Agilent U3606B Multimeter | DC Power Supply

Service Guide

Agilent Technologies

Notices

Manual Part Number

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Safety Notices

CAUTION

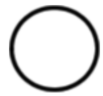
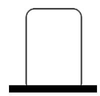
A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are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

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of 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)		Off (supply)
	Alternating current (AC)		On (supply)
	Both direct and alternating current		Caution, risk of danger (refer to this manual for specific Warning or Caution information)
	Earth (ground) terminal		Out position of a bi-stable push control
	Frame or chassis terminal		In position of a bi-stable push control
CAT II 300 V	Category II 300 V over voltage protection		

Safety Considerations

Read the information below before using this instrument.

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards for design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

WARNING

- **Do not use the device if it is damaged. Before you use the device, inspect the casing. Look for cracks or missing plastic. Do not operate the device around explosive gas, vapor, or dust.**
- **Always use the device with the cables provided.**
- **Observe all markings on the device before establishing any connection.**
- **Turn off the device and application system power before connecting to the I/O terminals.**
- **When servicing the device, use only the specified replacement parts.**
- **Do not operate the device with the cover removed or loosened.**
- **Use only the power adapter provided by the manufacturer to avoid any unexpected hazards.**

CAUTION

- If the device is used in a manner not specified by the manufacturer, the device protection may be impaired.
- Always use dry cloth to clean the device. Do not use ethyl alcohol or any other volatile liquid to clean the device.
- Do not permit any blockage of the ventilation holes of the device.

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**
	  • 0 °C to 55 °C
	• **Storage condition**
	  • –40 °C to 70 °C

Humidity	• **Operating condition**
	  • Up to 80% RH at 40 °C (non-condensing)
	• **Storage condition**
	  • Up to 95% RH at 40 °C (non-condensing)

Altitude	Up to 2000 m
Pollution degree	2

NOTE

The U3606B complies with the following safety and EMC compliances:

Safety compliance

- IEC 61010-1:2001/EN 61010-1:2001 (2nd Edition)
- Canada: CAN/CSA-C22.2 No. 61010-1-04
- USA: ANSI/UL 61010-1:2004

EMC compliance

- IEC 61326-1:2005/EN61326-1:2006
- CISPR11:2003/EN55011:2007, Group 1 Class A
- Canada: ICES/NMB-001:Issue 4, June 2006
- Australia/New Zealand: AS/NZS CISPR 11:2004

Regulatory Markings

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 US	The CSA mark is a registered trademark of the Canadian Standards Association.	40	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.

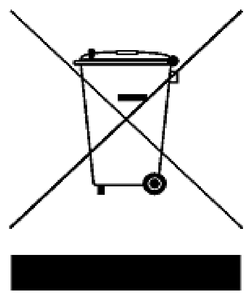
Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

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 website. You can search the DoC by its product model or description at the web address below.

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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List of Tables

1
Calibration Procedures

This chapter helps you to verify the instrument performance and to make adjustments where necessary.

Calibration Overview

This manual contains procedures to verify the performance of the U3606B and to perform adjustments (calibration) where necessary.

- The performance verification tests 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 25 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, after a Factory Reset (`*RST` command), or after an Instrument Preset (`SYSTem:PRESet` command).

Agilent calibration services

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

Calibration interval

The multimeter should be calibrated on a regular interval determined by the measurement accuracy requirements of your application.

A 1-year interval is recommended for the most demanding applications, while a 2-year interval may be adequate for less demanding applications. Agilent 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. Agilent 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 for the next calibration interval.

This criterion for the re-adjustment provides the best long-term stability. Performance data are measured during the "Calibration Security" 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 101 and verify that all the adjustments have been performed.

Time required for calibration

The instrument can be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests once the instrument is warmed-up (see "Test Considerations" on page 25).

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.

Table 1-1 Recommended test equipment

Application	Recommended equipment		Recommended accuracy requirements
Zero offset and gain verification procedures			
Zero calibration	Shorting plug — a dual banana plug with a copper wire shorting the two input terminals		2-wire and 4-wire short using ONLY copper interconnections
DC voltage	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
DC current	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
AC voltage	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
AC current	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
2-wire and 4-wire resistance	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
Frequency voltage and current	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
Capacitance	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
Diode	Calibrator	Fluke 5520A	<20% of instrument 1-year specification
Output verification procedures			
Constant voltage programming and readback	Digital multimeter	Agilent 3458A	8½ digit resolution
Constant voltage load effect (load regulation)	Digital multimeter	Agilent 3458A	8½ digit resolution
	Electronic load	Agilent 6060B	• Voltage range: 30 Vdc • Current range: 5 A • Open and short switches

Table 1-1 Recommended test equipment (continued)

Application	Recommended equipment		Recommended accuracy requirements
Constant voltage source effect (line regulation)	Digital multimeter	Agilent 3458A	8½ digit resolution
	Electronic load	Agilent 6060B	• Voltage range: 30 Vdc • Current range: 5 A • Open and short switches
	AC voltage source	Agilent 6813B	Capable of supplying 90 Vac to 250 Vac
Constant voltage peak to peak noise	Oscilloscope	Agilent DSO8064A or Infiniium equivalent	• Sensitivity: 1 mV • Bandwidth limit: 20 MHz • Probe: 1:1 with RF tip; 10:1 with RF tip for >50 V
	Fixed resistor	-	30 Ω (30 W), 2.67 Ω (24 W), 300 Ω (3 W), and 0.33 Ω (3 W)
	Differential amplifier	LeCroy DA1855A	• Bandwidth >20 MHz • AC coupling • Amplifier × 10
	50 Ω feed-thru termination	Pomona 4119-50	-
Constant voltage RMS noise	RMS voltmeter	R&S URE3 or equivalent	20 Hz to 20 MHz
	Differential amplifier	LeCroy DA1855A	• Bandwidth >20 MHz • AC coupling • Amplifier × 10
	50 Ω feed-thru termination	Pomona 4119-50	-
	Fixed resistor	-	30 Ω (30 W), 2.67 Ω (24 W), 300 Ω (3 W), and 0.33 Ω (3 W)
Load transient response time	Oscilloscope	Agilent DSO8064A or Infiniium equivalent	• Sensitivity: 1 mV • Bandwidth limit: 20 MHz • Probe: 1:1 with RF tip; 10:1 with RF tip for >50 V
	Electronic load	Agilent 6060B	• Voltage range: 30 Vdc • Current range: 5 A • Open and short switches

Table 1-1 Recommended test equipment (continued)

Application	Recommended equipment		Recommended accuracy requirements
Constant current programming and readback	Digital multimeter	Agilent 3458A	8½ digit resolution
	Current monitoring resistor (shunt)	ISOTEK Co. model A-H	• 0.01 Ω ± 0.1% • TCR less than 20 ppm/°C
Constant current load effect (load regulation)	Digital multimeter	Agilent 3458A	8½ digit resolution
	Electronic load	Agilent 6060B	• Voltage range: 30 Vdc • Current range: 5 A • Open and short switches
	Current monitoring resistor (shunt)	ISOTEK Co. model A-H	• 0.01 Ω ± 0.1% • TCR less than 20 ppm/°C
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	Current monitoring resistor (shunt)	ISOTEK Co. model A-H	• 0.01 Ω ± 0.1% • TCR less than 20 ppm/°C
	Electronic load	Agilent 6060B	• Voltage range: 30 Vdc • Current range: 5 A • Open and short switches
	AC voltage source	Agilent 6813B	Capable of supplying 90 Vac to 250 Vac
Constant current noise effect (RMS noise)	RMS voltmeter	R&S URE3 or equivalent	20 Hz to 20 MHz
	Electronic load	Agilent 6060B	• Voltage range: 30 Vdc • Current range: 5 A • Open and short switches
	Differential amplifier	LeCroy DA1855A	• Bandwidth >20 MHz • AC coupling • Amplifier × 10
	50 Ω feed-thru termination	Pomona 4119-50	-
	AC/DC current converter	Tektronix TCP305 and Tektronix TCPA300	-

General measurement techniques

A measurement made across the load includes the impedance of the leads to the load. The impedance of the load leads can easily be several orders of magnitude greater than the instrument impedance and thus invalidate the measurement. To avoid mutual coupling effects, each measuring device must be connected directly to the output terminals by using a separate pair of leads.

Using an electronic load

Many of the output test verification procedures require the use of a variable load resistor capable of dissipating the required power. Using a variable load resistor requires that switches should be used to connect, disconnect, and short the load resistor. An electronic load however, if available, can be used in place of a variable load resistor. The electronic load is considerably easier to use than load resistors. It eliminates the need for connecting resistors or rheostats in parallel to handle power, it is much more stable than a carbon-pile load, and it simplifies the work of switching between load conditions as is required for the load regulation and load response tests. Substitution of the electronic load requires minor changes to the test procedures in this chapter.

Connecting the current monitoring resistor

To eliminate the output measurement errors caused by voltage drops in the leads and connections, connect the current monitoring resistor between the − output terminal and the load as a four terminal device. Connect the current monitoring leads inside the load-lead connections directly at the monitoring points on the resistor element.

Test Considerations

Errors may be induced by AC signals present on the input leads during a self-test. Long test leads can also act as an antenna, causing the pick-up of AC signals.

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 (T_{cal}) is stable and is between 18 °C and 28 °C. Ideally the calibration should be performed at 23 °C ± 2 °C.
- Ensure that the ambient relative humidity is less than 80%.
- Allow a 60-minute[1] warm-up period with a shorting plug connected to the **V** (red) and **LO** (black) input terminals.
- Use a shielded twisted pair of PTFE-insulated cables to reduce settling and noise errors. Keep the input cables as short as possible.
- Connect the input cable shields to earth ground. Except where noted in the procedures, connect the calibrator **LO** source to earth ground at the calibrator. It is important that the **LO** to earth ground connection be made at only one place in the circuit to avoid ground loops.
- Because the instrument is capable of making highly accurate measurements, you must take special care to ensure that the calibration standards and test procedures used do not introduce additional errors.

