continued)

Menu	Legend	Available settings	Description	Learn more on:
MENU 2	DMM COUNTS	DDDDD or DDDD	Set the voltage, current, and frequency display count. Default is DDDD	page 114
	Cx COUNTS	DDDDD, DDDD, or DDD	Set the capacitance display count. Default is DDDD	page 114
	Rx COUNTS	DDDDD, DDDD, or DDD	Set the resistance display count. Default is DDDD	page 114
	EBR COUNTS	DDDD or DDD	Set the earth-bond resistance display count. Default is DDDD	page 114
	IR COUNTS	DDDD or DDD	Set the insulation resistance display count. Default is DDD	page 114
MENU 3	BEEP	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 115
	APO	01 m to 99 m (E or D)	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 10 minutes (10 m-E).	page 116
	BACKLIT	LOW, MEDIUM, HIGH, or AUTO-(01 to 99)	Set the default OLED behavior from low to high. You can also set the OLED to auto-dim (AUTO) and change the auto-dim settling time (1 to 99 seconds). Default is auto-dim (AUTO-90).	page 116
	MELODY	FACTORY, USER, BEEE, or OFF	Set the power-on melody to the factory default, a beep, or disable this feature (off). Default is BEEE.	page 117
	GREETING	FACTORY, USER, or OFF	Set the power-on greetings to the factory default or disable this feature (off). Default is FACTORY.	page 118

Table 4-2 Setup menu item descriptions (continued)

Menu	Legend	Available settings	Description	Learn more on:
MENU 4	BAUD	9600 or 19200	Set the baud rate for remote communication with a PC (9600 or 19200). Default is 9600.	page 119
	DATA BIT	7 or 8	Set the data bit length for remote communication with a PC (7-bit or 8-bit). Default is 8-bit.	page 120
	PARITY	NONE, EVEN, or ODD	Set the parity bit for remote communication with a PC (none, even, or odd). Default is none.	page 120
	ECHO	OFF or ON	Set the tester to echo (return) all the characters it receives. Default is disabled (off).	page 121
	PRINT	OFF or ON	Set the tester to print out the measured data when the measuring cycle is completed. Default is disabled (off).	page 121

Table 4-2 Setup menu item descriptions (continued)

Menu	Legend	Available settings	Description	Learn more on:
MENU 5	REVISION	-	Displays the tester's firmware revision.	-
	S/N	-	Displays the tester's serial number (only the last eight digits).	-
	DUAL DC+AC	YES or NO	Enable dual display for voltage and current measurements. (AC+DC measurements are shown on the secondary display.) Default is yes.	page 123
	ALERT HORN	BEE&LED, OFF&LED, BEE&OFF, OFF&OFF	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 (BEE&LED).	page 124
	CONTINUITY	SHORT, OPEN, or TONE (E or D)	Set the tester to sound a single beep or a tone during continuity alerts for short or open circuits. You can also disable this feature (D). Default is a single beep for short circuits (SHORT-E).	page 124

Table 4-2 Setup menu item descriptions (continued)

Menu	Legend	Available settings	Description	Learn more on:
MENU 6	DEFAULT	YES or NO	Reset the tester to its factory default settings.	page 126
	BATTERY	PRI or SEC	Change the battery selection from primary to secondary. Default is primary.	page 126
	MIN-Hz	0.5 Hz or 10 Hz	Set the minimum measurement frequency (0.5 Hz or 10 Hz). Default is 0.5 Hz.	page 127
	CABLE km/C	1 nF/km to 99 nF/km (E or D)	Set the capacitance measurement versus cable length scale from 1 to 99 nF/km. You can also disable this feature (D). Default is 40 nF/km (40nF-E).	page 127
	CL-UNIT	Meter (m) or Foot (ft)	Set the cable length unit (Meter or Foot) for capacitance measurements. Default is Meter (m).	page 128
MENU 7	mV INPUT	10 MΩ or >1 GΩ	Set the input impedance for mV measurements. Default is 10 MΩ.	page 129
	REMOTE KEY	K1 to K7 (D or E)	Change or disable the button operation on the remote probe. Default is Test (K7-E).	page 130
	LOCK ONCE	YES or NO	Enable or disable the lock once feature. Default is enabled (YES).	page 131
	INHIBIT V	30 V, 50 V or 75 V	Set the maximum inhibit voltage for insulation resistance test. Default is 30 V.	page 131
	DAR TIME	60:30 or 60:15 (seconds)	Set the Dielectric Absorption Ratio in seconds (60:30 or 60:15). Default is 60:30 (seconds).	page 132

Table 4-2 Setup menu item descriptions (continued)

Menu	Legend	Available settings	Description	Learn more on:
MENU 8	IR: 50 V	F 50 V or U (10 to 60) V	Set the insulation resistance test voltage to the factory default or user-defined. Default is factory.	page 133
	IR: 100 V	F 100 V or U (10 to 120) V		
	IR: 250 V	F 250 V or U (10 to 300) V		
	IR: 500 V	F 500 V or U (10 to 600) V		
	IR: 1000 V	F 1000 V or U (10 to 1100) V		
MENU 9	TEST TIME	00:05 to 59:59	Set the insulation resistance or earth-bond resistance test period. Default is 1 minute (01:00)	page 135
	SCAN TIME	1 to 99 (seconds)	Set the dwelling time for each step in the Scan function. Default is 10 seconds.	page 135
	SCAN STEP	001 to 100	Set the number of steps for the Scan function. Default is 5 steps.	page 136
	RAMP STEP	0001 to 1000	Set the number of steps for the Ramp function. Default is 100 steps.	page 137
	TRIP mA	0.001 mA to 1.500 mA	Set the trip current level. Default is 1.000 mA.	page 137

Table 4-2 Setup menu item descriptions (continued)

Menu	Legend	Available settings	Description	Learn more on:
MENU 10[1]	T-TYPE	J or K	Set the thermocouple type (type J or type K) for temperature measurements. Default is type K.	page 139
	T-UNIT	°C, °F/°C, °C/°F, or °F	Set the temperature unit (Celsius, Fahrenheit/Celsius, Celsius/Fahrenheit, or Fahrenheit) for temperature measurements. Default is °C (Celsius).	page 139
	LPF	ON or OFF	Enable the low-pass filter to filter out higher frequencies with (AC/DC path) V, mV, µA, or mA measurements. Default is off.	page 140
	mA SCALE	0-20 mA or 4-20 mA (D or E)	Set the % scale selection (0-20 mA or 4-20 mA) for DC current measurements. You can also disable this feature (D). Default is disabled (4-20mA-D).	page 141
	% & ms	+CYCLE-D	Set + or – cycle for duty cycle and pulse width measurements. You can also disable this feature (D). Default is disabled (+CYCLE-D).	page 141

[1] Model U1461A only.

