Keysight U1450 Series Insulation Testers and U1461A Insulation Multimeter

KEYSIGHT TECHNOLOGIES

Service Guide

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Manual Part Number

U1451-90014

Edition

Edition 6, June 3, 2020

Printed in:

Printed in Malaysia

Published by:

Keysight Technologies
Bayan Lepas Free Industrial Zone,
11900 Penang, Malaysia

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Safety Information

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 Keysight U1461A Insulation Multimeter and the U1450 Series Insulation Tester.

The word *tester* is used to represent both models.

WARNING

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

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 by 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.
- You are advised to use low leakage batteries when changing to new batteries. Please remember to remove the batteries when the tester is not in use for a long period of time. Warning on the risk of battery leakage.

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	Requirement
Temperature	Operating condition – –40 °C to 55 °C, 0% to 80% RH (using lithium batteries), >1 hour operating time[a] – –20 °C to 55 °C, 0% to 80% RH (using alkaline batteries), 20 minutes operating time[a] 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

[a] 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 not 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.		The RCM 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 conforme 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 SP ® 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 Keysight Service Center, or visit http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

- www.keysight.com/find/insulationtesters
  (product-specific information and support, software and documentation updates)
- www.keysight.com/find/assist
  (worldwide contact information for repair and service)

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1 Calibration Procedures

Calibration Overview

This manual contains procedures to verify the U1450 Series insulation testers/ U1461A insulation multimeter performance and to perform adjustments (calibration). The performance test procedures allow you to verify that the instrument is operating within its published specifications. The adjustment procedures ensure that the instrument remains within its specifications until the next calibration.

NOTE **Ensure that you have read the "Test Considerations" on page 20 before calibrating the instrument.**

Closed-case calibration

The instrument features closed-case electronic calibration. In other words, no internal mechanical adjustments are required. The instrument calculates correction factors based upon the input reference value you set. The new correction factors are stored in the nonvolatile memory until the next calibration adjustment is performed. The nonvolatile EEPROM calibration memory is retained even when the power is switched off.

Keysight calibration services

When your instrument is due for calibration, contact your local Keysight Service Center to enquire about recalibration services.

Calibration interval

A 1-year interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Accuracy specifications are not warranted beyond the 1-year calibration interval. Keysight does not recommend extending calibration intervals beyond 2 years for any application.

Adjustment is recommended

Specifications are only guaranteed within the period stated from the last adjustment. Keysight recommends that re-adjustment should be performed during the calibration process for best performance. This will ensure that the instrument will remain within the specifications until the next calibration interval.

This criterion for the re-adjustment provides the best long-term stability. Performance data are measured during the Performance Verification Tests but this does not guarantee that the instrument will remain within these limits unless the adjustments are performed.

Refer to the "Calibration Count" on page 49 and verify that all the adjustments have been performed.

Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures are listed below (Table 1-1). If the exact instrument is not available, substitute with another calibration standard of equivalent accuracy.

A suggested alternative method is to use the Keysight 3458A 8½ Digit Digital Multimeter to measure less accurate but stable sources. The output value measured from the source can be entered into the instrument as the target calibration value.

Table 1-1 Recommended test equipment

Application	Recommended equipment	Recommended accuracy requirements
DC voltage	Fluke 5520A/5522A	<20% of the instrument's 1-year specifications
AC voltage	Fluke 5520A/5522A	<20% of the instrument's 1-year specifications
Capacitance	Fluke 5520A/5522A	<20% of the instrument's 1-year specifications
Frequency	Fluke 5520A/5522A	<20% of the instrument's 1-year specifications
Earth-bond resistance	Fluke 5520A/5522A	<20% of the instrument's 1-year specifications
Resistance	Fluke 5520A/5522A	<20% of the instrument's 1-year specifications
Insulation resistance	M191	<20% of the instrument's 1-year specifications
Earth-bond resistance (6 Ω range)	Vishay RS Resistor 5.0 Ω	– Absolute uncertainty specifications ±(% of reading) – 5.0 Ω ± 0.5%
Temperature	TM Electronics KMPC1MP TC-to-TC	–

Calibration Process

1. Prior to performing the verification tests, see "Test Considerations" on page 20.
2. Perform the verification tests to characterize the instrument; see "Performance Verification Tests" on page 21.
3. Unsecure the instrument for calibration; see "Unsecuring the Instrument for Calibration" on page 32.
4. Prior to performing the adjustments, see "Adjustment considerations" on page 35.
5. Perform the adjustment procedure; see "Adjustment procedure" on page 46.
6. Secure the instrument against unauthorized calibration; see "Exiting the adjustment mode" on page 48. Ensure that the instrument has quit the adjustment mode and is turned off.
7. Record the new security code and calibration count in the instrument's maintenance records.

Test Considerations

For optimum performance, all procedures should comply with the following recommendations:

- The performance verification test or adjustment should be performed under laboratory conditions where the ambient temperature can be controlled.
- The instrument should be put under the laboratory environment for at least 1 hour.
- Ensure that the calibration ambient temperature is stable and is between 18 °C and 28 °C. Ideally the calibration should be performed at 23 °C ± 1 °C.
- Ensure that the ambient relative humidity is less than 80%.
- Allow a warm-up period of 3 minutes.
- Use a shielded twisted pair of PTFE-insulated cables to reduce settling and noise errors. Keep the input cables as short as possible. Long test leads can also act as antennas which may pick up AC signals.
- Connect the input cable shields to earth ground.

Performance Verification Tests

Use the performance verification tests to verify the measurement performance of the instrument. The performance verification tests use the instrument's specifications listed in the *U1461A/U1453A User's Guide* and the *U1452A/U1452AT/U1451A User's Guide* (available for download at www.keysight.com/find/hhTechLib).

The performance verification tests are recommended as acceptance tests when you first receive the instrument. The acceptance test results should be compared against the 1 year test limits. After acceptance, you should repeat the performance verification tests at every calibration interval.

If the instrument fails the performance verification tests, adjustment or repair is required.

NOTE Ensure that you have read the "Test Considerations" on page 20 before running the performance verification tests.