[1] A 120-minute warm-up period is required for instrument adjustments (calibration).

- Ideally, the standards used to verify and adjust the instrument should be an order of magnitude more accurate than each instrument range of full scale error specification.
- For the DC voltage, DC current, and resistance gain verification measurements, you should take careful measures to ensure that the calibrator “0” output is correct. You will need to set the offset for each range of the measuring function being verified.

Input and Output Connections

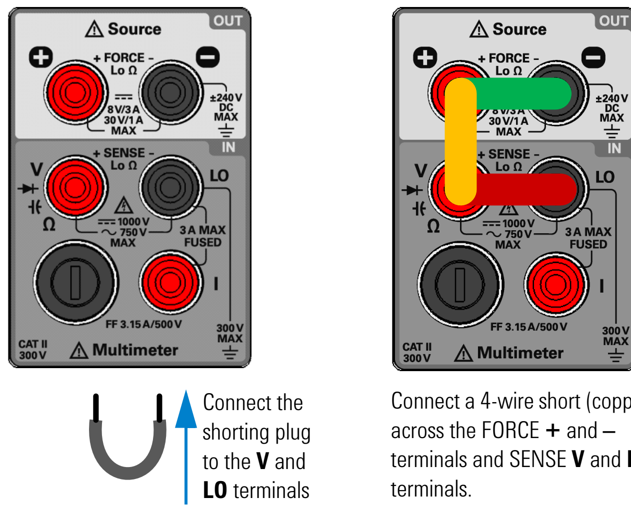
Test connections to the instrument are best accomplished by using a dual banana plug with a copper wire short between the two terminals for low-thermal offset measurement. Shielded, twisted-pair PTFE interconnecting cables of minimum length are recommended between the calibrator and the U3606B. Cable shields should be earth ground referenced. This configuration is recommended for optimal noises and settling time performance during calibration.

Zero Offset (Short) Verification Test Setup

Figure 1-1 Test setup for zero offset (short) verification

For DC voltage, DC current[1], 2-wire resistance, and capacitance

For 4-wire resistance



Connect the shorting plug to the **V** and **LO** terminals

Connect a 4-wire short (copper) across the FORCE **+** and – terminals and SENSE **V** and **LO** terminals.

[1] Open, by removing the shorting plug.

Gain Verification Test Setup

Figure 1-2 Test setup for DC voltage and AC voltage gain verification

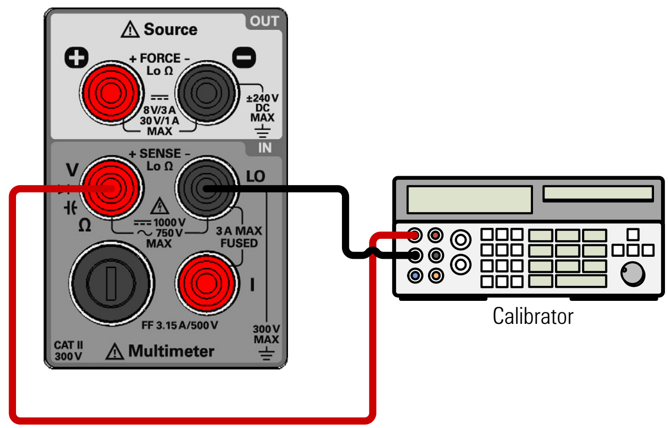
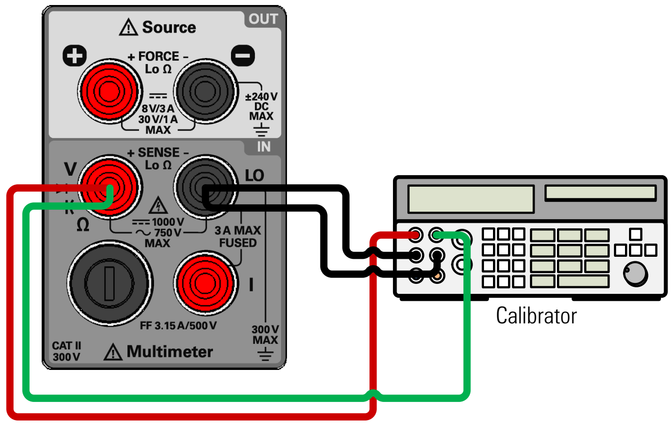


Figure 1-3 Test setup for capacitance gain verification

For test values ≥ 110 nF (2-wire compensation enabled)



For test values < 110 nF (compensation disabled)

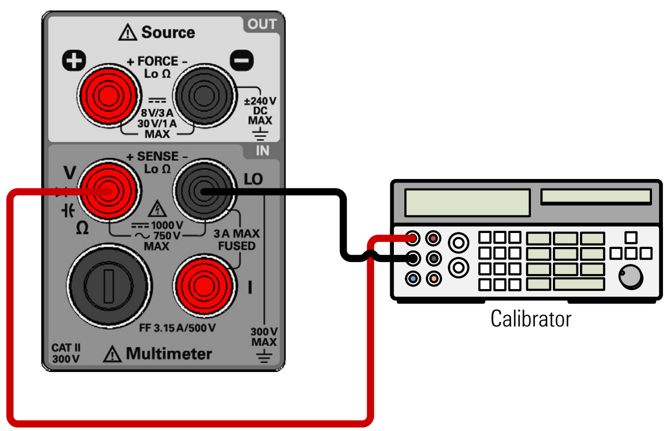
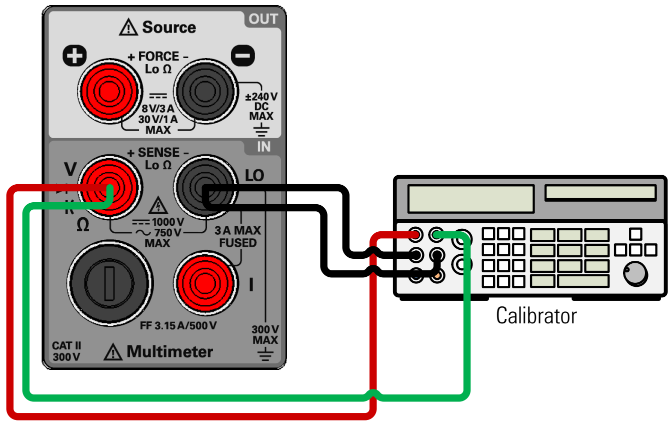


Figure 1-4 Test setup for 2-wire resistance gain verification

For test values < 110 kΩ (2-wire compensation enabled)



For test values ≥ 110 kΩ (compensation disabled)