Setup Menu Items

Menu 1

Changing the variation count

Menu Items	Learn more on:
AHOLD	"Changing the variation count" on page 109
D-LOG	"Changing the recording option" on page 110
LOG TIME	"Changing the sample interval duration" on page 110
D-UPDATE	"Changing the data update rate" on page 111
SMOOTH	"Enabling smooth mode" on page 112

This setting is used with the AutoHold feature (see page 89). When the variation of the measured value exceeds the value of the variation count, the AutoHold feature will be ready to trigger.

Parameter	Range	Default setting
AHOLD	(5 to 99999) counts	00500

To change the variation count:

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

2 Browse to **Menu 1 > AHOLD**, 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.

Changing the recording option

This setting is used with the Data Logging feature (see page 92). There are three available recording options for the Data Logging feature.

- HAND: Manual log
- AUTO: Interval log
- TRIG: Event log

Parameter	Range	Default setting
D-LOG	HAND, AUTO, or TRIG	HAND

To change the recording option:

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

2 Browse to **Menu 1 > D-LOG**, 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 sample interval duration

This setting is used with the Interval Data Logging feature (see page 93). The tester will record a measurement value at the beginning of every sample interval.

Parameter	Range	Default setting
LOG TIME	(1 to 99999) s	00001 S

To change the sample interval duration:

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

2 Browse to **Menu 1 > LOG TIME**, 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 data update rate

This setting is used to increase the data update rate for voltage, current, resistance, and diode measurements.

Parameter	Range	Default setting
D-UPDATE	5, 10, 20, or 40 times per second	5 times per second

To change the data update rate:

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

2 Browse to **Menu 1 > D-UPDATE**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the data update rate.

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 00001 to 99999. 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 109).

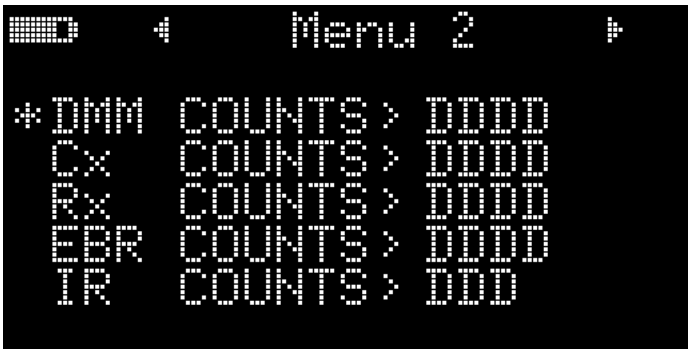
You can enable Smooth by holding T DAR PI while turning on the tester ("Your Tester in Brief" on page 10). This method, however, is temporary and Smooth will be turned off when you cycle the tester's power. You can permanently enable Smooth from the Setup menu.

Parameter	Range	Default setting
SMOOTH	• 00001 to 99999 • D(isabled) or E(nabled)	0009-D(isabled)

To change the smooth refresh rate:

1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to **Menu 1** > **SMOOTH**, 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.

Menu 2



Menu Items	Learn more on:
DMM	
Cx	
Rx	"Changing the display count" on page 114
EBR	
IR	

Changing the display count

Use these settings to change the display count for the following measurements/tests.

Parameter	Affects	Range[1]		
		DDDDD	DDDD	DDD
DMM	Voltage, current[2], and frequency measurements	66000/99999	**6600/9999**	-
Cx	Capacitance measurements	12000	**1200**	120
Rx	Resistance measurements	66000	**6600**	660
EBR	Earth-bond resistance measurements	-	**6600**	660
IR	Insulation resistance measurements	-	6600	**660**

[1] Default range is **bolded**.

[2] Model U1461A only.

NOTE DAR and PI indications 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 **Menu 2**, select the desired measurement display count (**DMM**, **Cx**, **Rx**, **EBR**, or **IR**) 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.

Menu 3

Menu Items	Learn more on:
BEEP	"Changing the beep frequency" on page 115
APO	"Changing the auto power-off (APO) timer" on page 116
BACKLIT	"Changing the OLED behavior" on page 116
MELODY	"Disabling the power-on melody" on page 117
GREETING	"Disabling the power-on greeting" on page 118

Changing the beep frequency

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

Parameter	Range	Default setting
BEEP	4267, 4151, 4042, 3938, 3840, 3746, 3675, 3572, 3491,3413, 3339, 3268, 3200 (Hz), or OFF	3840 Hz

To change the beep frequency:

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

2 Browse to **Menu 3** > **BEEP**, 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.

Parameter	Range	Default setting
APO	• (1 to 99) minutes • E(nabled) or D(isabled)	10 M-E

To change the APO timer period:

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

2 Browse to **Menu 3 > 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 OLED behavior

The OLED is set to auto-dim by default. However, you can manually control the OLED brightness by changing the values in this Setup item.

Parameter	Range	Default setting
BACKLIT	LOW, MEDIUM, HIGH, or AUTO-NN	AUTO-90

To change the OLED behavior:

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

2 Browse to **Menu 3** > **BACKLIT**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the OLED behavior.

4 If you select **AUTO** (to enable the auto-dim feature), you can also use the arrow keys to change the auto-dim settling time. The display will auto-dim after (1 to 99 seconds) depending on the value selected.

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

6 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.

Parameter	Range	Default setting
MELODY	FACTORY, 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 **Menu 3** > **MELODY**, 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 reserved 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.

Disabling the power-on greeting

The tester displays the Agilent logo when it is powered on.

Parameter	Range	Default setting
GREETING	FACTORY, USER, or OFF	FACTORY

To disable the power on greeting:

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

2 Browse to **Menu 3** > **GREETING**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the power-on greeting. Select **OFF** to disable the power-on greeting.

NOTE The **USER** option is reserved 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.