Performance verification tests for U1452A/U1452AT/U1451A

Table 1-2 Performance verification tests (U1452A/U1452AT/U1451A)

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1451A	U1452AT/U1452A
1	**DCV** Turn the rotary switch to the Auto V position.	6 V	6 V	±0.032 V	±0.014V
		60 V	60 V	±0.32 V	±0.14 V
		600 V	600 V	±3.2 V	±1.4 V
		1000 V	1000 V	±7 V	±4 V

Table 1-2 Performance verification tests (U1452A/U1452AT/U1451A) (continued)

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1451A	U1452AT/U1452A
2	**ACV** Turn the rotary switch to the Auto V position.	6 V	6 V, 45 Hz	±0.123 V	±0.123 V
			6 V, 400 Hz	±0.123 V	±0.123 V
		60 V	60 V, 45 Hz	±1.23 V	±1.23 V
			60 V, 400 Hz	±1.23 V	±1.23 V
		600 V	600 V, 45 Hz	±12.3 V	±12.3 V
			600 V, 400 Hz	±12.3 V	±12.3 V
		1000 V	1000 V, 45 Hz	±23 V	±23 V
			1000 V, 400 Hz	±23 V	±23 V
3	**Capacitance** Turn the rotary switch to the ⊣⊢ position.	100 nF	100 nF	±3.2 nF	±3.2 nF
		1 µF	1 µF	±0.032 µF	±0.032 µF
		10 µF	10 µF	±0.32 µF	±0.32 µF
		100 µF	100 µF	±10.2 µF	±10.2 µF
4	**Resistance** Turn the rotary switch to the Ω position.	600 Ω[a]	600 Ω	±9.3 Ω	±6.3 Ω
		6 kΩ[a]	6000 Ω	±0.093 kΩ	±0.063 kΩ
		60 kΩ[a]	60000 Ω	±0.93 kΩ	±0.63 kΩ
		600 kΩ	600000 Ω	±9.3 kΩ	±6.3 kΩ
		6 MΩ	6000000 Ω	±0.123 MΩ	±0.075 MΩ
		60 MΩ	60000000 Ω	±1.53 MΩ	±1.23 MΩ

[a] The accuracy of the 600 Ω, 6 kΩ, and 60 kΩ range is specified using a 2-wire compensation configuration and after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).

Table 1-2 Performance verification tests (U1452A/U1452AT/U1451A) (continued)

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1451A	U1452AT/U1452A
5	**Earth-Bond Resistance** Turn the rotary switch to the Ω_{EB} position.	60 Ω	60 Ω	±0.93 Ω	±0.63 Ω
		600 Ω	600 Ω	±9.3 Ω	±6.3 Ω
		6 kΩ	6 kΩ	±0.093 kΩ	±0.063 kΩ
		60 kΩ	60 kΩ	±0.93 kΩ	±0.63 kΩ
6	**Frequency Sensitivity** While the rotary switch is in the Auto V position, press Lock Hz Esc.	199.9 Hz	199.9 Hz, 1 V	±0.5 Hz	±0.5 Hz

Step	Test function	Range	M191 output	Error from nominal 1 year		
				U1451A	U1452AT	U1452A
7	**Insulation Resistance** Turn the rotary switch to the appropriate Ω_{Mega} position.	50 V, 6 MΩ	6 MΩ	-	±0.125 MΩ	±0.125 MΩ
		50 V, 60 MΩ	60 MΩ	-	±1.26 MΩ	±1.26 MΩ
		50 V, 600 MΩ	600 MΩ	-	±19.1 MΩ	±19.1 MΩ
		50 V, 6 GΩ	6 GΩ	-	±0.839 GΩ	±0.839 GΩ
		50 V, 60 GΩ	30 GΩ	-	±18.62 GΩ	±18.62 GΩ
		100 V, 6 MΩ	6 MΩ	-	±0.125 MΩ	±0.125 MΩ
		100 V, 60 MΩ	60 MΩ	-	±1.25 MΩ	±1.25 MΩ
		100 V, 600 MΩ	600 MΩ	-	±15.5 MΩ	±15.5 MΩ
		100 V, 6 GΩ	6 GΩ	-	±0.479 GΩ	±0.479 GΩ
		100 V, 60 GΩ	30 GΩ	-	±9.62 GΩ	±9.62 GΩ

Step	Test function	Range	M191 output	Error from nominal 1 year		
				U1451A	U1452AT	U1452A
7	**Insulation Resistance** Turn the rotary switch to the appropriate Ω_{Mega} position.	250 V, 6 MΩ	6 MΩ	±0.095 MΩ	-	±0.095 MΩ
		250 V, 60 MΩ	60 MΩ	±0.95 MΩ	-	±0.95 MΩ
		250 V, 600 MΩ	600 MΩ	±10.3 MΩ	-	±10.3 MΩ
		250 V, 6 GΩ	6 GΩ	±0.233 GΩ	-	±0.233 GΩ
		250 V, 30 GΩ	30 GΩ	±4.07 GΩ	-	-
		250 V, 60 GΩ	60 GΩ	-	-	±15.29 GΩ
		250 V, 100 GΩ	100 GΩ	-	-	±41.9 GΩ
		500 V, 6 MΩ	6 MΩ	±0.095 MΩ	-	±0.095 MΩ
		500 V, 60 MΩ	60 MΩ	±0.95 MΩ	-	±0.95 MΩ
		500 V, 600 MΩ	600 MΩ	±9.6 MΩ	-	±9.6 MΩ
		500 V, 6 GΩ	6 GΩ	±0.161 GΩ	-	±0.161 GΩ
		500 V, 30 GΩ	30 GΩ	±2.27 GΩ	-	-
		500 V, 60 GΩ	60 GΩ	-	-	±8.09 GΩ
		500 V, 100 GΩ	100 GΩ	-	-	±21.9 GΩ
		1000 V, 6 MΩ	6 MΩ	±0.095 MΩ	-	±0.095 MΩ
		1000 V, 60 MΩ	60 MΩ	±0.95 MΩ	-	±0.95 MΩ
		1000 V, 600 MΩ	600 MΩ	±9.5 MΩ	-	±9.5 MΩ
		1000 V, 6 GΩ	6 GΩ	±0.125 GΩ	-	±0.125 GΩ
		1000 V, 30 GΩ	30 GΩ	±1.39 GΩ	-	-
		1000 V, 60 GΩ	60 GΩ	-	-	±4.49 GΩ
		1000 V, 200 GΩ	100 GΩ	-	-	±11.9 GΩ

Performance verification tests for U1461A/U1453A

Table 1-3 Performance verification tests for models U1461A/U1453A

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1453A	U1461A
1	**DCA** Turn the rotary switch to the Auto μA mA position.	6 μA	6 μA	-	±0.049 μA
		60 μA	60 μA	-	±0.25 μA
		600 μA	600 μA	-	±1.3 μA
		6 mA	6 mA	-	±0.013 mA
		60 mA	60 mA	-	±0.13 mA
		440 mA	220 mA	-	±0.5 mA
2	**ACA** Turn the rotary switch to the Auto μA mA position.	6 μA	235.2 mV, 45 Hz[a]	-	±0.122 μA[a]
			235.2 mV, 1 kHz[a]	-	±0.122 μA[a]
		60 μA	60 μA, 45 Hz	-	±0.92 μA
			60 μA, 1 kHz		±0.92 μA
		600 μA	600 μA, 45 Hz	-	±6.2 μA
			600 μA, 1 kHz		±6.2 μA
		6 mA	6 mA, 45 Hz	-	±0.062 mA
			6 mA, 1 kHz		±0.062 mA
		60 mA	60 mA, 45 Hz	-	±0.62 mA
			60 mA, 1 kHz		±0.62 mA
		220 mA	220 mA, 45 Hz	-	±4.6 mA
			220 mA, 1 kHz		±4.6 mA

[a] The Fluke 5520A/5522A is unable to support the testing of the 6 μA range; therefore an alternative test is used, in which the Cal factor for the 6 μA is 235.2 mV and it is used as an output from the Fluke 5520A/5522A.