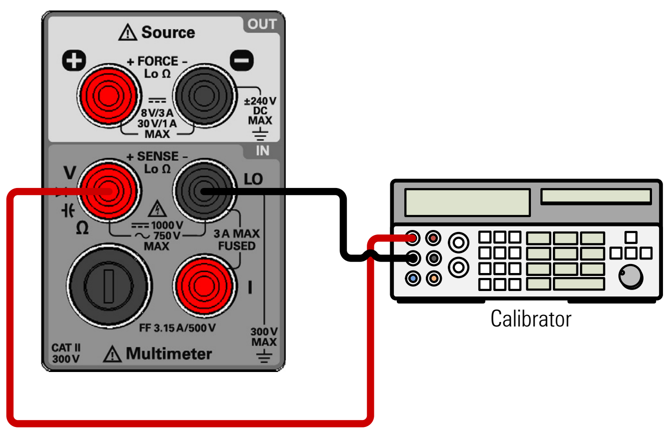


Figure 1-5 Test setup for 4-wire resistance gain verification

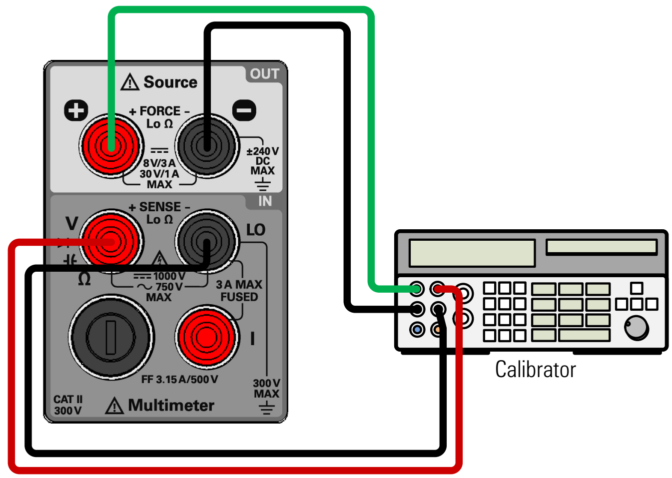


Figure 1-6 Test setup for DC current and AC current gain verification

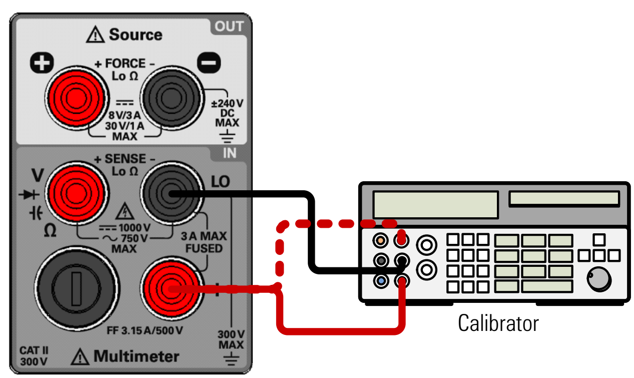


Figure 1-7 Test setup for frequency voltage gain verification

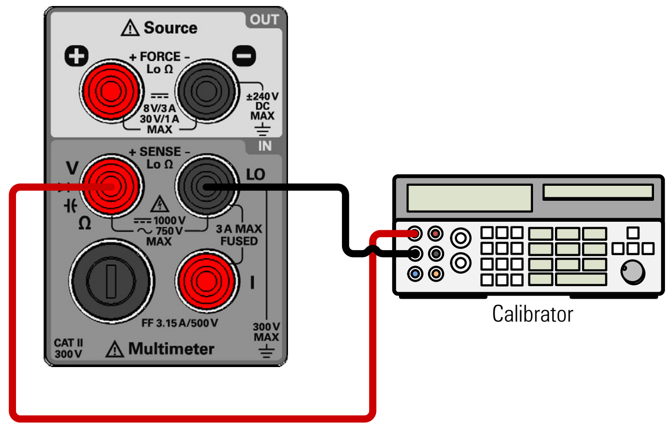


Figure 1-8 Test setup for frequency current gain verification

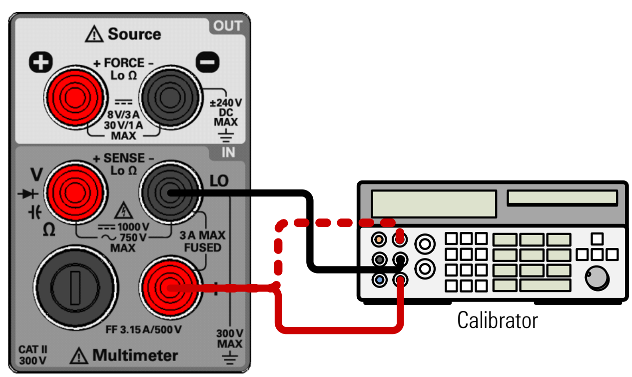
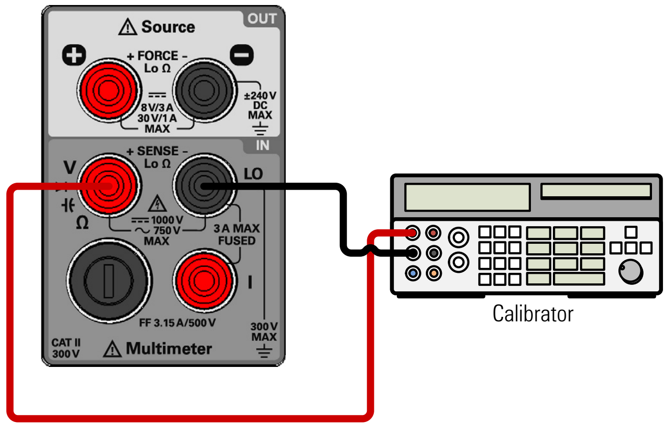


Figure 1-9 Test setup for diode voltage gain verification



Output Verification Test Setup

Figure 1-10 Test setup for constant voltage programming and readback accuracy verification

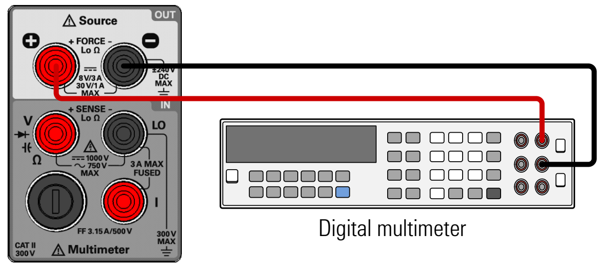


Figure 1-11 Test setup for constant voltage load and line regulation verification

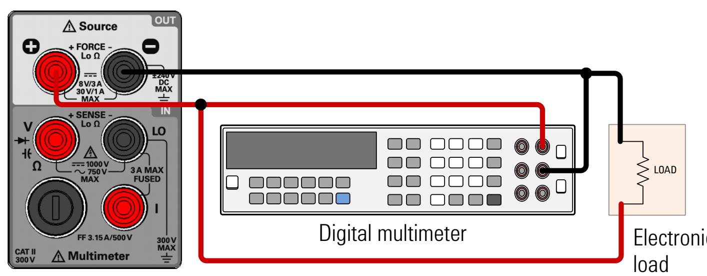


Figure 1-12 Test setup for constant voltage noise effect (peak-to-peak and RMS noise) verification

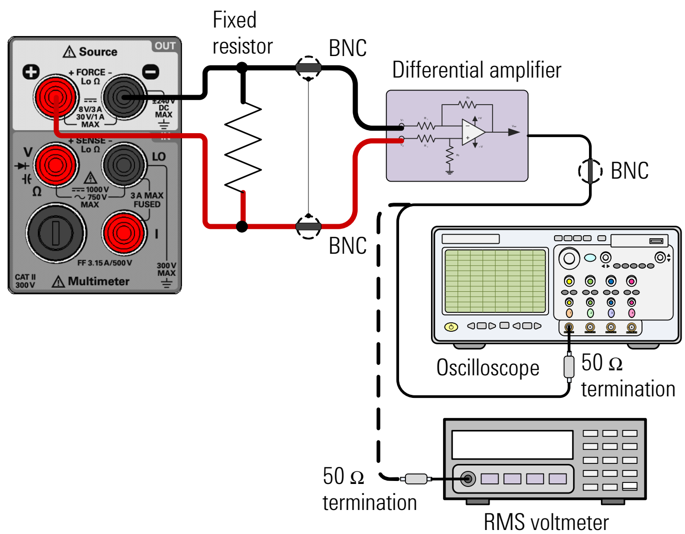


Figure 1-13 Test setup for load transient response time verification

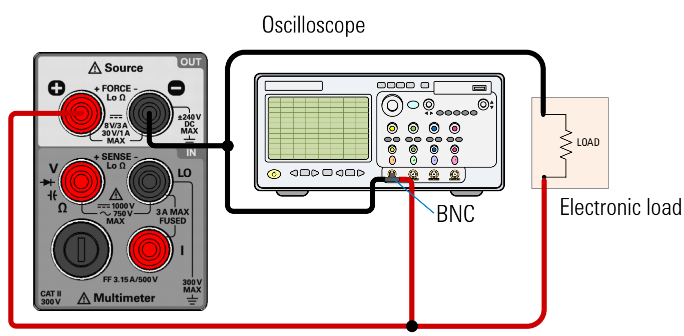


Figure 1-14 Test setup for constant current programming and readback accuracy verification

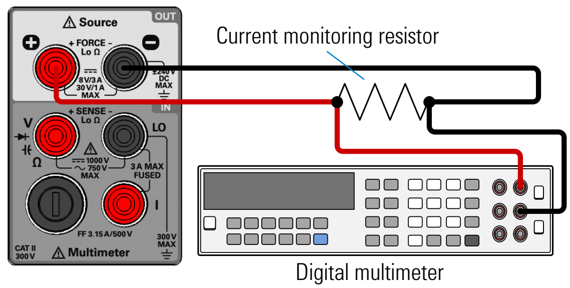


Figure 1-15 Test setup for constant current load and line regulation verification

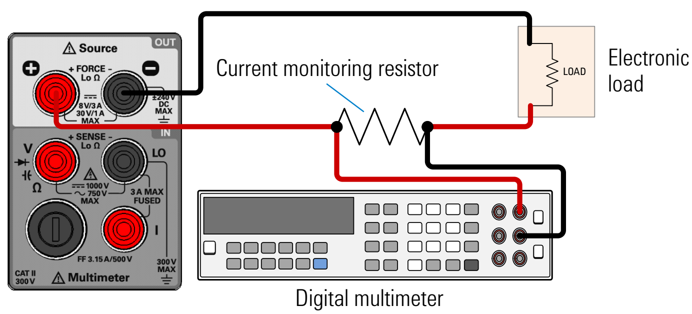
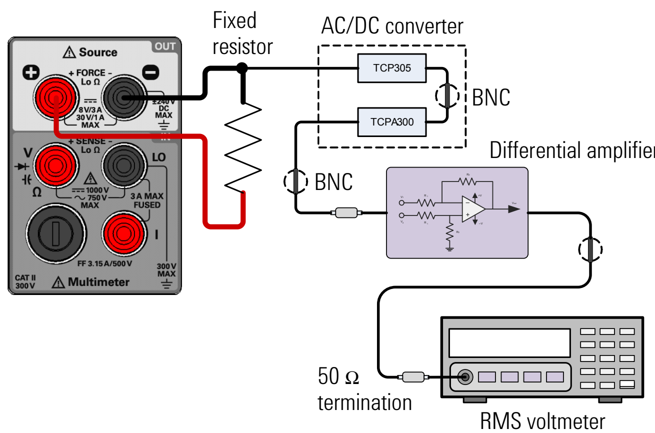


Figure 1-16 Test setup for constant current RMS noise effect verification



Performance Verification Tests Overview

Use the verification and performance tests to verify the measurement performance of the instrument. The verification and performance tests use the specifications of the instrument listed in *Chapter 5 of the U3606B User's Guide, "Characteristics and Specifications," starting on page 155*.

You can perform three different levels of verification and performance tests:

Self-tests A series of internal verification tests, which gives a high confidence that the instrument is operational.

Performance verification tests An extensive set of tests that are recommended as an acceptance test when you first receive the instrument or after performing adjustments.

Additional verification tests Tests that are not performed with every calibration. Perform these tests to verify additional specifications or functions of the instrument.

Self-Tests

A brief power-on self-test occurs automatically whenever you turn on the instrument. This limited test assures that the instrument is capable of operation. During the self-test, all display segments and annunciators are turned on before **doinG** and **SELF.t** is shown on the primary and upper secondary displays respectively.

If the self-test fails, the **Error** annunciator is turned on.

Read the errors using the utility menu (see *Chapter 4 of the U3606B User's Guide, "Reading error messages," starting on page 129*), or use the `SYSTem:ERRor?` query from the remote interface (see the *U3606B Programmer's Reference*).