Menu 4

Menu Items	Learn more on:
BAUD	"Changing the baud rate" on page 119
DATA BIT	"Changing the data bits" on page 120
PARITY	"Changing the parity check" on page 120
ECHO	"Enabling the echo feature" on page 121
PRINT	"Enabling the print feature" on page 121

Changing the baud rate

This setting changes the baud rate for remote communications with a PC.

Parameter	Range	Default setting
BAUD	(9600 or 19200) bits/second	9600

To change the baud rate:

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

2 Browse to **Menu 4 > BAUD**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the baud rate.

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 data bits

This setting changes the number of data bits (data width) for remote communications with a PC. The number of stop bit is always 1, and this cannot be changed.

Parameter	Range	Default setting
DATA BIT	8-bit or 7-bit	8

To change the data bit:

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

2 Browse to **Menu 4 > DATA BIT**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the data bit.

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 parity check

This setting changes the parity check for remote communications with a PC.

Parameter	Range	Default setting
PARITY	NONE, EVEN, or ODD	NONE

To change the parity check:

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

2 Browse to **Menu 4 > PARITY**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the parity check.

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 the echo feature

When the echo feature is enabled, the tester echoes (returns) all the characters it receives when it is connected to a remote PC.

Parameter	Range	Default setting
ECHO	OFF or ON	OFF

To enable the echo feature:

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

2 Browse to **Menu 4 > ECHO**, and press T DAR PI to edit the value.

3 Use the arrow keys to enable the echo 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.

Enabling the print feature

When the print feature is enabled, the tester will print out the measured data when the measuring cycle is complete. The tester will automatically send new data to the remote PC host continuously. The tester does not accept any commands from the PC host when this feature is enabled.

Parameter	Range	Default setting
PRINT	OFF or ON	OFF

To enable the print feature:

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

2 Browse to **Menu 4 > PRINT**, and press T DAR PI to edit the value.

3 Use the arrow keys to enable the print 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.

Menu 5

Menu Items	Learn more on:
REVISION	-
S/N	-
DUAL DC+AC	"Enabling dual display for voltage and current measurements" on page 123
ALERT HORN	"Changing the alert indicators" on page 124
CONTINUITY	"Changing the continuity alert" on page 124

Enabling dual display for voltage and current measurements

This setting is used to enable dual display for voltage and current measurements. The AC+DC measurement will be shown on the secondary display.

Parameter	Range	Default setting
DUAL DC+AC	YES or NO	YES

To enable dual display:

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

2 Browse to **Menu 5 > DUAL DC+AC**, and press T DAR PI to edit the value. Select **NO** to disable the dual display.

3 Use the arrow keys to enable the dual display.

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 68) and values exceeding the Limit values set (see page 68).

Parameter	Range	Default setting
ALERT HORN	BEE&LED, OFF&LED, BEE&OFF, OFF&OFF	BEE&LED

To change the alert indicators:

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

2 Browse to **Menu 5 > ALERT HORN**, and press T DAR PI to edit the value.

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

This setting is used with continuity tests (see page 68). The tester will beep to alert users to the presence of circuit continuities for short or open circuits.

Parameter	Range	Default setting
CONTINUITY	• SHORT, OPEN, or TONE • D(isabled) or E(nabled)	SHORT-E

To change the continuity alert:

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

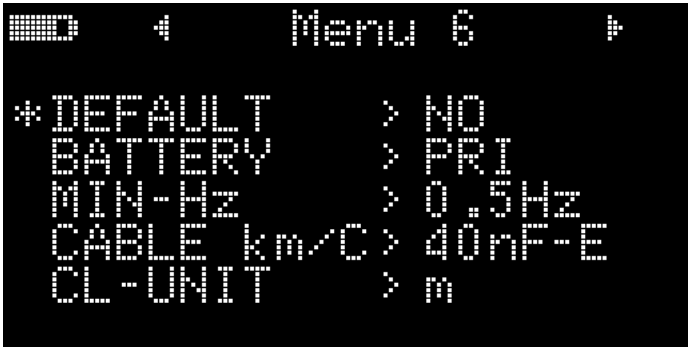
2 Browse to **Menu 5** > **CONTINUITY**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the continuity alert. Select **D** to disable the continuity alert for either the **SHORT**, **OPEN**, or **TONE** alerts.

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.

Menu 6



Menu Items	Learn more on:
DEFAULT	"Resetting the tester's Setup options" on page 126
BATTERY	"Changing the battery type" on page 126

Menu Items	Learn more on:
MIN-Hz	"Changing the minimum measurable frequency" on page 127
CABLE km/C	"Changing the cable length scale" on page 127
CL-UNIT	"Changing the cable length unit" on page 128

Resetting the tester's Setup options

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

Parameter	Range	Default setting
DEFAULT	YES or NO	NO

1 Press ✳ for more than 1 second to enter the Setup menu.
2 Browse to **Menu 6** > **DEFAULT**, 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 battery type

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

Parameter	Range	Default setting
BATTERY	PRI or SEC	PRI

To change the battery type:

1 Press ✳ for more than 1 second to enter the Setup menu.
2 Browse to **Menu 6** > **BATTERY**, 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.

Changing the minimum measurable frequency

This setting is used with frequency tests (see page 63). Changing the minimum measurable frequency will influence the measurement rates for frequency, duty cycle, and pulse width measurements. The typical measurement rate as defined in the specification is based on a minimum measurable frequency of 10 Hz.

Parameter	Range	Default setting
MIN-Hz	0.5 Hz or 10 Hz	0.5 Hz

To change the minimum measurable frequency:

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

2 Browse to **Menu 6 > MIN-Hz**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the minimum measurable frequency.

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 75). Change the unit (Meter of Feet) of the cable length display.

Parameter	Range	Default setting
CABLE km/C	• (1 to 99) nF • D(isabled) or E(nabled)	40 nF-E

To change the cable length scale:

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

2 Browse to **Menu 6 > CABLE km/C** and press T DAR PI to edit the value.

3 Use the arrow keys to change the cable length scale. Select **D** to disable the cable length display in capacitance measurements.

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 75). Change the scale from 1 nF to 99 nF per kilometer for capacitance transfers to cable length.