Table 1-3 Performance verification tests for models U1461A/U1453A (continued)

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1453A	U1461A
3	**DCV** Turn the rotary switch to the Auto V position.	6 V	6 V	±0.006 V	±0.006 V
		60 V	60 V	±0.06 V	±0.06 V
		600 V	600 V	±0.6 V	±0.6 V
		1000 V	1000 V	±2 V	±2 V
4	**DCmV** Turn the rotary switch to the Auto mV position.	60 mV	60 mV[a]	-	±0.064 mV
		600 mV	600 mV[a]	-	±0.64 mV
[a] The accuracy is specified after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).					
5	**ACV** Turn the rotary switch to the Auto V position.	6 V	6 V, 65 Hz	±0.063 V	±0.063 V
			6 V, 5 kHz	±0.093 V	±0.093 V
			6 V, 20 kHz	±0.124 V	±0.124 V
		60 V	60 V, 65 Hz	±0.63 V	±0.63 V
			60 V, 5 kHz	±0.93 V	±0.93 V
			60 V, 20 kHz	±1.24 V	±1.24 V
		600 V	600 V, 65 Hz	±6.3 V	±6.3 V
			600 V, 999 Hz	±9.3 V	±9.3 V
		1000 V	1000 V, 65 Hz	±13 V	±13 V
			1000 V, 999 Hz	±18 V	±18 V
6	**ACV (LPF)** While the rotary switch is in the LPF V position, press T DAR Pf once.	6 V	6 V, 439 Hz	-	±0.363 V
		60 V	60 V, 439 Hz	-	±3.63 V
		600 V	600 V, 439 Hz	-	±36.3 V
		1000 V	1000 V, 439 Hz	-	±63 V

Table 1-3 Performance verification tests for models U1461A/U1453A (continued)

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1453A	U1461A
7	**ACmV** Turn the rotary switch to the Auto mV position.	60 mV	60 mV, 65 Hz	-	±0.63 mV
			60 mV, 5 kHz	-	±0.93 mV
			60 mV, 20 kHz	-	±1.24 mV
		600 mV	600 mV, 65 Hz	-	±6.3 mV
			600 mV, 5 kHz	-	±9.3 mV
			600 mV, 20 kHz	-	±12.4 mV
8	**Resistance** Turn the rotary switch to the Ω position.	600 Ω[b]	600 Ω	±3.2 Ω	±3.2 Ω
		6 kΩ[b]	6000 Ω	±0.032 kΩ	±0.032 kΩ
		60 kΩ[b]	60000 Ω	±0.32 kΩ	±0.32 kΩ
		600 kΩ	600000 Ω	±3.2 kΩ	±3.2 kΩ
		6 MΩ	6000000 Ω	±0.050 MΩ	±0.050 MΩ
		60 MΩ	60000000 Ω	±0.93 MΩ	±0.93 MΩ
[b] The accuracy of the 600 Ω, 6 kΩ, and 60 kΩ range is specified using a 2-wire compensation configuration and after the Null function is used to subtract the test lead resistance and thermal effect (by shorting the test leads).					
9	**Capacitance** While the rotary switch is in the Ω position, press T DAR PI thrice.	10 nF	10 nF	±0.12 nF	±0.12 nF
		100 nF	100 nF	±1.2 nF	±1.2 nF
		1 µF	1 µF	±0.012 µF	±0.012 µF
		10 µF	10 µF	±0.12 µF	±0.12 µF
		100 µF	100 µF	±1.2 µF	±1.2 µF
		1 mF	1 mF	±0.012 mF	±0.012 mF
		10 mF	10 mF	±0.12 mF	±0.12 mF
10	**Diode** While the rotary switch is in the Ω position, press T DAR PI twice.	1 V	0.85 V	±0.020 V	±0.020 V

Table 1-3 Performance verification tests for models U1461A/U1453A (continued)

Step	Test function	Range	5520A/5522A output	Error from nominal 1 year	
				U1453A	U1461A
11	**Earth-Bond Resistance** Turn the rotary switch to the Ω_{EB} position.	6 Ω[b]	5.0 Ω	±0.045 Ω[a]	±0.045 Ω[a]
		60 Ω[b]	60 Ω	±0.32 Ω	±0.32 Ω
		600 Ω[b]	600 Ω	±3.2 Ω	±3.2 Ω
		6 kΩ	6 kΩ	±0.032 kΩ	±0.032 kΩ
		60 kΩ	60 kΩ	±0.32 kΩ	±0.32 kΩ
[a] The accuracy of the 6 Ω range is specified using a 5.0 Ω resistor for measurement.					
[b] 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).					
12	**Frequency Sensitivity** While the rotary switch is in the Auto V position, press Lock Hz Ext.	99.99 Hz	99.99 Hz, 1 V	±0.03 Hz	±0.03 Hz
13	**Temperature** While the rotary switch is in the Auto mV position, press T DAR Pt thrice.	–200 °C to 1372 °C	0 °C	-	± 1 °C

Step	Test function	Range	M191 output	Error from nominal 1 year	
				U1453A	U1461A
14	**Insulation Resistance** Turn the rotary switch to the appropriate Ω_{Mega} position.	50 V, 6 MΩ	6 MΩ	±0.095 MΩ	±0.095 MΩ
		50 V, 60 MΩ	60 MΩ	±0.96 MΩ	±0.96 MΩ
		50 V, 600 MΩ	600 MΩ	±0.13 MΩ	±0.13 MΩ
		50 V, 6 GΩ	6 GΩ	±0.452 GΩ	±0.452 GΩ
		50 V, 60 GΩ	30 GΩ	±9.49 GΩ	±9.49 GΩ