A list of the possible self-test errors is given in *Chapter 6 of the U3606B User's Guide, "List of Error Messages," starting on page 181*. If repair is required, contact the nearest Agilent Service Center.

You can initiate a more complete self-test from the utility menu (see *Chapter 4 of the U3606B User's Guide, "Performing a self-test," starting on page 142*), or by sending the `*TST?` command to the instrument from a remote interface.

The command may take up to 30 seconds to complete. You may need to set an appropriate remote interface SCPI query time-out value.

NOTE

- The instrument returns to normal operation if all self-tests pass. The **Error** annunciator is turned on if a failure occurs.
- The `*TST?` command returns a `+0` if all self-tests pass or a `+1` if a failure occurred.

Performance Verification Tests

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, adjustment or repair is required.

Adjustment is recommended at every calibration interval. If adjustment is not made, you must establish a *guard band*, using no more than 80% of the specifications, as the verification limits.

Zero offset verification test

This test is used to check the zero offset performance of the instrument. Verification checks are only performed for those functions and ranges with unique offset calibration constants. Measurements are checked for each function and range as described in the procedure on the next page.

Zero offset verification procedure

1 Connect the shorting plug (low-thermal EMF double banana short bar) to the **V** (red) and **LO** input terminals (see Figure 1-1, “Test setup for zero offset (short) verification,” on page 27). Leave the current input open.
2 Select each function and range in the order shown in Table 1-2. (Remember to remove the shorting plug for zero offset capacitance and DC current verification.) Make a measurement and observe the result.
3 Compare the measurement results to the appropriate test limits in Table 1-2.

NOTE

The resistance measurements uses the Null math function (the null reading is taken with the test leads connected together) to eliminate the test lead resistance. See *Chapter 2 of the U3606B User's Guide, "Null," starting on page 63* for more information on the Null math function.

Table 1-2 Zero offset verification test

Input	Function	Range	Error from nominal 1-year
Short	DC voltage	19.9999 mV	±0.008 mV
		100.000 mV	±0.008 mV
		1.00000 V	±0.00005 V
		10.0000 V	±0.0005 V
		100.000 V	±0.005 V
		1000.00 V	±0.05 V
	2-wire resistance	100 Ω	±0.008 Ω
		1000 Ω	±0.05 Ω
		10 kΩ	±0.0005 kΩ
		100 kΩ	±0.005 kΩ
		1 MΩ	±0.00005 MΩ
		10 MΩ	±0.0005 MΩ
		100 MΩ	±0.005 MΩ
	4-wire resistance	0.1 Ω	±0.00005 Ω
		1 Ω	±0.0003 Ω
		10 Ω	±0.003 Ω
		100 Ω	±0.03 Ω
		1000 Ω	±0.3 Ω

CAUTION Zero offset calibration using a multifunction calibrator is NOT recommended. The calibrator and cabling offset can be large and unstable causing poor offset calibration of the Agilent U3606B or any multimeter.

Table 1-2 Zero offset verification test (continued)

Input	Function	Range	Error from nominal 1-year
Open	Capacitance	1 nF	±0.008 nF
		10 nF	±0.05 nF
		100 nF	±0.5 nF
		1 µF	±5 nF
		10 µF	±0.05 µF
		100 µF	±0.5 µF
		1000 µF	±5 µF
		10000 µF	±50 µF
	DC current	10 mA	±0.0015 mA
		100 mA	±0.005 mA
		1 A	±0.00007 A
		3 A	±0.00021 A

Gain verification test

This test checks the full-scale reading accuracy of the instrument. Verification checks are performed only for those functions and ranges with unique gain calibration constants.

DC voltage gain verification test

1 Connect the calibrator to the front panel **V** (red) and **LO** (black) input terminals (see Figure 1-2, “Test setup for DC voltage and AC voltage gain verification,” on page 28).

2 Press [≂V] to select the DC voltage function. The DC annunciator will turn on according to your selection.

3 Select each range in the order shown below. Provide the indicated input voltage. Compare the measurement results to the appropriate test limits in Table 1-3. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-3 DC voltage gain verification test

Input voltage	Range	Error from nominal 1-year
19.0000 mV	19.9999 mV	±0.0127 mV
100.000 mV	100.000 mV	±0.033 mV
1.00000 V	1.00000 V	±0.0003 V
10.0000 V	10.0000 V	±0.003 V
100.000 V	100.000 V	±0.03 V
1000.00 V	1000.00 V	±0.3 V

CAUTION Set the calibrator output to 0 V before disconnecting from the instrument input terminals.

DC current gain verification test

1 Connect the calibrator to the front panel **I** (red) and **LO** (black) input terminals (see Figure 1-6, “Test setup for DC current and AC current gain verification,” on page 31).

2 Press [≂I] to select the DC current function. The DC annunciator will turn on according to your selection.

3 Select each range in the order shown below. Provide the indicated input current. Compare the measurement results to the appropriate test limits in Table 1-4. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-4 DC current gain verification test

Input current	Range	Error from nominal 1-year
10 mA	10 mA	±0.0065 mA
100 mA	100 mA	±0.055 mA
1 A	1 A	±0.00157 A
2.9 A	3 A	±0.00456 A

AC voltage verification test

1 Connect the calibrator to the front panel **V** (red) and **LO** (black) input terminals (see Figure 1-2, “Test setup for DC voltage and AC voltage gain verification,” on page 28).

2 Press **[≂V]** to select the AC voltage function. The AC annunciator will turn on according to your selection.

3 Select each range in the order shown below. Provide the indicated input voltage and frequency. Compare the measurement results to the appropriate test limits in Table 1-5. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-5 AC voltage gain verification test

Input voltage	Input frequency	Range	Error from nominal 1-year
10 mV	1 kHz	100 mV	±0.12 mV
100 mV	1 kHz	100 mV	±0.3 mV
0.1 V	1 kHz	1 V	±0.0012 V
1 V	1 kHz	1 V	±0.003 V
1 V	1 kHz	10 V	±0.012 V
10 V	1 kHz	10 V	±0.03 V
10 V	1 kHz	100 V	±0.12 V
100 V	1 kHz	100 V	±0.3 V
100 V	1 kHz	750 V	±0.95 V
750 V	1 kHz	750 V	±2.25 V

CAUTION Set the calibrator output to 0 V before disconnecting from the instrument input terminals.

AC current verification test

1. Connect the calibrator to the front panel **I** (red) and **LO** (black) input terminals (see Figure 1-6, “Test setup for DC current and AC current gain verification,” on page 31).
2. Press [≂I] to select the AC current function. The AC annunciator will turn on according to your selection.
3. Select each range in the order shown below. Provide the indicated input current and frequency. Compare the measurement results to the appropriate test limits in Table 1-6. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-6 AC current gain verification test

Input current	Input frequency	Range	Error from nominal 1-year
1 mA	1 kHz	10 mA	±0.015 mA
10 mA	1 kHz	10 mA	±0.06 mA
10 mA	1 kHz	100 mA	±0.15 mA
100 mA	1 kHz	100 mA	±0.6 mA
0.1 A	1 kHz	1 A	±0.0015 A
1 A	1 kHz	1 A	±0.006 A
1 A	1 kHz	3 A	±0.008 A
3 A	1 kHz	3 A	±0.018 A

2-wire resistance gain verification test

1 Connect the calibrator to the front panel **Ω** (red) and **LO** (black) input terminals (see Figure 1-4, “Test setup for 2-wire resistance gain verification,” on page 30).

2 Press **[Ω •))]** to select the resistance function.

3 Select each range in the order shown below. Provide the indicated input resistance. Compare the measurement results to the appropriate test limits in Table 1-7. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-7 2-wire resistance gain verification test

Input resistance	Range	Error from nominal 1-year
100 Ω	100 Ω	±0.058 Ω[1]
1 kΩ	1 kΩ	±0.00055 kΩ[1]
10 kΩ	10 kΩ	±0.0055 kΩ[1]
100 kΩ	100 kΩ	±0.055 kΩ

Table 1-7 2-wire resistance gain verification test (continued)

Input resistance	Range	Error from nominal 1-year
1 MΩ	1 MΩ	±0.00065 MΩ
10 MΩ	10 MΩ	±0.0255 MΩ
100 MΩ	100 MΩ	±2.005 MΩ

[1] Specifications stated are for 2-wire resistance measurements using the Null math operation. Without null, add an additional error of 0.2 Ω.

4-wire resistance gain verification test

1 Connect the calibrator to the front panel Ω (red) and **LO** (black) input terminals and ⊕ (red) and ⊖ (black) output terminals (see Figure 1-5, “Test setup for 4-wire resistance gain verification,” on page 31).

2 Press **[Ω •))]** to select the resistance function.

3 Select each range in the order shown below. Provide the indicated input resistance. Compare the measurement results to the appropriate test limits in Table 1-8. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

NOTE For the 1 Ω and 10 Ω range, please perform calibrator zeroing before testing the resistance values of the device-under-test (DUT) to ensure that the 5520A is maintained with a zero cal. every 12 hours ± 1°C

Table 1-8 4-wire resistance gain verification test

Input resistance	Range	Error from nominal 1-year
1 Ω[1]	1 Ω	±0.0028 Ω
10 Ω[1]	10 Ω	±0.012 Ω

Table 1-8 4-wire resistance gain verification test (continued)

Input resistance	Range	Error from nominal 1-year
100 Ω	100 Ω	±0.12 Ω
1000 Ω	1000 Ω	±1.2 Ω

[1] Calibrator ohms zero cal. every 12 hours ± 1°C

Frequency voltage gain verification test

1 Connect the calibrator to the front panel **V** (red) and **LO** (black) input terminals (see Figure 1-7, "Test setup for frequency voltage gain verification," on page 32).