Parameter	Range	Default setting
CL-UNIT	m (Meter) or ft (Feet)	m (Meter)

To change the cable length unit:

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

2 Browse to **Menu 6 > CL-UNIT** 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.

Menu 7

Menu Items	Learn more on:
mV INPUT	"Changing the input impedance for mV measurements" on page 129
REMOTE KEY	"Changing the button operation on the remote switch probe" on page 130
LOCK ONCE	"Disabling the lock once feature" on page 131
INHIBIT V	"Changing the maximum inhibit voltage for insulation resistance tests" on page 131
DAR TIME	"Changing the Dielectric Absorption Ratio (DAR) for insulation resistance tests" on page 132

Changing the input impedance for mV measurements

This setting is used with voltage measurements, up to millivolts (see page 36). Select an appropriate input impedance value according to your requirements.

Parameter	Range	Default setting
mV INPUT	10 MΩ or >1 GΩ	10 MΩ

To change the input impedance for mV measurements:

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

2 Browse to **Menu 7 > mV INPUT**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the input impedance value.

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.

Parameter	Range	Default setting
REMOTE KEY	• K1 - Limit • K2 - Δ Null • K3 - Range • K4 - Lock Hz Esc • K5 - ⚙ • K6 - T DAR PI • K7 - Test Trig Hold/ Auto Hold • D(isable) or E(nable)	K7 - E

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 **Menu 7 > REMOTE KEY**, 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.

Disabling the lock once feature

This setting is used with insulation resistance tests (see page 51) and earth-bond resistance measurements (see page 51). 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.

Parameter	Range	Default setting
LOCK ONCE	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 **Menu 7 > LOCK ONCE**, and press T DAR PI to edit the value.
3. Use the arrow keys to select **NO**.
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 insulation resistance tests

This setting is used with insulation resistance tests (see page 51). The tester will not perform the insulation resistance test if it detects that the external voltage exceeds the inhibit voltage value set here.

Parameter	Range	Default setting
INHIBIT V	30 V, 50 V, or 75 V	75 V

To change the maximum inhibit voltage:

1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to **Menu 7 > INHIBIT V**, 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.

Changing the Dielectric Absorption Ratio (DAR) for insulation resistance tests

This setting is used with insulation resistance tests (see page 51). The tester performs the DAR test using the ratio set here.

Parameter	Range	Default setting
DAR TIME	60:30 or 60:15 (seconds)	60:30 (seconds)

To change the DAR ratio:

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

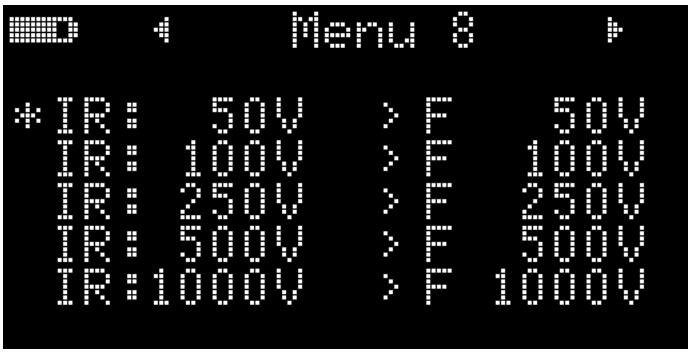
2 Browse to **Menu 7 > DAR TIME**, and press T DAR PI to edit the value.

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.

Menu 8



Menu Items	Learn more on:
IR: 50 V	
IR: 100 V	
IR: 250 V	"Changing the insulation resistance test voltage" on page 133
IR: 500 V	
IR: 1000 V	

Changing the insulation resistance test voltage

This setting is used with insulation resistance tests (see page 51). Select **U**(ser) to manually change the test voltage value for insulation resistance tests.

Parameter	Range	
	F(actory)	U(ser)[1]
IR: 50 V	50 V	10 V to 60 V
IR: 100 V	100 V	10 V to 120 V
IR: 250 V	250 V	10 V to 300 V

Parameter	Range	
	F(actory)	U(ser)[1]
IR: 500 V	500 V	10 V to 600 V
IR: 1000 V	1000 V	10 V to 1100 V

[1] Minimum increment of 1 V between each subsequent value.

To change the insulation resistance test voltage:

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

2 Browse to **Menu 10**, select the desired insulation resistance test voltage (**IR: 50 V**, **IR: 100 V**, **IR: 250 V**, **IR: 500 V**, or **IR: 1000 V**) and press T DAR PI to edit the value.

3 Select **U** and use the arrow keys to change the test 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.

Menu 9

Menu Items	Learn more on:
TEST TIME	"Changing the insulation resistance and earth-bond resistance test period" on page 135
SCAN TIME	"Changing the scan signal dwelling time" on page 135
SCAN STEP	"Changing the scan signal number of steps" on page 136
RAMP STEP	"Changing the ramp signal number of steps" on page 137
TRIP mA	"Changing the trip current value" on page 137

Changing the insulation resistance and earth-bond resistance test period

This setting is used with insulation resistance tests (see page 51) or earth-bond resistance measurements (see page 51). The tester performs the test over the timed period defined in this setting.

Parameter	Range	Default setting
TEST TIME	00:05 to 59:59	01:00

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 **Menu 9 > TEST TIME**, 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 scan signal dwelling time

This setting is used with insulation resistance tests (see page 51). The scan signal will "dwell" in the present step for the length of time stated in the scan dwelling time before incrementing to the next step.

Parameter	Range	Default setting
SCAN TIME	(1 to 99) seconds	10 seconds

To change the scan signal dwelling time:

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

2 Browse to **Menu 9** > **SCAN TIME**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the dwelling time.

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 scan signal number of steps

This setting is used with insulation resistance tests (see page 51). The increment of each step in the scan signal will be the amplitude end position divided by the number of steps. Each step should be set to greater than 10 V and the last step is equal to or less than the test voltage setting.

Parameter	Range	Default setting
SCAN STEP	(1 to 100) steps	5 steps

To change the scan signal number of steps:

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

2 Browse to **Menu 9** > **SCAN STEP**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the number of steps.

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 ramp signal number of steps

This setting is used with insulation resistance tests (see page 51). The increment of each step in the ramp signal will be the amplitude end position divided by the number of steps. For example, a 50 V amplitude end position divided by 100 steps gives an increment of 0.5 V per step.