Step	Test function	Range	M191 output	Error from nominal 1 year	
				U1453A	U1461A
14	**Insulation Resistance** Turn the rotary switch to the appropriate Ω_{Mega} position.	100 V, 6 MΩ	6 MΩ	±0.095 MΩ	±0.095 MΩ
		100 V, 60 MΩ	60 MΩ	±0.95 MΩ	±0.95 MΩ
		100 V, 600 MΩ	600 MΩ	±12.8 MΩ	±12.8 MΩ
		100 V, 6 GΩ	6 GΩ	±0.272 GΩ	±0.272 GΩ
		100 V, 60 GΩ	30 GΩ	±4.99 GΩ	±4.99 GΩ
		250 V, 6 MΩ	6 MΩ	±0.095 MΩ	±0.095 MΩ
		250 V, 60 MΩ	60 MΩ	±0.95 MΩ	±0.95 MΩ
		250 V, 600 MΩ	600 MΩ	±9.9 MΩ	±9.9 MΩ
		250 V, 6 GΩ	6 GΩ	±0.164 GΩ	±0.164 GΩ
		250 V, 60 GΩ	60 GΩ	±8.12 GΩ	±8.12 GΩ
		250 V, 200 GΩ	100 GΩ	±22 GΩ	±22 GΩ
		500 V, 6 MΩ	6 MΩ	±0.077 MΩ	±0.077 MΩ
		500 V, 60 MΩ	60 MΩ	±0.77 MΩ	±0.77 MΩ
		500 V, 600 MΩ	600 MΩ	±7.8 MΩ	±7.8 MΩ
		500 V, 6 GΩ	6 GΩ	±0.110 GΩ	±0.110 GΩ
		500 V, 60 GΩ	60 GΩ	±4.34 GΩ	±4.34 GΩ
		500 V, 200 GΩ	100 GΩ	±11.7 GΩ	±11.7 GΩ
		1000 V, 6 MΩ	6 MΩ	±0.077 MΩ	±0.077 MΩ
		1000 V, 60 MΩ	60 MΩ	±0.77 MΩ	±0.77 MΩ
		1000 V, 600 MΩ	600 MΩ	±7.7 MΩ	±7.7 MΩ
		1000 V, 6 GΩ	6 GΩ	±0.092 GΩ	±0.092 GΩ
		1000 V, 60 GΩ	60 GΩ	±2.54 GΩ	±2.54 GΩ
		1000 V, 200 GΩ	100 GΩ	±6.7 GΩ	±6.7 GΩ

Figure 1-1 Connecting the U1450 Series/U1461A to the M191

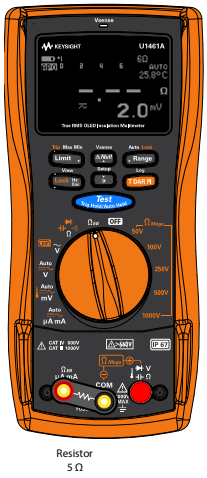


Figure 1-2 Connecting the U1450 Series/U1461A for 6 Ω EBR measurement

Calibration Security

The calibration security code prevents accidental or unauthorized adjustments to the instrument. When you first receive your instrument, it is secured. Before you can adjust the instrument, you must unsecure it by entering the correct security code (see "Unsecuring the Instrument for Calibration" on page 32).

NOTE **The security code can only be changed after the instrument has been unsecured. You can unsecure the instrument from its front panel.**

The security code is set to "1234" when the instrument is shipped from the factory. The security code is stored in nonvolatile memory and does not change when power has been turned off.

The security code may contain up to four numeric characters.

Unsecuring the Instrument for Calibration

Before you can adjust the instrument, you must unsecure it by entering the correct security code.

The default security code is set to “1234”.

NOTE If you forget your security code, see “To reset the calibration security code to its factory default” on page 33.

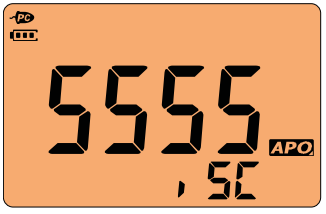
To unsecure the instrument from the front panel

1 Power-on the instrument, and press the T DAR PI and Lock keys simultaneously for more than 1 second.

The calibration security code entry is shown on the display.

U1461A/U1453A

U1452A/U1452AT/U1451A



2 Key in the default security code if you are unsecuring your instrument for the first time.

- Press Limit or Range to move the cursor to the right or to the left.
- Press Δ/Null or ☀ to increment or decrement the digit.

3 Press T DAR PI when you are done.

If the correct security code is entered, **PASS** is shown briefly, after which the instrument will enter the adjustment mode.

If an incorrect security code is entered, an error code will appear briefly, after which the instrument will prompt you for the security code again.

To change the calibration security code

1 After the instrument has been unsecured, press Test (for U1452A/U1452AT/U1451A) or press Lock (for U1461A/U1453A) for more than 1 second.

2 The factory default calibration security code “1234” is shown on the display if you are changing the calibration security code for the first time.

U1461A/U1453A

U1452A/U1452AT/U1451A

3 Set your new calibration security code (0000 to 9999).

- Press Limit or Range to move the cursor to the right or to the left.
- Press Null or to increment or decrement the digit.

4 Press T DAR PI to save the new calibration security code.

5 Alternatively, press Test (for U1452A/U1452AT/U1451A) or press Lock (for U1461A/U1453A) for more than 1 second to cancel the changes made.

If the new calibration security code has been successfully stored, the display will show **PASS**. Record down your new calibration security code, and store it in a safe location.

To reset the calibration security code to its factory default

If you have forgotten the correct calibration security code, you may follow the steps below to reset the calibration security code to the factory default code (1234).

NOTE If you do not have a record (or have lost the record) of the security code, first try the factory default code, “1234”.

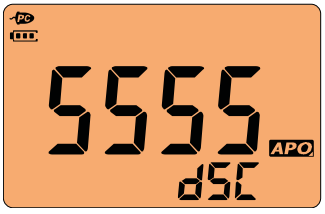
1 Before you begin, note down the last four digits of the instrument’s serial number (located at the bottom of the rear panel).

2 Power-on the instrument, and press T DAR PI and Lock Hz Esc simultaneously for more than 1 second.

The calibration security code entry is shown on the display.

U1461A/U1453A

U1452A/U1452AT/U1451A



3 Press Lock Hz Esc for more than 1 second.

4 Set the code to the same as the last four digits of the instrument’s serial number.

- Press Limit or Range to move the cursor to the right or to the left.
- Press Δ Null or ∧ to increment or decrement the digit.

5 Press T DAR PI to confirm the entry.

If the four digits entered are correct, the display will show **PASS**. The calibration security code is now set to its factory default code, “1234”.

If the incorrect security code is entered, an error code will appear briefly, after which the instrument will prompt you for the security code again.

If you want to enter a new security code, see “To change the calibration security code” on page 33. Ensure that you record down the new security code.

Using the Front Panel for Adjustments

This section describes the procedures to perform adjustments from the front panel.

To unsecure the instrument, see "To unsecure the instrument from the front panel" on page 32. Once unsecured, the reference value will be indicated on the display.

Adjustment considerations

1. Use the Fluke 5520A/5522A calibrator (or equivalent) for the adjustment procedure.
2. Allow the instrument to warm up and stabilize for 1 hour before performing the adjustments.
3. Ensure that during the adjustments, the low battery indicator does not appear. If the low battery indicator appears, replace the batteries as soon as possible to avoid false readings.
4. Consider the thermal effects as you are connecting the test leads to the calibrator and tester. It is recommended to wait for 1 minute before you begin the calibration after connecting the test leads.
5. Before proceeding with the ambient temperature adjustment, be sure to turn on the tester for at least 1 hour with the K-type thermocouple connected.
6. When the word "SHORT" is used, connect the specified terminals with copper wires on banana plugs as short as possible.
7. When the word "OPEN" is used, remove all test leads from the instrument's terminals.