2 Press **[Hz ms %]** to select the frequency function.

3 Select each range in the order shown below. Provide the indicated input frequency and voltage. Compare the measurement results to the appropriate test limits in Table 1-9. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-9 Frequency voltage gain verification test

Input frequency	Input voltage	Range	Error from nominal 1-year
1 kHz	1 V	1.999 kHz	±0.00026 kHz

Frequency current gain verification test

1 Connect the calibrator to the front panel **I** (red) and **LO** (black) input terminals (see Figure 1-8, "Test setup for frequency current gain verification," on page 32).

2 Press **[Hz ms %]** to select the frequency function.

3 Select each range in the order shown below. Provide the indicated input frequency and current. Compare the measurement results to the appropriate test limits in Table 1-10. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-10 Frequency current gain verification test

Input frequency	Input current	Range	Error from nominal 1-year
1 kHz	0.1 A	1.999 kHz	±0.00026 kHz

Diode voltage gain verification test

1. Connect the calibrator to the front panel ⏩ (red) and **LO** (black) input terminals (see Figure 1-9, “Test setup for diode voltage gain verification,” on page 33).
2. Press **[⏩ ⊣⊢]** to select the diode function. The diode annunciator will turn on according to your selection.
3. Select the range shown below. Provide the indicated input voltage. Compare the measurement results to the appropriate test limits in Table 1-11. (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 1-11 Diode voltage gain verification test

Input voltage	Range	Error from nominal 1-year
1.0000 V	1.0000 V	±0.00055 V

Output verification test

This test verifies that the output functions (constant voltage and constant current) are within specifications. Note that the measurement values over the remote interface should be identical to those displayed on the front panel.

NOTE

You should consider programming the U3606B over the remote interface for this test to avoid round off errors. See the *U3606B Programmer's Reference* for more information on remote interface programming.

CV programming and readback accuracy

This test verifies that the constant voltage programming and readback accuracy are within published specifications.

1 Turn off the instrument and connect a digital multimeter between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-10, "Test setup for constant voltage programming and readback accuracy verification," on page 34).
2 Turn on the instrument. Press **[Voltage]** to select the constant voltage mode.
3 Output each value in the order shown below. Ensure that the appropriate range is selected.

   Record the output voltage reading on the digital multimeter. Compare the measurement results to the appropriate test limits in Table 1-12.

Table 1-12 Constant voltage programming and readback accuracy verification test

Output voltage	Range (parameter)	Error from nominal 1-year
0 V	S1 (30 V)	±0.005 V
30 V		±0.02 V

Table 1-12 Constant voltage programming and readback accuracy verification test (continued)

Output voltage	Range (parameter)	Error from nominal 1-year
0 V	S2 (8 V)	±0.005 V
8 V		±0.009 V
0 V	S2m (1000 mV)	±0.001 V
1000 mV		±0.0005 V

CV load effect (load regulation)

This test measures the change in the output voltage resulting from a change in the output current from full load to no load or vice versa.

1 Turn off the instrument and connect a digital multimeter between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-11, “Test setup for constant voltage load and line regulation verification,” on page 34).
2 Turn on the instrument. Press **[Voltage]** to select the constant voltage mode.
3 Set the output voltage to the full rated value (30 V for S1 range, 8 V for S2 range, or 1 V for S2m range) and current to full scale. Ensure that the appropriate range is selected.
4 Connect an additional electronic load across the front panel ⊕ (red) and ⊖ (black) output terminals in parallel with a digital multimeter.
5 Operate the electronic load in constant current (CC) mode, and set its current (1 A for S1, 3 A for S2, or 3 A for S2m).

   Ensure that the U3606B is operating within the specified limit and protection values. If not, adjust the electronic load by increasing the resistance so that the current drops slightly until the U3606B is operating in the constant voltage mode.

6 Output the full rated value in the order shown below. Record the output voltage reading on the digital multimeter.

7 Within a few seconds after step 6, operate the electronic load in open mode. Record the output voltage reading on the digital multimeter.

8 Compare the difference between the measurement results to the appropriate test limits in Table 1-13.

9 Repeat step 3 to step 8 for the S2 (8 V/3 A) and the S2m (1000 mV/3 A) ranges.

Table 1-13 Constant voltage load effect (load regulation) verification test

Output voltage	Range (parameter)	Error from nominal 1-year
30 V	S1 (30 V)	±0.009 V
8 V	S2 (8 V)	±0.021 V
1 V	S2m (1000 mV)	±0.0183 V

CV source effect (line regulation)

This test measures the change in output voltage that results from a change in AC line voltage from the minimum value to the maximum value.

1 Turn off the instrument and connect a digital multimeter between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-11, “Test setup for constant voltage load and line regulation verification,” on page 34).

2 Connect the AC power line through an AC voltage source. Adjust the AC voltage source to provide nominal input voltage to the instrument.

3 Turn on the instrument. Press **[Voltage]** to select the constant voltage mode. Ensure that the appropriate range is selected.

4 Set the output voltage to the full rated value (30 V for S1 range, 8 V for S2 range, or 1 V for S2m range) and the current to full scale. Enable the output.

5 Connect an additional electronic load across the front panel ⊕ (red) and ⊖ (black) output terminals in parallel with a digital multimeter.

6 Operate the electronic load in constant current (CC) mode, and set its current (1 A for S1, 3 A for S2, or 3 A for S2m).

Ensure that the U3606B is operating within the specified limit and protection values. If not, adjust the electronic load by increasing the resistance so that the current drops slightly until the U3606B is operating in the constant voltage mode.

7 Adjust the AC voltage source to the low line voltage limit. Record the output voltage reading on the digital multimeter.

8 Within a few seconds after step 7, adjust the AC voltage source to the high line voltage limit. Record the output voltage reading on the digital multimeter.

9 Compare the difference between the measurement results to the appropriate test limits shown in Table 1-14.

10 Repeat step 3 to step 9 for the S2 (8 V/3 A) and S2m (1000 mV/3 A) ranges.

Table 1-14 Constant voltage source effect (line regulation) verification test

Input AC line	Low line voltage limit	High line voltage limit	Range (parameter)	Error from nominal 1-year
100 V_{ac}	90 V_{ac}	110 V_{ac}	S1 (30 V)	±0.003 V
			S2 (8 V)	±0.003 V
			S2m (1000 mV)	±0.0003 V
115 V_{ac}	104 V_{ac}	127 V_{ac}	S1 (30 V)	±0.003 V
			S2 (8 V)	±0.003 V
			S2m (1000 mV)	±0.0003 V

Table 1-14 Constant voltage source effect (line regulation) verification test (continued)

Input AC line	Low line voltage limit	High line voltage limit	Range (parameter)	Error from nominal 1-year
230 V_{ac}	207 V_{ac}	253 V_{ac}	S1 (30 V)	±0.003 V
			S2 (8 V)	±0.003 V
			S2m (1000 mV)	±0.0003 V

CV noise effect (peak-to-peak or RMS noise)

This test measures the peak-to-peak or RMS output voltage in the frequency range from 20 Hz to 20 MHz.

1. Turn off the instrument and connect a differential amplifier and a fixed resistor (30 Ω for S1 range, 2.67 Ω for S2 range, or 0.33 Ω for S2m range) between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-12, “Test setup for constant voltage noise effect (peak-to-peak and RMS noise) verification,” on page 35).
2. Connect a 50 Ω feed-thru termination to the differential amplifier output and an oscilloscope to the 50 Ω feed-thru termination.
3. Turn on the instrument. Press **[Voltage]** to select the constant voltage mode. Ensure that appropriate range is selected.
4. Set the output voltage to the full rated value (30 V for S1 range, 8 V for S2 range, or 1 V for S2m range) and current to full scale. Enable the output.

5 Configure the differential amplifier as follows:
   i Set to the AC mode (positive and negative) to remove the DC component.
   ii Set to the differential mode.
   iii Set the gain to ×10.
   iv Set the attenuation to 1.
   v Set the low-pass filter to 20 MHz bandwidth limit to filter out input signals containing higher frequencies.
   vi Set to the zero precision voltage generator.
   vii Set the input impedance to 1 MΩ .
6 Configure the oscilloscope as follows:
   i Set the time/div range to 5 ms/div.
   ii Set the oscilloscope to acquire every single sample at the maximum sampling rate but retain only the minimum and maximum values in a sampling region.
   iii Set a 20 MHz cut-off frequency for better high frequency cut-off.
   iv Enable AC coupling.
   v Enable auto-triggering.
7 Allow the oscilloscope to run for a few seconds to generate enough measurement points.
8 Obtain the maximum peak-to-peak voltage measurement as indicated in the oscilloscope. Divide the value by 10 to get the constant voltage peak-to-peak noise measurement. The result should not exceed 0.03 V_{pp} as shown in Table 1-15.

Table 1-15 Constant voltage peak -to-peak noise verification test

Output voltage	Range (parameter)	Error from nominal 1-year
30 V with 30 Ω	S1 (30 V)	±0.03 V_{pp}
8 V with 2.67 Ω	S2 (8 V)	±0.03 V_{pp}
1 V with 0.33 Ω	S2m (1000 mV)	±0.03 V_{pp}

9 Disconnect the oscilloscope and connect an RMS voltmeter in its place. Do not disconnect the 50 Ω feed-thru termination.

10 Configure the RMS voltmeter as follows:

   i Set the high-pass filter to 10 Hz.

   ii Enable AC coupling.

11 Obtain the maximum RMS voltage measurement as indicated in the RMS voltmeter. Divide the value by 10 to get the constant voltage RMS noise measurement.

12 Repeat step 3 to step 11 for the S2 (8 V/3 A) and S2m (1000 mV /3 A) ranges. All the result should not exceed 0.002 V_{rms} as shown in Table 1-16.