Parameter	Range	Default setting
RAMP STEP	(1 to 1000) steps	100 steps

To change the ramp signal number of steps:

1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to **Menu 9** > **RAMP STEP**, and press T DAR PI to edit the value.
3. Use the arrow keys to change the number of steps.
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 trip current value

This setting is used with insulation resistance tests (see page 51). Set the current value for tripping the insulation resistance test (trip by leakage current/breakdown current).

Parameter	Range	Default setting
TRIP mA	(0.001 to 1.500) mA	1.000 mA

To change the trip current value:

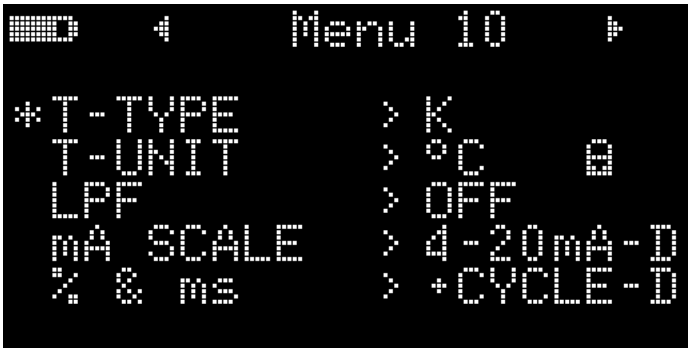
1. Press ✳ for more than 1 second to enter the Setup menu.
2. Browse to **Menu 9** > **TRIP mA**, and press T DAR PI to edit the value.
3. Use the arrow keys to change the trip current.

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.

Menu 10

NOTE Menu 10 is for model U1461A only.



Menu Items	Learn more on:
T-TYPE	"Changing the thermocouple type" on page 139
T-UNIT	"Changing the temperature unit" on page 139
LPF	"Enabling the low-pass filter" on page 140
mA SCALE	"Changing the % (mA) scale range" on page 141
% & ms	"Enabling the (+ or –) duty cycle and pulse width display" on page 141

Changing the thermocouple type

This setting is used with temperature measurements (see page 78). Select a thermocouple type that matches the thermocouple sensor you are using for temperature measurements.

Parameter	Range	Default setting
T-TYPE	Type-J or Type-K	K

To change the thermocouple type:

1. Press ✱ for more than 1 second to enter the Setup menu.
2. Browse to **Menu 10 > T-TYPE**, and press T DAR PI to edit the value.
3. Use the arrow keys to change the thermocouple 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.

Changing the temperature unit

CAUTION This Setup item is locked for certain regions. Always set the temperature unit display per the official requirements and in compliance with the National laws of your region.

This setting is used with temperature measurements (see page 78). Four combinations of displayed temperature unit(s) are available:

- Celsius only: Temperature measured in °C.
- Fahrenheit/Celsius: During temperature measurements, press Range to switch between °F and °C.
- Celsius/Fahrenheit: During temperature measurements, press Range to switch between °C and °F.
- Fahrenheit only: Temperature measured in °F.

Press and hold Lock Hz Esc for more than 1 second to unlock this setting.

Parameter	Range	Default setting
T-UNIT	°C, °F/°C, °C/°F, or °F	°C

To change the temperature unit:

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

2 Browse to **Menu 10** > **T-UNIT**. Press and hold Lock Hz Esc for more than 1 second to unlock this setting, then press T DAR PI to edit the value.

3 Use the arrow keys to change the temperature 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.

Enabling the low-pass filter

This setting is used to enable the low-pass filter to filter out higher frequencies with (AC/DC path) V, mV, µA, or mA measurements. The LPF symbol is shown during these measurements.

Parameter	Range	Default setting
LPF	ON or OFF	OFF

To enable the filter:

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

2 Browse to **Menu 10** > **LPF**, and press T DAR PI to edit the value.

3 Use the arrow keys to enable the filter.

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 % (mA) scale range

This setting is used with % (mA) scale current measurements (see page 62). The tester converts DC current measurements to a percentage scale readout of 0% to 100% based on the selected range in this menu. For example, a 25% readout represents a DC current of 8 mA on the 4-20 mA % scale, or a DC current of 5 mA on the 0-20 mA % scale.

Parameter	Range	Default setting
mA SCALE	• 4-20 mA or 0-20 mA • D(isable) or E(nable)	4-20 mA-D

To change the % (mA) scale range:

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

2 Browse to **Menu 10 > mA SCALE**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the % scale range. Select **D** to disable the mA scale readout.

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 the (+ or –) duty cycle and pulse width display

This setting is used with frequency measurements (see page 63). Enabling this feature will allow you to display (+ or –) duty cycle and pulse width along with frequency for voltage or current measurements.

Parameter	Range	Default setting
% & ms	• +CYCLE or –CYCLE • D(isable) or E(nable)	+CYCLE-D

To enable the duty cycle and pulse width display:

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

2 Browse to **Menu 10 > % & ms**, and press T DAR PI to edit the value.

3 Use the arrow keys to change the duty cycle and pulse width settings. Select **E** to enable the duty cycle and pulse width display.

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 U1461A/U1453A 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 Lithium Iron Disulfide batteries (ANSI/NEDA 15LF or IEC FR6)
- 4 × 1.5 V AA Zinc Chloride batteries (ANSI/NEDA 15D or IEC R6)

Battery life:

- Based on new alkaline batteries for DC voltage measurement at room temperature:
  - 50 hours typical at high brightness
  - 60 hours typical at medium brightness
  - 80 hours typical at low brightness
- Note that the lithium batteries provided with the shipment typically last two times longer than the battery life or the test times stated for alkaline batteries.
- 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 at low brightness.
- Earth-Bond Resistance (EBR) test: 2500 or 2100 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 at low brightness.
- Low battery indicator will flash when the battery voltage drops below
  - For normal operation: 4.1 V (approximately)
  - For IR and EBR operation: 4.7 V (approximately)

POWER CONSUMPTION

2.7 VA maximum (with maximum brightness)

FUSE

10 × 35 mm 30 kA fast-acting fuse

DISPLAY

- Organic LED (OLED) with maximum reading of 6600/66000 and 660/6600 counts selectable

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 with holster.