NOTE After each adjustment, the display shows **PASS**. If the calibration fails, the instrument sounds a beep, and an error number is shown on the display. Calibration error messages are described in "Calibration Error Codes" on page 50.

CAUTION Never turn off the instrument during an adjustment. This may delete the calibration memory for the present function.

Valid adjustment input values (U1452A/U1452AT/U1451A)

Adjustment can be accomplished using the following input values below.

Table 1-4 Adjustment input values (U1452A/U1452AT/U1451A)

Test function sequence	Step	Reference value	Valid reference input
1. DCV Turn the rotary switch to the Auto V position.	600 mV	0.00 mV	Reference Zero Point
	600 mV	300.00 mV	0.9 to 1.1 × Reference Value
	6 V	3.0000 V	0.9 to 1.1 × Reference Value
	60 V	30.000 V	0.9 to 1.1 × Reference Value
	600 V	300.00 V	0.9 to 1.1 × Reference Value
	SHORT	SHORT mV	SHORT VΩ/COM Terminals
2. ACV Turn the rotary switch to the Auto V position.	600 mV	030.0 mV (55 Hz)	0.9 to 1.1 × Reference Value
		300.0 mV (55 Hz)	0.9 to 1.1 × Reference Value
	6 V	0.300 V (55 Hz)	0.9 to 1.1 × Reference Value
		3.000 V (55 Hz)	0.9 to 1.1 × Reference Value
	60 V	3.00 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.00 V (55 Hz)	0.9 to 1.1 × Reference Value
	600 V	30.00 V (55 Hz)	0.9 to 1.1 × Reference Value
		300.0 V (55 Hz)	0.9 to 1.1 × Reference Value

Table 1-4 Adjustment input values (U1452A/U1452AT/U1451A) (continued)

Test function sequence	Step	Reference value	Valid reference input
3. DCA at Ω_{EB} Turn the rotary switch to the Ω_{EB} position.	6.000 µA	0.000 µA	-
	6.000 µA	3.000 µA	0.9 to 1.1 × Reference Value
	60 µA	30.00 µA	0.9 to 1.1 × Reference Value
	600 µA	300.0 µA	0.9 to 1.1 × Reference Value
	6.000 mA	3.000 mA	0.9 to 1.1 × Reference Value
	60 mA	30.00mA	0.9 to 1.1 × Reference Value
	600 mA	300.0 mA	0.9 to 1.1 × Reference Value
	OPEN	OPEN µA	OPEN Terminals
4. ACA at Ω_{EB} Turn the rotary switch to the Ω_{EB} position.	60 µA	30.00 µA (55 Hz)	0.9 to 1.1 × Reference Value
		60.00 µA (55 Hz)	0.9 to 1.1 × Reference Value
	600 µA	030.0 µA (55 Hz)	0.9 to 1.1 × Reference Value
		300.0 µA (55 Hz)	0.9 to 1.1 × Reference Value
	6.000 mA	0.300 mA (55 Hz)	0.9 to 1.1 × Reference Value
		2.000 mA (55 Hz)	0.9 to 1.1 × Reference Value
5. ZERO at Ω[a] Turn the rotary switch to the Ω position.	SHORT	SHORT	SHORT VΩ/COM Terminals
6. IR 50 V[b] Turn the rotary switch to the Ω_{Mega} 50V position.	OPEN	OPEN	OPEN Terminals

[a] Zero calibration should be executed after the mV and µA/mA calibration are completed.

[b] The IR test voltage calibration should be executed after the voltage calibration is completed.

Valid adjustment input values (U1453A)

Adjustment can be accomplished using the following input values.

Table 1-5 Adjustment input values (U1453A)

Test function sequence	Step	Reference value	Valid reference input
1. DCV Turn the rotary switch to the Auto V position.	600.00 mV	0.00 mV	-
	600.00 mV	300.00 mV	0.9 to 1.1 × Reference Value
	6.0000 V	3.0000 V	0.9 to 1.1 × Reference Value
	60.000 V	30.000 V	0.9 to 1.1 × Reference Value
	600.00 V	300.00 V	0.9 to 1.1 × Reference Value
	1000.0V	1000.0 V	0.9 to 1.1 × Reference Value
	SHORT	SHORT	-

Table 1-5 Adjustment input values (U1453A) (continued)

Test function sequence	Step	Reference value	Valid reference input
2. ACV Turn the rotary switch to the Auto V position.	600.00 mV	300.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 mV (20 kHz)	0.9 to 1.1 × Reference Value
		030.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
	6.0000 V	3.0000 V (55 Hz)	0.9 to 1.1 × Reference Value
		3.0000 V (5 kHz)	0.9 to 1.1 × Reference Value
		0.3000 V (55 Hz)	0.9 to 1.1 × Reference Value
		3.0000 V (55 Hz)	0.9 to 1.1 × Reference Value
	60.000 V	30.000 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 V (5 kHz)	0.9 to 1.1 × Reference Value
		30.000 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 V (5 kHz)	0.9 to 1.1 × Reference Value
		03.000 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 V (55 Hz)	0.9 to 1.1 × Reference Value
	600.00 V	030.00 V (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 V (55 Hz)	0.9 to 1.1 × Reference Value
	1000.0 V	0030.0 V (55 Hz)	0.8 to 1.2 × Reference Value
		0300.0 V (55 Hz)	0.9 to 1.1 × Reference Value
3. DCA at Ω_{EB} Turn the rotary switch to the Ω_{EB} position.	OPEN	OPEN	OPEN Terminals
	6 μA	3.0000 μA	Ω_{EB} μA mA/COM Terminals
	60 μA	30.000 μA	Ω_{EB} μA mA/COM Terminals
	600 μA	300 μA	Ω_{EB} μA mA/COM Terminals
	6 mA	3 mA	Ω_{EB} μA mA/COM Terminals

Table 1-5 Adjustment input values (U1453A) (continued)

Test function sequence	Step	Reference value	Valid reference input
6. Earth-Bond Resistance[a] Turn the rotary switch to the Ω_{EB} position.	SHORT	SHORT	SHORT VΩ/COM Terminals
	6 µA	3.0000 µA	Ω_{EB} µA mA/COM Terminals
	60 µA	30.000 µA	Ω_{EB} µA mA/COM Terminals
	300 µA	300 µA	Ω_{EB} µA mA/COM Terminals
	60 mA	30.000 mA	Ω_{EB} µA mA/COM Terminals
8. Resistance Turn the rotary switch to the position.	6 Ω	0.000 Ω	SHORT VΩ/COM Terminals
	60.000 MΩ	OPEN	OPEN Terminals
		10.000 MΩ	0.9 to 1.1 × Reference Value
	6.0000 MΩ	3.0000 MΩ	0.9 to 1.1 × Reference Value
	600.00 kΩ	300.00 kΩ	0.9 to 1.1 × Reference Value
	60.000 kΩ	30.000 kΩ	0.9 to 1.1 × Reference Value
	6.0000 kΩ	3.0000 kΩ	0.9 to 1.1 × Reference Value
	600.00 Ω	300.00 Ω	0.9 to 1.1 × Reference Value
	60.000 Ω	30.000 Ω	0.9 to 1.1 × Reference Value
	SHORT	SHORT	-
9. Diode While the rotary switch is in the position, press REL twice.	1 V	0.000 Ω	SHORT V/COM Terminals
	1.0000 V	1.0000 V	0.9 to 1.1 × Reference Value
	SHORT	SHORT	