Table 1-16 Constant voltage RMS noise verification test

Output voltage	Range (parameter)	Error from nominal 1-year
30 V with 30 Ω	S1 (30 V)	±0.002 V_{rms}
8 V with 2.67 Ω	S2 (8 V)	±0.002 V_{rms}
1 V with 0.33 Ω	S2m (1000 mV)	±0.002 V_{rms}

Load transient response time

This test measures the time for the output voltage to recover to within 15 mV of nominal output voltage following a load change from full load to half load or vice versa.

1 Turn off the instrument and connect an oscilloscope between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-13, “Test setup for load transient response time verification,” on page 35).

2 Turn on the instrument. Press **[Voltage]** to select the constant voltage mode. Ensure that appropriate range is selected.

3 Set the output voltage to the full rated value (30 V for S1 range, 8 V for S2 range, or 1 V for S2m range) and current to full scale.

4 Connect an additional electronic load across the front panel ⊕ (red) and ⊖ (black) output terminals in parallel with a oscilloscope. Operate the electronic load in the constant current (CC) mode.

5 Set the electronic load in transient operation mode between one half of the output full rated value and the output full rated value at a 1 kHz rate with 50% duty cycle.

6 Set the oscilloscope for AC coupling, internal synchronization, and lock on either the positive or negative load transient.

7 Adjust the oscilloscope to display transients as shown in Figure 1-17. Note that the pulse width (t_2 – t_1) of the transients at 15 mV from the base line should be no more than 100 µs for the output.

8 Repeat step 2 to step 7 for the S2 (8 V/3 A) and S2m (1000 mV/3 A) ranges. All the transient response time result should less than 100 µs for the output to recover to within 15 mV as shown in Table 1-17.

Table 1-17 Transient response time

Output voltage	Range (parameter)	Error from nominal 1-year
30 V	S1 (30 V)	<100 µs
8 V	S2 (8 V)	<100 µs
1 V	S2m (1000 mV)	<100 µs

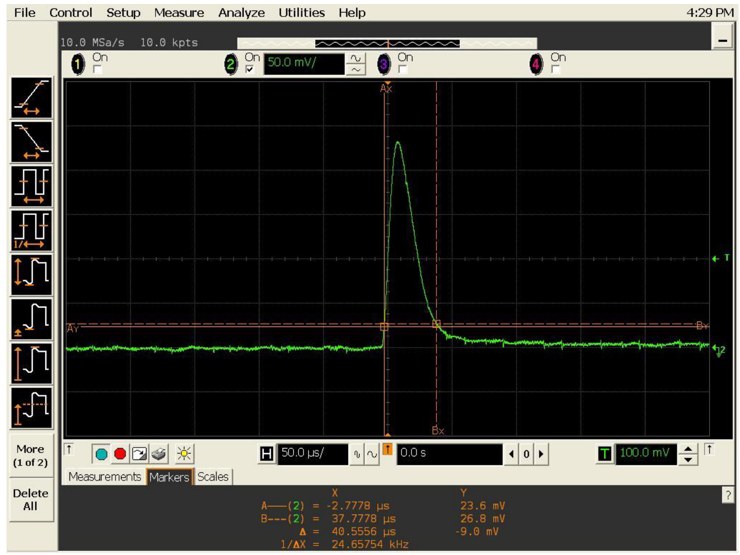


Figure 1-17 Graph of load transient response time for S1 range

CC programming and readback accuracy

This test verifies that the constant current programming and readback accuracy are within published specifications. The accuracy of the current monitoring resistor must be 0.1% or better.

1 Turn off the instrument and connect a 0.01 Ω current shunt monitoring resistor across the front panel ⊕ (red) and ⊖ (black) output terminals and a digital multimeter across the current shunt monitoring resistor (see Figure 1-14, “Test setup for constant current programming and readback accuracy verification,” on page 36).

2 Turn on the instrument. Press **[Current]** to select the constant current mode. Ensure that the appropriate range is selected.

3 Output each of the full rated value in the order shown below. Divide the voltage drop (reading on the digital multimeter) across the current monitoring resistor by its

resistance. Record and compare the measurement results to the appropriate test limits shown in Table 1-18.

4 Repeat step 2 and step 3 for the S2 (8 V/3 A) and S1m (100 mA/30 V) ranges.

Table 1-18 Constant current programming and readback accuracy verification test

Output current	Range (parameter)	Error from nominal 1-year
0 A	S1 (1 A)	±0.003 A
1 A		±0.0045 A
0 A	S2 (3 A)	±0.003 A
3 A		±0.0075 A
0 A	S1m (100 mA)	±0.00015 A
0.1 A		±0.0002 A

CC load effect (load regulation)

This test measures the change in the output current resulting from a change in the load from a full rated output voltage to a short circuit.

1 Turn off the instrument and connect a 0.01 Ω current shunt monitoring resistor and a digital multimeter across the current shunt monitoring resistor with an electronic load in series between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-15, “Test setup for constant current load and line regulation verification,” on page 36).

2 Turn on the instrument. Press **[Current]** to select the constant current mode. Ensure that the appropriate range is selected.

3 Set the output current to the full rated value (1 A for S1 range, 3 A for S2 range, or 0.1 A for S1m) and voltage to full scale.

4 Operate the electronic load in constant voltage (CV) mode, and set its voltage (30 V for S1 range or 8 V for S2 range).

Ensure that the U3606B is operating within the specified limit and protection values. If not, adjust the electronic load by reducing the resistance so that the voltage drops slightly until the U3606B is the constant current (CC) mode.

For the S1m range, operate the electronic load in constant resistance mode, and set its resistance to 300 Ω. Ensure that the U3606B is operating within the specified limit and protection values. If not, adjust the electronic load by reducing the resistance so that the voltage drops slightly until the U3606B is operating within the specified limit and protection values.

5 Output the full rated value in the order shown below. Divide the voltage drop (reading on the digital multimeter) across the current monitoring resistor by its resistance. Record the output current reading on the digital multimeter.

6 Within a few seconds after step 5, operate the electronic load in short mode. Record the output current reading on the digital multimeter.

7 Compare the difference between the measurement results to the appropriate test limits shown in Table 1-19.

8 Repeat step 2 to step 7 for the S2 (8 V/3 A) and S1m (100 mA /30 V) ranges.

Table 1-19 Constant current load regulation (load effect) verification test

Output current	Range (parameter)	Error from nominal 1-year
1 A	S1 (1 A)	±0.0006 A
3 A	S2 (3 A)	±0.0012 A
0.1 A	S1m (100 mA)	±0.00006 A

CC source effect (line regulation)

This test measures the change in output current that results from a change in the AC line voltage from the minimum value to the maximum value.

1 Turn off the instrument and connect a 0.01 Ω current shunt monitoring resistor and a digital multimeter across the current shunt monitoring resistor with an electronic load in series between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-15, “Test setup for constant current load and line regulation verification,” on page 36).
2 Connect the AC power line through an AC voltage source. Adjust the AC voltage source to provide nominal input voltage to the instrument.
3 Turn on the instrument. Press **[Current]** to select the constant current mode. Ensure that the appropriate range is selected.
4 Set the output current to the full rated value (1 A for S1 range, 3 A for S2 range, or 0.1 A for S1m range) and voltage to full scale. Enable the output.
5 Operate the electronic load in constant voltage (CV) mode, and set its voltage (30 V for S1 range or 8 V for S2 range).

   Ensure that the U3606B is operating within the specified limit and protection values. If not, adjust the electronic load by reducing the resistance so that the voltage drops slightly until the U3606B is the constant current (CC) mode.

   For the S1m range, operate the electronic load in constant resistance mode, and set its resistance to 300 Ω. Ensure that the U3606B is operating within the specified limit and protection values. If not, adjust the electronic load by reducing the resistance so that the voltage drops slightly until the U3606B is operating within the specified limit and protection values.
6 Adjust the AC voltage source to the low line voltage limit. Divide the voltage drop (reading on the digital multimeter) across the current monitoring resistor by its

resistance. Record the output current reading on the digital multimeter.

7 Within a few seconds after step 6, adjust the AC voltage source to the high line voltage limit. Record the output current reading on the digital multimeter.

8 Compare the difference between the measurement results to the appropriate test limits shown in Table 1-20.

9 Repeat step 3 to step 8 for the S2 (8 V/3 A) and S1m (100 mA/30 V) ranges.

Table 1-20 Constant current source effect (line regulation) verification test

Input AC line	Low line current limit	High line current limit	Range (parameter)	Error from nominal 1-year
100	90 V_{ac}	110 V_{ac}	S1 (1 A)	±0.0015 A
			S2 (3 A)	±0.0015 A
			S1m (100 mA)	±0.00015 A
115	104 V_{ac}	127 V_{ac}	S1 (1 A)	±0.0015 A
			S2 (3 A)	±0.0015 A
			S1m (100 mA)	±0.00015 A
230	207 V_{ac}	253 V_{ac}	S1 (1 A)	±0.0015 A
			S2 (3 A)	±0.0015 A
			S1m (100 mA)	±0.00015 A

CC noise effect

This test measures the RMS output current in the frequency range from 20 Hz to 20 MHz with the U3606B operating in the constant current (CC) mode.

1 Turn off the instrument and connect a fixed resistor (30 Ω for S1 range, 2.67 Ω for S2 range, or 300 Ω for S1m range) between the front panel ⊕ (red) and ⊖ (black) output terminals (see Figure 1-16, “Test setup for

constant current RMS noise effect verification,” on page 37).

2 Connect an AC/DC converter to the fixed resistor and a 50 Ω feed-thru termination to the AC/DC converter. Connect a differential amplifier to the 50 Ω feed-thru termination.

3 Connect another 50 Ω feed-thru termination to the differential amplifier output and an RMS voltmeter to the 50 Ω feed-thru termination.

4 Turn on the instrument. Press **[Current]** to select the constant current mode. Ensure that the appropriate range is selected.

5 Set the output current to the full rated value (1 A for S1 range, 3 A for S2 range, or 0.1 A for S1m range) and voltage to full scale. Enable the output.