TEMPERATURE COEFFICIENT

0.05 × (specified accuracy) / °C (from –40 °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

686 grams (with lithium batteries and orange rubber holster)

WARRANTY

Please refer to http://www.agilent.com/go/warranty_terms

- 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, and resolution counts are 6000. For high resolution, the accuracy will be 10 times of the offset.
- AC V and AC mA specifications are AC coupled, are true RMS, and are valid from 5% of range to 100% of range.
- The crest factor may be up to 3.0 at full-scale except for the 1000 V range where it is 1.5 at full scale.
- For non-sinusoidal waveforms, add (2% reading + 2% full scale) typical, for crest factors up to 3.

WARNING **Exceeding the crest factor limit may result in an incorrect or a lower reading. Do not exceed the crest factor limit to avoid instrument damage and the risk of electric shock.**

Measurement Category

The Agilent U1461A/U1453A 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 overcurrent protection devices and ripple control units.

Electrical Specifications

NOTE Specification considerations are given on page 146.

DC specifications

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

Function	Range	Resolution	Accuracy	Input impedance
Voltage	60 mV[1]	0.01 mV	0.09% + 1	10 MΩ[3]
	600 mV[1]	0.1 mV	0.09% + 1	10 MΩ[3]
	6 V[2]	0.001 V	0.09% + 1	11.11 MΩ
	60 V[2]	0.01 V	0.09% + 1	10.1 MΩ
	600 V[2]	0.1 V	0.09% + 1	10 MΩ
	1000 V[2]	1 V	0.09% + 1	10 MΩ

Notes:

1 The following statements are true for DC mV measurements:
- DC mV measurements are for model U1461A only.
- The accuracy is specified after the Null function is used to subtract the thermal effect (by shorting the test leads).
- DC mV overload protection: 1000 V_{RMS} for short circuits with <0.3 A current.

2 DC V overload protection: 1000 V_{RMS}.

3 The input impedance may be set to >1 GΩ in the Setup menu.

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

Function	Range	Resolution	Accuracy	Continuity Threshold
Resistance[1]	600 Ω[2]	0.1 Ω	0.5% + 2	12 ± 4 Ω
	6 kΩ	0.001 kΩ	0.5% + 2	0.06 ± 0.02 kΩ
	60 kΩ	0.01 kΩ	0.5% + 2	0.33 ± 0.17 kΩ
	600 kΩ	0.1 kΩ	0.5% + 2	3.6 ± 1.8 kΩ
	6 MΩ[3]	0.001 MΩ	0.8% + 2	0.13 ± 0.07 MΩ
	60 MΩ[3][4]	0.01 MΩ	1.5% + 3	0.13 ± 0.07 MΩ

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 <+2.1 V.
- The built-in buzzer beeps when the resistance measured is less than 12 Ω ± 4 Ω. The tester can capture intermittent measurements longer than 1 ms.

2 The accuracy of the 600 MΩ range is specified after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).

3 For the ranges of 6 MΩ and 60 MΩ, the RH is specified for <60% @ 30 °C.

4 The temperature coefficient of the 60 MΩ range is 0.1 × (specified accuracy)/°C (from –40 °C to 18 °C or 28 °C to 55 °C).

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

Function	Range	Resolution	Accuracy	Test current
Diode[1]	1 V[2]	0.001 V	2% + 3	0.21 mA
	Auto[3]	0.001 V	2% + 3	0.21 mA

Notes:

1 The following statements are true for diode tests:
- Overload protection: 1000 VRMS for short circuits with <0.3 A current.
- The built-in buzzer beeps continuously when the voltage measured is less than 0.04 ± 0.02 V and beeps once for forward-biased diode or semiconductor junctions measured between 0.3 V and 0.8 V (0.3 V ≤ reading ≤ 0.8 V).

2 Open voltage for diode: <+2.1 VDC.

3 Open voltage for Auto-diode: <+2.1 VDC and >–2.1 VDC.

4 The maximum indication of threshold voltage is less than 1 V.

Table 5-4 DC current specifications with accuracy of ± (% of reading + no. of least significant digit) (model U1461A only)

Function	Range	Resolution	Accuracy	Burden voltage /Shunt
Current[1]	6 µA	0.001 µA	0.8% + 2[3]	<0.24 V/39.2 kΩ
	60 µA	0.01 µA	0.4% + 1[3]	<0.24 V/3.56 kΩ
	600 µA	0.1 µA	0.2% + 1	<0.062 V/100 Ω
	6 mA	0.001 mA	0.2% + 1	<0.62 V/100 Ω
	60 mA	0.01 mA	0.2% + 1	<0.16 V/1 Ω
	440 mA[2]	0.1 mA	0.2% + 1	<1.17 V/1 Ω

Notes:

1 Overload protection: 0.44 A/1000 V; 10 × 35 mm 30 kA fast-acting fuse.
2 Specification for 440 mA range: 440 mA continuous for signals >440 mA up to 600 mA for 120 seconds maximum.
3 The accuracy of the 6 µA to 60 µA range is specified after the Null function is used to zero the offset (by opening the test leads).

AC specifications

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

Function	Range	Resolution	Accuracy		
			45 Hz to 65 Hz	65 Hz to 5 kHz	5 kHz to 20 kHz
Voltage[6]	60 mV[1][2][4]	0.01 mV	1.0% + 3	1.5% + 3	2.0% + 4
	600 mV[1][2][4]	0.1 mV	1.0% + 3	1.5% + 3	2.0% + 4
	6 V[3][5]	0.001 V	1.0% + 3	1.5% + 3	2.0% + 4
	60 V[3][5]	0.01 V	1.0% + 3	1.5% + 3	2.0% + 4
	600 V[3][5]	0.1 V	1.0% + 3	1.5% + 3 @ <1 kHz	-
	1000 V[3][5]	0.1 V	1.0% + 3	1.5% + 3 @ <1 kHz	-
	LPF (low-pass filter) enabled, applicable for all voltage ranges and resolution[1][3][5]		1.0% + 3	1.5% + 3 @ <200 Hz 6.0% + 3 @ <440 Hz	-

Notes:

1 AC mV and LPF measurements are for model U1461A only.
2 AC mV overload protection: 1000 V_{RMS} for short circuits with <0.3 A current.
3 AC V overload protection: 1000 V_{RMS}.
4 AC mV input impedance: The input impedance may be set to >1 GΩ in the Setup menu, the default input impedance is 10 MΩ in parallel with 100 pF (nominal).
5 AC V input impedance: 10 MΩ in parallel with <100 pF (nominal).
6 The input signal is lower than the product of 20,000,000 V×Hz.