Table 1-5 Adjustment input values (U1453A) (continued)

Test function sequence	Step	Reference value	Valid reference input
10. Capacitance While the rotary switch is in the position, press thrice.	OPEN	OPEN	OPEN Terminals
	10.000 nF	3.000 nF	0.9 to 1.1 × Reference Value
		10.000 nF	0.9 to 1.1 × Reference Value
	100.00 nF	10.00 nF	0.9 to 1.1 × Reference Value
		100.00 nF	0.9 to 1.1 × Reference Value
	1.0000 µF	0.1000 µF	0.9 to 1.1 × Reference Value
		1.0000 µF	0.9 to 1.1 × Reference Value
	10.000 µF	1.000 µF	0.9 to 1.1 × Reference Value
		10.000 µF	0.9 to 1.1 × Reference Value
	100.00 µF	10.00 µF	0.9 to 1.1 × Reference Value
		100.00 µF	0.9 to 1.1 × Reference Value
	1.0000 mF	0.1000 mF	0.9 to 1.1 × Reference Value
		1.0000 mF	0.9 to 1.1 × Reference Value
	10.000 mF	1.000 mF	0.9 to 1.1 × Reference Value
		10.000 mF	0.9 to 1.1 × Reference Value
13. IR 50 V[b] Turn the rotary switch to the position.	OPEN	OPEN	OPEN Terminals

[a] Zero calibration should be executed after the mV and µA/mA calibration at the Ω_{EB} position are completed.

[b] The IR test voltage calibration should be executed after the DCV calibrations are completed.

Valid adjustment input values (U1461A)

Adjustment can be accomplished using the following input values.

Table 1-6 Adjustment input values (U1461A)

Test function sequence	Step	Reference value	Valid reference input
1. DCA Turn the rotary switch to the Auto μA mA position.	OPEN	OPEN	OPEN Terminals
	6.0000 μA	3.0000 μA	0.9 to 1.1 × Reference Value
	60.000 μA	30.000 μA	0.9 to 1.1 × Reference Value
	600.00 μA	300.00 μA	0.9 to 1.1 × Reference Value
	6.0000 mA	3.0000 mA	0.9 to 1.1 × Reference Value
	60.000 mA	30.000mA	0.9 to 1.1 × Reference Value
	600.00 mA	300.00 mA	0.9 to 1.1 × Reference Value
2. DCmV Turn the rotary switch to the Auto mV position.	60 mA	0.000 mV	SHORT VΩ/COM Terminals
	60.000 mV	30.000 mV	0.9 to 1.1 × Reference Value
	600.00 mV	300.00 mV	0.9 to 1.1 × Reference Value
	SHORT	SHORT	-
3. ACmV Turn the rotary switch to the Auto mV position.	60.000 mV	03.000 mV (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 mV (55 Hz)	0.9 to 1.1 × Reference Value
	600.00 mV	030.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
4. DCV Turn the rotary switch to the Auto V position.	600 mV	0.00 mV	-
	600.00 mV	300.00 mV	0.9 to 1.1 × Reference Value
	6.0000 V	3.0000 V	0.9 to 1.1 × Reference Value
	60.000 V	30.000 V	0.9 to 1.1 × Reference Value
	600.00 V	300.00 V	0.9 to 1.1 × Reference Value
	1000.0V	1000.0 V	0.9 to 1.1 × Reference Value
	SHORT	SHORT	-

Table 1-6 Adjustment input values (U1461A) (continued)

Test function sequence	Step	Reference value	Valid reference input
5. ACV Turn the rotary switch to the Auto V position.	600.00 mV	300.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 mV (20 kHz)	0.9 to 1.1 × Reference Value
		030.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 mV (55 Hz)	0.9 to 1.1 × Reference Value
	6.0000 V	3.0000 V (55 Hz)	0.9 to 1.1 × Reference Value
		3.0000 V (5 kHz)	0.9 to 1.1 × Reference Value
		0.3000 V (55 Hz)	0.9 to 1.1 × Reference Value
		3.0000 V (55 Hz)	0.9 to 1.1 × Reference Value
	60.000 V	30.000 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 V (5 kHz)	0.9 to 1.1 × Reference Value
		30.000 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 V (5 kHz)	0.9 to 1.1 × Reference Value
		03.000 V (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 V (55 Hz)	0.9 to 1.1 × Reference Value
	600.00 V	030.00 V (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 V (55 Hz)	0.9 to 1.1 × Reference Value
	1000.0 V	0030.0 V (55 Hz)	0.8 to 1.2 × Reference Value
		0300.0 V (55 Hz)	0.9 to 1.1 × Reference Value
6. EBR at W_{EB}[a] Turn the rotary switch to the Ω_{EB} position.	SHORT	SHORT	-
	6 μA	3.0000 μA	Ω_{EB} μA mA/COM Terminals
	60 μA	30.000 μA	Ω_{EB} μA mA/COM Terminals
	600 μA	300.00 μA	Ω_{EB} μA mA/COM Terminals
	60 mA	30.000 mA	Ω_{EB} μA mA/COM Terminals

Table 1-6 Adjustment input values (U1461A) (continued)

Test function sequence	Step	Reference value	Valid reference input
7. ACA Turn the rotary switch to the Auto μA mA position.	6.0000 μA	0.3000 μA (55 Hz)[b]	0.8 to 1.2 × Reference Value
		3.0000 μA (55 Hz)	0.9 to 1.1 × Reference Value
	60.000 μA	03.000 μA (55 Hz)	0.8 to 1.2 × Reference Value
		30.000 μA (55 Hz)[b]	0.9 to 1.1 × Reference Value
	600.00 μA	030.00 μA (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 μA (55 Hz)	0.9 to 1.1 × Reference Value
	6.0000 mA	0.3000 mA (55 Hz)	0.9 to 1.1 × Reference Value
		3.0000 mA (55 Hz)	0.9 to 1.1 × Reference Value
	60.000 mA	03.000 mA (55 Hz)	0.9 to 1.1 × Reference Value
		30.000 mA (55 Hz)	0.9 to 1.1 × Reference Value
	600.00 mA	030.00 mA (55 Hz)	0.9 to 1.1 × Reference Value
		300.00 mA (55 Hz)	0.9 to 1.1 × Reference Value
8. Resistance Turn the rotary switch to the Ω position.	60 Ω	0.000 Ω	-
	60.000 MΩ	OPEN	OPEN Terminals
		10.000 MΩ	0.9 to 1.1 × Reference Value
	6.0000 MΩ	3.0000 MΩ	0.9 to 1.1 × Reference Value
	600.00 kΩ	300.00 kΩ	0.9 to 1.1 × Reference Value
	60.000 kΩ	30.000 kΩ	0.9 to 1.1 × Reference Value
	6.0000 kΩ	3.0000 kΩ	0.9 to 1.1 × Reference Value
	600.00 Ω	300.00 Ω	0.9 to 1.1 × Reference Value
	60.000 Ω	30.000 Ω	0.9 to 1.1 × Reference Value
	SHORT	SHORT	-
9. Diode While the rotary switch is in the Ω position, press T DAR PI twice.	1 V	0 Ω	-
	1.0000 V	1.0000 V	0.9 to 1.1 × Reference Value
	SHORT	SHORT	-