6 Configure the differential amplifier as follows:

- **i** Set to the AC mode (positive and negative) to remove the DC component.
- **ii** Set to the differential mode.
- **iii** Set the gain to ×10.
- **iv** Set the attenuation to 1.
- **v** Set the low-pass filter to 20 MHz bandwidth limit to filter out input signals containing higher frequencies.
- **vi** Set to the zero precision current generator.
- **vii** Set the input impedance to 1 MΩ.

7 Configure the RMS voltmeter as follows:

- **i** Set the high-pass filter to 10 Hz.
- **ii** Enable AC coupling.

8 Obtain the maximum RMS current measurement as indicated in the RMS voltmeter. Divide the value by 10 and then multiply by 5 to get the constant current RMS noise measurement.

9 Repeat the step 4 to step 8 for the S2 (8 V/3 A) and S1m (100 mA/30 V) ranges. All the results should not exceed 0.001 A_{rms} as shown in Table 1-21.

Table 1-21 Constant current RMS noise verification test

Output current	Range (parameter)	Error from nominal 1-year
1 A with 30 Ω	S1 (1 A)	±0.001 A_{rms}
3 A with 2.67 Ω	S2 (3 A)	±0.001 A_{rms}
0.1 A with 300 Ω	S1m (100 mA)	±0.001 A_{rms}

Additional Verification Tests

Optional capacitance gain verification test

1 Connect the calibrator to the front panel ⊣⊢ (red) and **LO** (black) input terminals (see Figure 1-3, “Test setup for capacitance gain verification,” on page 29).

2 Press [⊣⊢] to select the capacitance function.

   i For ranges lower than 1.000 µF, please perform Null at the device-under-test (DUT) before recording the final measurement. This will compensate the capacitance errors present in the test leads and terminals of the Fluke 5520A calibrator.

   ii Output 190 pF (equivalent to 0.19 nF) from the Fluke 5520A Calibrator (**NORMAL HI+LO**) to the DUT terminals (**V+LO**). The lowest capacitance value that can be sourced from the Fluke 5520A calibrator is 190 pF.

   iii Select the desired range to perform measurement; as an example, for the 10.00 nF range, set measurements to continuous auto trigger, and then press **[Null]** to perform the Null offset.

   iv Press **[Null]** again to edit the Null offset value.

   v Deduct the Null value displayed on the DUT's front panel with 190 pF (equivalent to 0.19 nF) using the arrow keys and press **[Shift]** > **[Save]** to save the new Null offset value.

   vi Perform the subsequent measurements in the desired active range as selected in step iii with the new edited Null offset value saved in the DUT.

3 Please repeat steps in step i to step v for any change of ranges that is lower than 1.000 µF.

Table 1-22 Optional capacitance gain verification test

Input capacitance	Range	Error from nominal 1-year
1 nF	1 nF	±0.028 nF
10 nF	10 nF	±0.15 nF
100 nF	100 nF	±1.5 nF
1 μF	1 μF	±15 nF
10 μF	10 μF	±0.15 μF
100 μF	100 μF	±1.5 μF
1000 μF	1000 μF	±15 μF
10000 μF	10000 μF	±250 μF

Calibration Process

The test equipment recommended for the calibration process and procedure is listed in "Recommended Test Equipment" on page 21.

The following procedure is the recommended method to complete a full instrument calibration.

1. Prior to performing the verification tests, see the "Test Considerations" on page 25.
2. Perform the verification tests to characterize the instrument; see the "Performance Verification Tests Overview" on page 38.
3. Unsecure the instrument for calibration; see "Unsecuring the Instrument for Calibration" on page 69.
4. Prior to performing the adjustments, see the "Adjustment Considerations" on page 75.
5. Perform the adjustment procedure; see "Adjustments Procedures" on page 76.
6. Secure the instrument against unauthorized calibration; see "Finishing the adjustments" on page 100. 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.

NOTE Ensure that you quit the adjustment mode before powering off the U3606B.

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 69).

NOTE

Changing the security code from the front panel

You can unsecure the instrument from the front panel using the default security code, but you cannot change the security code from the front panel. The security code can only be changed from the remote interface after the instrument has been unsecured. Refer to "Changing the calibration security code" on page 71 for more details.

The security code is set to "ATU3606B" 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, after a Factory Reset (`*RST` command), or after an Instrument Preset (`SYSTem:PRESet` command).

The security code may contain up to 12 alphanumeric characters. The first character must be a letter. The remaining characters can be letters or numbers. You do not have to use all 12 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 **ATU3606B**.

Unsecuring the instrument from the front panel

NOTE

Only four characters (the fourth, fifth, sixth, and seventh characters) of the security code are used to unsecure the instrument from the front panel. If there are letters instead of digits in any of the fourth through seventh characters, those letters will be represented by the numeral "0" from the front panel.

Example 1 Assume that the calibration security code is the factory default setting of "ATU3606B". When unsecuring from the front panel, the code length is four characters and the first three characters (ATU) are ignored.

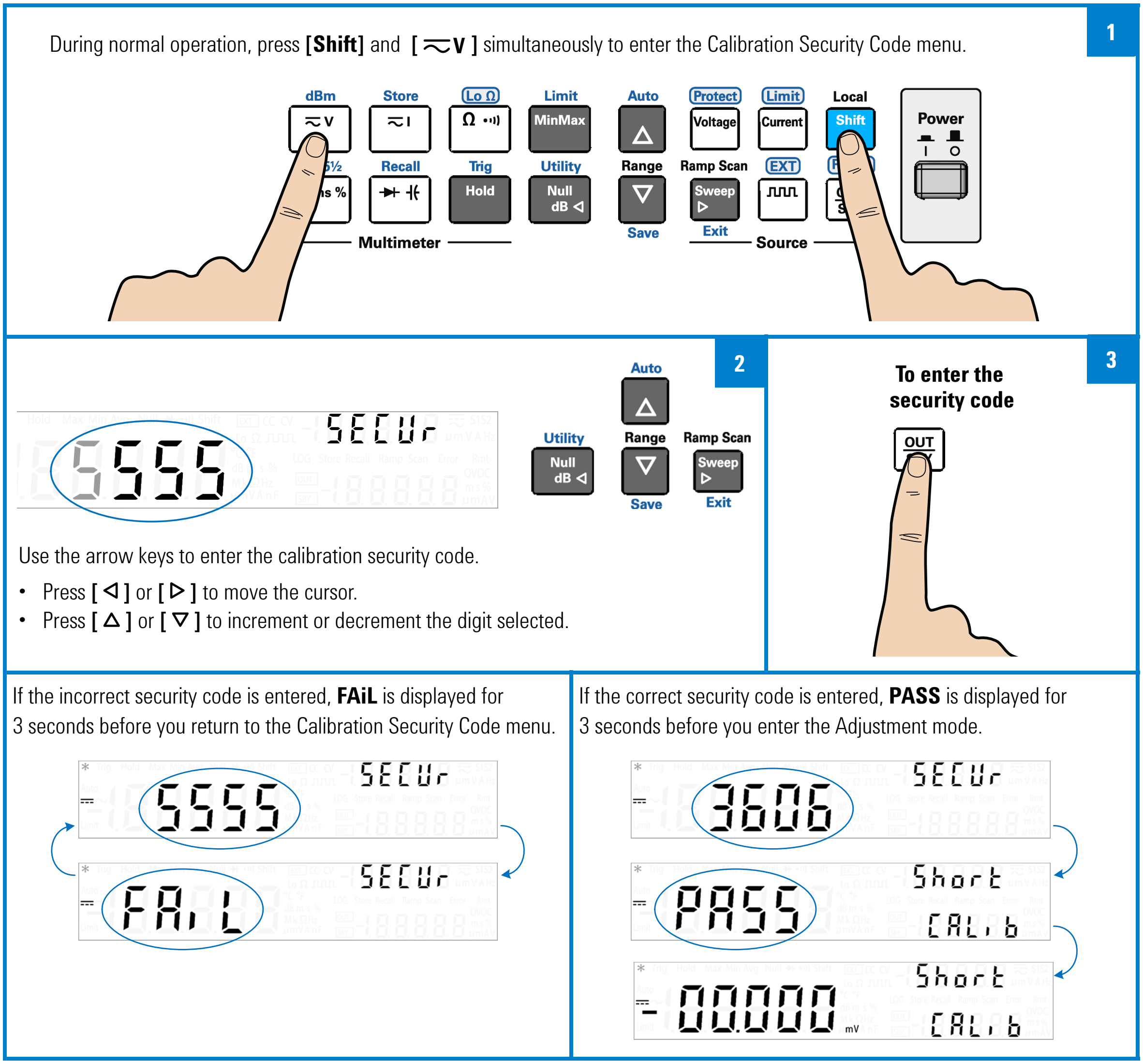
Use this code to unsecure: 3606

Example 2 Assume that the calibration security code was set to "AT01A234" from the remote interface. When unsecuring from the front panel, the first three characters and any characters after (the seventh through twelfth characters) are ignored. In this example, the code now becomes: 1A23. From the front panel, any letters ("A" in this example) are represented by the numeral "0".

Use this code to unsecure: 1023

Example 3 Assume that the calibration security code has been set to "AB123CD45" from the remote interface. The first three characters (AB1) are ignored. The numerals "2" and "3" are still used, and the letters "C" and "D" are represented by zeros.

Use this code to unsecure: 2300



NOTE If you forget your security code, you can disable the security feature by applying a temporary short inside the instrument as described in “Resetting the security code to the factory default” on page 72.

Unsecuring the instrument from the remote interface

Send the `CALibration:SECurity:CODE <mode>, <code>` command from the remote interface.

→ `CAL:SEC:CODE OFF, ATU3606B`	*This command unsecures the instrument for calibration. The default security code is ATU3606B. The security code can only be changed when the instrument is unsecured.*
→ `CAL:SEC:CODE ON, ATU3606B`	*This command secures the instrument from accidental or unauthorized adjustments.*

Changing the calibration security code

The security code can only be changed from the remote interface after the instrument has been unsecured.