Table 5-6 True RMS AC current specifications with accuracy of ± (% of reading + no. of least significant digit) (model U1461A only)

Function	Range	Resolution	Accuracy	Burden voltage /Shunt
			45 Hz to 1 kHz	
Current[1]	6 µA	0.001 µA	2.0% + 2	<0.24 V/39.2 kΩ
	60 µA	0.01 µA	1.5% + 2	<0.24 V/3.56 kΩ
	600 µA	0.1 µA	1.0% + 2	<0.062 V/100 Ω
	6 mA	0.001 mA	1.0% + 2	<0.62 V/100 Ω
	60 mA	0.01 mA	1.0% + 2	<0.16 V/1 Ω
	440 mA[2]	0.1 A	1.0% + 2	<1.17 V/1 Ω

Notes:

1 Overload protection: 0.44 A/1000 V; 10 × 35 mm 30 kA fast-acting fuse.
2 Specification for 440 mA range: 440 mA continuous for signals >440 mA up to 600 mA for 120 seconds maximum.

Capacitance specifications

Table 5-7 Capacitance specifications with accuracy of ± (% of reading + no. of least significant digit)[1][2]

Range	Resolution	Accuracy	Measuring rate (at full scale)
10 nF	0.01 nF	1% + 2	5 times/second
100 nF	0.1 nF	1% + 2	
1 µF	0.001 µF	1% + 2	2.4 times/second
10 µF	0.01 µF	1% + 2	
100 µF	0.1 µF	1% + 2	
1 mF	0.001 mF	1% + 2	1.0 times/second
10 mF	0.01 mF	1% + 2	0.1 times/second

Notes:

1 Overload protection: 1000 V_{RMS} 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).

Temperature specifications

Table 5-8 Temperature specifications with accuracy of ± (% of reading + offset error)[1]

Thermal type	Range	Resolution	Accuracy
K	–200 °C to 1372 °C	0.1 °C	1% + 1 °C
	–328 °F to 2502 °F	0.1 °F	1% + 1.8 °F
J	–200 °C to 1200 °C	0.1 °C	1% + 1 °C
	–346 °F to 2192 °F	0.1 °F	1% + 1.8 °F

Notes:

1 The following statements are true for temperature measurements:
- The specifications above are specified after 60 minutes of warm-up time.
- The accuracy does not include the tolerance of the thermocouple probe.
- Do not allow the temperature sensor to contact a surface that is energized above 30 VRMS or 60 VDC. Such voltages pose a shock hazard.
- Ensure that the ambient temperature is stable within ±1 °C and that the Null function is used to reduce the test lead's thermal effect and temperature offset. Before using Null function, set the tester to measure temperature without ambient compensation ( ) and keep the thermocouple probe as close to the tester as possible (avoid contact with any surface that has a different temperature from the ambient temperature).
- When measuring temperature with respect to any temperature calibrator, try to set both the calibrator and tester with an external reference (without internal ambient compensation). If both the calibrator and tester are set with internal reference (with internal ambient compensation), some deviations may show between the readings of the calibrator and tester, due to differences in ambient compensation between the calibrator and tester. Keeping the tester close to the output terminal of calibrator will help reduce the deviation.
- The temperature calculation is specified according to the safety standards of EN/IEC-60548-1 and NIST175.

Frequency specifications

Table 5-9 Frequency specifications with accuracy of ± (% of reading + no. of least significant digit)[1][2]

Range	Resolution	Accuracy	Minimum input frequency
99.99 Hz	0.01 Hz	0.02% + 1	0.5 Hz
999.9 Hz	0.1 Hz	0.02% + 1	
9.999 kHz	0.001 kHz	0.02% + 1	
99.99 kHz	0.01 kHz	0.02% + 1	
999.9 kHz	0.1 kHz	0.02% + 1 @ ≤ 100 kHz	
9.999 MHz	0.001 MHz	0.02% + 1 @ ≤ 100 kHz	

Notes:

1 Overload protection: 1000 V; input signal is <20,000,000 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. Turning on the low-pass filter (model U1461A only) may help you to filter out the noise and achieve a stable reading.

Duty cycle and pulse width specifications (model U1461A only)

Table 5-10 Duty cycle and pulse width specifications with accuracy of ± (% of reading + no. of least significant digit) [2]

Function	Mode	Range	Resolution	Accuracy at full scale
Duty cycle[2]	DC coupling	99.9%	-	0.3% per kHz + 0.3%
	AC coupling	99.9%	-	0.3% per kHz + 0.3%
Pulse width[3]	-	999.9 ms	0.01 ms	(duty cycle accuracy/frequency) + 0.01 ms
	-	2000 ms	0.1 ms	(duty cycle accuracy/frequency) + 0.1 ms

Notes for duty cycle and pulse width specifications:

1 Overload protection: 1000 V; input signal is <20,000,000 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. Turning on the low-pass filter (model U1461A only) may help you to filter out the noise and achieve a stable reading.
3 The accuracy for duty cycle and pulse width measurements is based on a 6 V square-wave input to the DC 6 V range. For AC couplings, the duty cycle range can be measured within the range of 10% to 90% for signal frequencies >20 Hz.
4 The range of the duty cycle is determined by the frequency of the signal:
{10 µs × frequency × 100%} to {[1 – (10 µs × frequency)] × 100%}
5 The pulse width (positive or negative) must be >10 µs. The range of the pulse width is determined by the frequency of the signal.