Table 1-6 Adjustment input values (U1461A) (continued)

Test function sequence	Step	Reference value	Valid reference input
10. Capacitance While the rotary switch is in the position, press T DAR PI thrice.	OPEN	OPEN	OPEN Terminals
	10.000 nF	3.000 nF	0.9 to 1.1 × Reference Value
		10.000 nF	0.9 to 1.1 × Reference Value
	100.00 nF	10.00 nF	0.9 to 1.1 × Reference Value
		100.00 nF	0.9 to 1.1 × Reference Value
	1.0000 µF	0.1000 µF	0.9 to 1.1 × Reference Value
		1.0000 µF	0.9 to 1.1 × Reference Value
	10.000 µF	1.000 µF	0.9 to 1.1 × Reference Value
		10.000 µF	0.9 to 1.1 × Reference Value
	100.00 µF	10.00 µF	0.9 to 1.1 × Reference Value
		100.00 µF	0.9 to 1.1 × Reference Value
	1.0000 mF	0.1000 mF	0.9 to 1.1 × Reference Value
		1.0000 mF	0.9 to 1.1 × Reference Value
	10.000 mF	1.000 mF	0.9 to 1.1 × Reference Value
		10.000 mF	0.9 to 1.1 × Reference Value
11. Temperature While the rotary switch is in the Auto mV position, press T DAR PI thrice.	K type	000.0 °C	0 °C with Ambient Compensation Required
12. Vsense[c] While the rotary switch is in any position, press and hold Δ Null.	Hi.10 V	10 V (55 Hz)	High Sense
	Lo.30 V	30 V (55 Hz)	Low Sense
13. IR 50 V[d] Turn the rotary switch to the Ω_{Mega} 50V position.	OPEN	OPEN	OPEN Terminals

[a] Zero calibration should be executed after the mV and µA/mA calibration at the Ω_{EB} position are completed.

[b] The minimum AC current output of the Fluke 5520A/5522A calibrator is 29.00 µA only. Be sure to set at least 30.00 µA for the calibration source of the ACµA.

[c] Vsense function for model U1461A only.

[d] The IR test voltage calibration should be executed after the DCV calibrations are completed.

Adjustment procedure

NOTE Review the Test Considerations and Adjustment considerations before beginning the adjustment procedures.

1. Turn the rotary switch to the respective test function position as shown in the adjustment input values table (Table 1-6).
2. Unsecure the instrument to enter the adjustment mode. (See "Unsecuring the Instrument for Calibration" on page 32).

NOTE While in the adjustment mode, press T DAR Hz and Lock Hz Esc simultaneously to exit the adjustment mode.

3. The reference value of the calibration item will be shown on the display.
4. Configure each calibration item.
5. Use the arrow keys to select the calibration range.
6. Apply the input signal shown in the Reference value column of Table 1-6. The analog bar graph displays the input reading. There is no bar graph display for temperature adjustment.

NOTE You are highly recommended to complete the adjustments in the same order as shown in Table 1-6.

7. Use the arrow keys to enter the actual applied input values.
8. Press T DAR Hz to start the adjustment. **CAL** is shown on the display to indicate that the calibration is in progress.

9 Upon completion of each adjustment value, the display will show **PASS**. If the adjustment fails, the instrument will sound a long beep and the calibration error number is shown on the display.

NOTE **If the adjustment fails, check the input value, range, function, and entered adjustment value before repeating the adjustment steps. Refer to "Calibration Error Codes" on page 50 for more information where necessary.**

10 Turn the rotary switch to the next function according to the Test function sequence column shown in Table 1-6. Repeat step 3 to step 8 for each adjustment point shown in the adjustment table.

11 Verify the adjustments using the "Performance Verification Tests" on page 21.

Non-Contact Voltage (NCV) Calibration

- Ensure that the tester is REMOVED from the holster prior to performing this calibration.
- Keep the tester away from electrical noise sources during the tests, i.e., fluorescent lights, dimmable lights, motors, etc. These sources can invalidate the calibration.
- It may be necessary in step 4 and step 8 below to slightly adjust the tester's position for maximum signal strength.

Refer the following procedure to calibrate the NCV function properly:

1 Turn the rotary switch to the  position. **Hi.10 V** is shown on the display.

2 Connect a double banana plug (open type) into the output voltage terminals of the calibrator.

3 Ensure that the **EARTH** button of calibrator is turned ON.

4 Put the tester and ensure the tester's top is vertically and horizontally centered to contact the banana plug's Hi terminal.

5 Set the source output to 10 V/55 Hz.

6 Press T DAR PI to start the calibration. If the tester passes the calibration then the display will indicate **Lo.30 V**.

7 Set the source to output to 30 V/55Hz.

8 Press T DAR PI to start the calibration.

9 When the calibration has been done, set the calibrator to the standby mode.

Exiting the adjustment mode

1 Remove all the shorting plugs and connectors from the instrument.

2 Record the new Calibration Count.

3 Press T DAR PI and Lock Hz Esc simultaneously to exit the Adjustment Mode.

4 Cycle the instrument's power. The instrument will then be secured.

Calibration Count

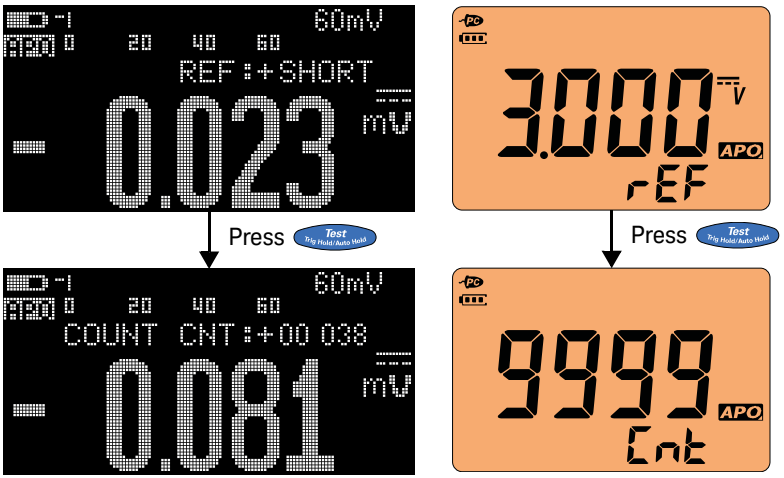
You can query the instrument to determine how many adjustments have been performed.