Duty cycle and pulse width calculation example

Table 5-11 Duty cycle and pulse width calculation example

Frequency	Duty cycle range[1]		Accuracy	
	From	To	Duty cycle[2]	Pulse width[3]
100 Hz	0.1%	99.9%	0.33%	0.043 ms
1 kHz	1%	99%	0.6%	0.016 ms

Notes for duty cycle and pulse width calculation example:

1 The range of the duty cycle is determined from this equation:
{10 µs × frequency × 100%} to {[1 – (10 µs × frequency)] × 100%}
2 The accuracy of the duty cycle is determined from this equation: [0.3% × (frequency kHz)] + 0.3%
3 The accuracy of the pulse width is determined from this equation: (duty cycle accuracy/frequency) + 0.01 ms

Frequency sensitivity specifications

For voltage measurements

Table 5-12 Frequency sensitivity and trigger level specifications for voltage measurements

Input range[1]	Minimum sensitivity (RMS sine wave)	Trigger level for DC coupling
	20 Hz to 100 kHz	20 Hz to 100 kHz
60 mV	10 mV	15 mV
600 mV	27 mV	55 mV
6 V	0.25 V	0.55 V
60 V	2.5 V	5.5 V
600 V	25 V	55 V
1000 V	170 V	460 V

Notes:

1 Maximum input for specified accuracy, refer to "AC specifications" on page 150.

For current measurements (model U1461A only)

Table 5-13 Frequency sensitivity specifications for current measurements

Input range[1]	Minimum sensitivity (RMS sine wave)
	20 Hz to 20 kHz
6 µA	0.5 µA
60 µA	5 µA
600 µA	45 µA
6 mA	0.45 mA
60 mA	4.5 mA
440 mA	45 mA

Notes:

1 Maximum input for specified accuracy, refer to "AC specifications" on page 150.

Insulation resistance specifications

Table 5-14 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	1.5% + 5	1 mA @ 50 kΩ
	<50 MΩ	0.01 MΩ	1.5% + 5	
	~60 GΩ	~0.01 GΩ	1.5% + 5[7]	
100 V	6 MΩ	0.001 MΩ	1.5% + 5	1 mA @ 100 kΩ
	60 MΩ	0.01 MΩ	1.5% + 5	
	<100 MΩ	0.1 MΩ	1.5% + 5	
	~60 GΩ	~0.01 GΩ	1.5% + 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	1.2% + 5	1 mA @ 500 kΩ
	60 MΩ	0.01 MΩ	1.2% + 5	
	<500 MΩ	0.1 MΩ	1.2% + 5	
	~200 GΩ	~0.1 GΩ	1.2% + 5[7]	
1000 V	6 MΩ	0.001 MΩ	1.2% + 5	1 mA @ 1 MΩ
	60 MΩ	0.01 MΩ	1.2% + 5	
	600 MΩ	0.1 MΩ	1.2% + 5	
	<1 GΩ	0.001 GΩ	1.2% + 5	
	~200 GΩ	~0.1 GΩ	1.2% + 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 marked test voltage and the actual test voltage may be different if the test voltage is adjusted in the Setup. Refer to the table below for more details:

Ω_{Mega} position (Mark)	1000 V	500 V	250 V	100 V	50 V
Default test voltage (Factory)	1000 V	500 V	250 V	100 V	50 V
Deviation	2.0 V	1,5 V	1.5 V	1.5 V	1.0 V
	0.2%	0.3%	0.6%	1.5%	2.0%
Adjustable test voltage (User)	10 to 1100 V	10 to 600 V	10 to 300 V	10 to 120 V	10 to 60 V
Incremental	1 V	1 V	1 V	1 V	1 V

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	1.2% + 5	1.2% + 5	1.5% + 5	1.5% + 5	1.5% + 5
Additional accuracy	0.05%/GΩ	0.1%/GΩ	0.2%/GΩ	0.5%/GΩ	1.0%/GΩ

Earth-bond resistance specifications

Table 5-15 Earth-bond resistance specifications with accuracy of ± (% of reading + no. of least significant digit)[1]

Range	Resolution	Accuracy	Open circuit voltage
6 Ω[2]	0.001 Ω	0.5% + 20	>4 V and <7V
60 Ω[2]	0.01 Ω	0.5% + 2	
600 Ω[2]	0.1 Ω	0.5% + 2	
6 kΩ	0.001 kΩ	0.5% + 2	
60 kΩ	0.01 kΩ	0.5% + 2	

Notes:

1 The following statements are true for earth-bond resistance tests:
- Overload protection: 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 of the 6 Ω to 600 Ω range is specified after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).

Adjustable DC test voltage specifications

Table 5-16 Adjustable DC test voltage specifications with accuracy of ± (% of reading + no. of least significant digit)[1][2]

Range	Resolution	Accuracy	Rate current
1100 V	1 V	0.5% + 1	1 mA nominal

Notes:

1 The minimum test voltage may be set from 10 V.

2 The indication at the rated output voltage across a resistor with a value of UN × (1000 Ω/V) shall not differ by more than 10% relative to the indicated value, as a result of possibly present AC voltage components in the output voltage, when a capacitor of 1 µF is connected in parallel with the insulation resistance to be measured.

EN61557 specifications

The following specifications are a requirement for European labeling.

Measurement	Intrinsic uncertainty		Operating uncertainty[1]
	U1461A	U1453A	
Voltage	± (0.09% + 1)	± (0.09% + 1)	30%
Earth-bond resistance	± (0.5% + 2)	± (0.5% + 2)	30%
	± (0.5% + 20)[2]	± (0.5% + 20)[2]	30%
Insulation resistance	Based on the test voltage and range. See "Insulation resistance specifications" on page 159.		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%.
2 For 6 Ω range only.

Test voltage[1][2]	IR <	Intrinsic uncertainty (A)	Temperature (E3)	Operating Uncertainty
50 V	25.7 GΩ	27.65%	2%	27.65% + 1.15 × E3
100 V	51.4 GΩ	27.65%	2%	27.65% + 1.15 × E3
250 V	131 GΩ	25.65%	2%	25.65% + 1.15 × E3
500 V	260 GΩ	27.45%	2%	27.45% + 1.15 × E3
1000 V	260 GΩ	14.45%	2%	14.45% + 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.

Display update rate (approximate)

Table 5-17 Display update rate (approximate)[1] [2]

Function	Slow (times/second)	Fast (times/second)
AC V (V or mV)	5	10/20/40
DC V (V or mV)	5	10/20/40
Ω	5	10/20/40
Diode	5	10/20/40
Auto-diode	1	-
Capacitance	1 (<1 mF)	-
DC mA/µA	5	10/20/40
AC mA/µA	5	10/20/40
Temperature	5	10/20/40
Frequency	1 (>10 Hz)	-

[1] The tester has a built in combination filter for data update rate.

[2] The CMRR and NMRR are specified based on five times the data update rate.

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