NOTE **The instrument has been calibrated before it left the factory. You are recommended to record the initial value of the calibration count once you receive the instrument.**

The count value increases by one for each calibration point, from 0000 up to the maximum of 19999. After the maximum count, the calibration count will reset to 0. The calibration count can be read from the front panel after the instrument has been unsecured.

1 In adjustment mode, press Test to view the calibration count.

U1461A/U1453A **U1452A/U1452AT/U1451A**



2 Take note of the calibration count to keep track of the number of calibrations that have been performed.

3 Press Test again to exit the calibration count mode.

Calibration Error Codes

The following errors indicate failures that may occur during a calibration.

Table 1-7 Calibration error codes

Code	Descriptions
200/ER200	Calibration error: calibration mode is secured
002/ER002	Calibration error: secure code invalid
003/ER003	Calibration error: serial number code invalid
004/ER004	Calibration error: calibration aborted
005/ER005	Calibration error: value out of range
006/ER006	Calibration error: signal measurement out of range
007/ER007	Calibration error: frequency out of range
008/ER008	EEPROM write failure

2 Service and Maintenance

This chapter will help you troubleshoot a failing instrument. It also describes how to obtain repair services and lists the replaceable assemblies.

Troubleshooting

WARNING To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

CAUTION Any repair or service which is not covered in this manual should only be performed by qualified personnel.

If the instrument fails to operate, check the batteries and the test leads. Replace them if necessary. If the instrument still does not function, check the operating procedures in this manual. When servicing, use only the specified replacement parts.

The table below will assist you in identifying some basic malfunctions.

Table 2-1 Operating checklist

Malfunction	Identification
No display when powered ON using the rotary switch	– Verify the batteries health and replace batteries as necessary.
No beeper tone	– Verify that the beeper is enabled in the Setup mode.
Failed on current measurement (U1461A only)	– Verify the fuses health and replace the fuses as necessary.
Failed on remote control	– Verify the optical side of the IR-USB cable connected to the tester – the Keysight logo should be facing up. – Verify the baud rate, data bit, and parity settings in the tester's setup mode. (Default values are 9600, 8, and none.) – Verify that the driver for the IR-USB interface is installed on the PC.

Fuse Replacement

NOTE No recalibration is required after replacing the fuse.

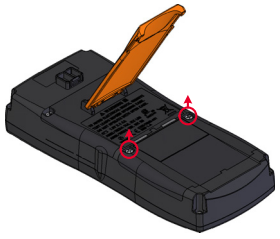
The current input and earth-bond resistance terminals of your tester are fuse protected. The fuses are located next to the battery compartment.

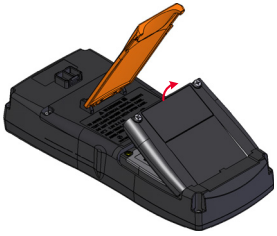
The terminals are protected by a 10 × 35 mm 440 mA/1000 V 30 kA fast-acting fuse.

CAUTION **Before you proceed with the fuse replacement, remove all cable connections to the terminals and ensure that the rotary switch is at the OFF position.**

If you are certain that a fuse is faulty, replace it with one of the same size and rating.

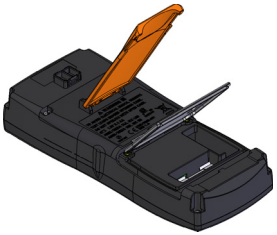
1. Remove the orange rubber holster. Pull from a top corner and stretch the orange rubber holster off the tester.
2. Loosen and remove the two screws with a suitable Phillips screwdriver as shown on the right.

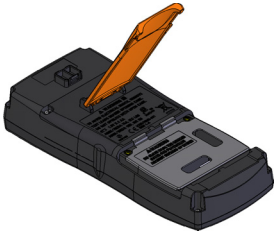




3. Lift and remove the fuse cover as shown on the left.

4 Lift the inner rubber cover to access the fuse compartment.
5 Locate the faulty fuse. Gently remove the defective fuse by prying one end of the fuse with a flathead screwdriver and removing it out of the fuse bracket. Replace a new fuse of the same size and rating into the center of the fuse holder.





6 Ensure that the inner rubber cover is positioned properly.
7 Replace the fuse cover back in its original position and tighten the screws.
8 Finally fit the orange rubber holster back on the tester.

Returning the Instrument for Service

Before shipping your instrument for repair or replacement, Keysight recommends that you acquire the shipping instructions from the Keysight Service Center. A clear understanding of the shipping instructions is necessary to secure your product for shipment.

1. Attach a tag to the instrument with the following information:
   - Name and address of owner
   - Instrument model number
   - Instrument serial number
   - Description of the service required or failure indications
2. Remove all accessories from the instrument. Do not include accessories unless they are associated with the failure symptoms.
3. Place the instrument in its original container with appropriate packaging material for shipping.

If the original shipping container is not available, place your unit in a container which will ensure at least 4 inches of compressible packaging material around all sides for the instrument. Use static-free packaging materials to avoid additional damage to your unit.

NOTE Keysight suggests that you always insure your shipments.

Replaceable Parts

This section contains information for ordering replacement parts for your instrument. You can find the instrument support parts list at Keysight's Test & Measurement Parts Catalog: http://www.keysight.com/find/parts

The parts lists include a brief description of each part with its corresponding Keysight part number.

To order replaceable parts

You can order replaceable parts from Keysight using the Keysight part number. Note that not all parts listed are available as field-replaceable parts.

To order replaceable parts from Keysight, do the following:

1. Contact your nearest Keysight Sales Office or Service Center.
2. Identify the parts by the Keysight part number shown in the support parts list.
3. Provide the instrument model number and serial number.

Types of Service Available

If your instrument fails during the warranty period, Keysight will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices.

Extended service contracts

Many Keysight products are available with optional service contracts that extend the covered period after the standard warranty expires. If you have such a service contract and your instrument fails during the covered period, Keysight will repair or replace it in accordance with the contract.

Obtaining Repair Service (Worldwide)

To obtain service for your instrument (in-warranty, under service contract, or post-warranty), contact your nearest Keysight Service Center. They will arrange to have your unit repaired or replaced, and can provide warranty or repair-cost information where applicable.

To obtain warranty, service, or technical support information you can contact Keysight at one of the following telephone numbers:

- In the United States: (800) 829-4444
- In Europe: 31 20 547 2111
- In Japan: 0120-421-345

Or use our Web link for information on contacting Keysight worldwide: www.keysight.com/find/assist

Or contact your Keysight representative.

Before shipping your instrument, request the Keysight Service Center to provide shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for use in such shipments.

Edition 6, June 3, 2020

Printed in Malaysia

U1451-90014
www.keysight.com

KEYSIGHT TECHNOLOGIES