Send the `CALibration:SECurity:CODE <new_code>` command from the remote interface after the instrument has been unsecured.

→ `CAL:SEC:CODE OFF, ATU3606B`	*This command unsecures the instrument for calibration. The default security code is ATU3606B. The security code can only be changed when the instrument is unsecured.*
→ `CAL:SEC:CODE ABC1234`	*This command changes the security code to "ABC1234".*
→ `CAL:SEC:CODE ON, ABC1234`	*This command secures the instrument from accidental or unauthorized adjustments.*

See the `CALIbration` subsystem in the *U3606B Programmer's Reference* for more information on the `CALibration:SECurity:CODE` command.

Resetting the security code to the factory default

If you have forgotten the correct security code, you may follow the steps below to change the security code back to the factory default (ATU3606B).

NOTE

If you do not have a record (or have lost the record) or the security code, first try the factory default code — “3606”, from the front panel or “ATU3606B”, from the remote interface — before you use the procedure below.

To unsecure the instrument without the correct security code, follow the steps below.

WARNING

Be careful not to touch the power line connections or high voltages on the power input module and transformer. Power is present even if the instrument is turned off when the line cord is connected.

1 Disconnect the power cord and all input connections.
2 Disassemble the instrument using the “General disassembly” on page 113.
3 Solder a temporary short between the two exposed metal pads on the main printed circuit (PC) board assembly. The general location is shown in Figure 1-18. On the U3606B PC board, the pads are marked as “SECUR”.

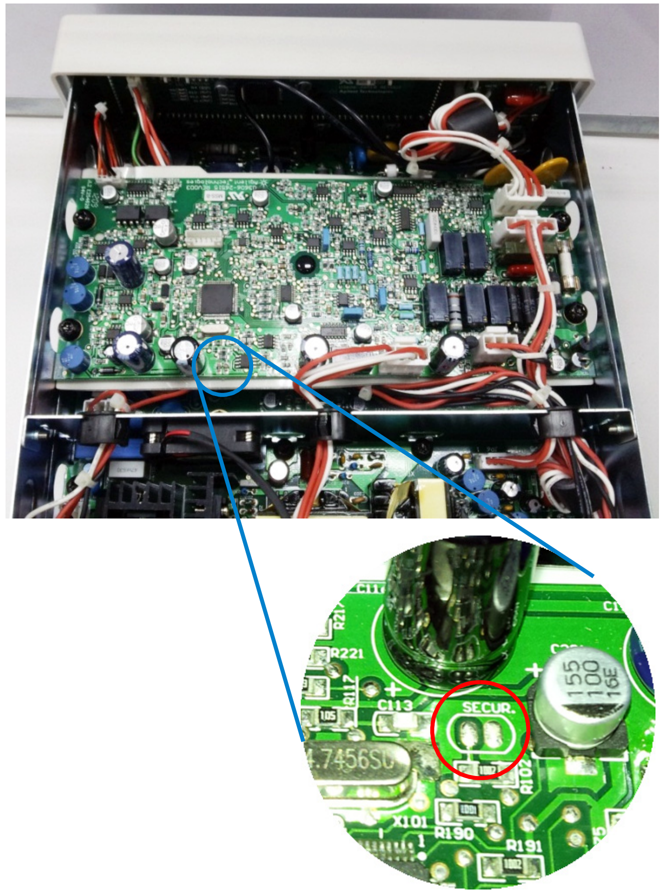


Figure 1-18 SECUR pads location

4 Apply power and turn on the instrument.

5 The display will show the message “CALib”. The instrument is now unsecured. (The security code resets to the factory default value.)

6 Turn off the instrument and remove the power cord.

7 Remove the temporary short installed in step 3.

8 Reassemble the instrument.

9 Unsecure the instrument with the default security code “ATU3606B”. (Use “3606” if you are unsecuring the instrument from the front panel.)

10 You can now enter a new security code if you wish. See “Changing the calibration security code” on page 71. Be sure you record the new security code.

CAUTION

Never calibrate the instrument while the case is open. Reassemble the instrument before performing any calibration procedures.

Using the Front Panel for Adjustments

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

To unsecure the instrument, see "Unsecuring the Instrument for Calibration" on page 69. Once unsecured, "CALib" is displayed on the lower secondary display to indicate that the instrument is now in Adjustment mode.

Adjustment Considerations

1 Allow the instrument to warm up and stabilize for 3 minutes before performing the adjustments.
2 Consider the thermal effects as you are connecting the test leads to the calibrator and multimeter. It is recommended to wait for 1 minute before you begin the calibration after connecting the test leads.

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

Aborting a Calibration in Progress

Sometimes it may be necessary to abort a calibration after the procedure has already been initiated. You can abort a calibration at any time on any module by pressing **[Shift]**.

CAUTION If you abort a calibration in progress when the instrument is attempting to write new calibration constants to EEPROM, you may lose all calibration constants for the function. Typically, upon re-applying power, the instrument will report error 705, "Cal:Aborted". You may also generate errors 742 through 748. If this occurs, you should not use the instrument until a complete re-adjustment has been performed. A list of the possible calibration errors is given on page 103.

Adjustments Procedures

You will need a test input cable and connectors set, and a shorting plug to adjust the instrument (see "Input and Output Connections" on page 26).

NOTE

After each adjustment finishes successfully, the primary display briefly shows "PASS". If the calibration fails, the instrument beeps, the primary display shows "FAil", and an error number is shown in the upper secondary display. Calibration error messages are described on page 103. In the event of a calibration failure, correct the problem and repeat the procedure.

Zero offset adjustment

Each time you perform a zero offset adjustment, the instrument stores a new set of offset correction constants for measurement functions and ranges. The instrument will sequence through all required functions and ranges automatically and store new zero offset calibration constants.

CAUTION

Never turn off the instrument during zero offset adjustment. This may cause ALL calibration memory to be lost.

Zero offset adjustment procedure

Be sure to allow the instrument to warm up and stabilize for 120 minutes before performing the adjustments. Follow the steps outlined below. Review the "Test Considerations" on page 25 before beginning this test.

1 Unsecure the instrument to enter the Adjustment mode. Connect the shorting plug between the **V** (red) and

LO (black) front panel input terminals. Leave the current input **I** (red) open.

NOTE To minimize thermal effects, wait at least 1 minute after connecting the shorting plug before executing the zero offset adjustment.

2 Press **[Shift]** > **[Hold]**. The word CALib starts flashing to indicate that the calibration is in progress.
3 The display will show the measurement functions and ranges as the adjustments progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
   - An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat step 2.
4 Remove the shorting plug from the input terminals.
5 Press **[Shift]** > **[MinMax]**. The word CALib starts flashing to indicate that the calibration is in progress.
6 The display will show the measurement functions and ranges as the adjustments progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
   - An adjustment failure is indicated by a long beep and the display showing FAiL along with a calibration error number. Correct the problem and repeat step 5.
7 Perform the “Zero Offset (Short) Verification Test Setup” on page 27 to check the zero calibration results.

Gain adjustments

The instrument calculates and stores gain corrections for each input value. The gain constant is computed from the calibration value entered for the calibration command and from measurements made automatically during the adjustment procedure.

NOTE Most measuring functions and ranges have gain adjustment procedures. The 100 MΩ range does not have gain calibration procedures.

Adjustments for each function should be performed ONLY in the order shown.

Gain adjustment considerations

- The zero offset adjustment procedure must have been recently performed prior to beginning any gain adjustment procedures.
- Be sure to allow the instrument to warm up and stabilize for 120 minutes before performing the adjustments.
- Consider the thermal effects as you are connecting test leads to the calibrator and instrument. It is recommended to wait 1 minute before starting the calibration after connecting the test leads.

CAUTION Never turn off the instrument during a gain adjustment. This may cause the calibration memory for the present function to be lost.

Valid gain adjustment input values

Gain adjustment can be accomplished using the following input values.

Table 1-23 Valid gain adjustment input values

Function	Range	Valid amplitude input values	Page
DC voltage	• 100 mV • 1 V • –1 V • 10 V • 100 V • 1000 V	0.9 to 1.1 × full scale	page 80
AC voltage (frequency as 1 kHz)	• 10 mV • 100 mV • 1 V • 10 V • 100 V • 750 V	0.9 to 1.1 × full scale	page 82
Frequency	Autorange/1 kHz	Input ≥ 100 mV_{rms}, 900 Hz to 1100 Hz	page 83
Resistance (2-wire)	• 100 Ω • 1 kΩ • 10 kΩ • 100 kΩ • 1 MΩ • 10 MΩ	0.9 to 1.1 × full scale	page 84
DC current	• 10 mA • 100 mA • 1000 mA	0.9 to 1.1 × full scale	page 86

Table 1-23 Valid gain adjustment input values (continued)

Function	Range	Valid amplitude input values	Page
AC current	• 1 mA • 10 mA • 100 mA • 1000 mA	0.9 to 1.1 × full scale	page 87
Capacitance	• 0.4 nF • 1 nF • 10 nF • 100 nF • 1 µF • 10 µF • 100 µF • 1000 µF • 10000 µF	0.9 to 1.1 × full scale	page 88

Review the "Test Considerations" on page 25 and "Gain adjustment considerations" on page 78 sections before beginning any of the procedures listed below.

DC voltage gain adjustment procedure

1 Press [≂V] to enter the DC voltage gain calibration.
2 The display shows the uncalibrated value and the reference value of the adjustment item.
3 Configure each adjustment item shown in Table 1-24.

NOTE If the zero offset adjustment procedure has been recently performed prior to the DC voltage gain calibration procedure, the adjustment item "Short" can be omitted.

4 Use △ or ▽ to select the adjustment item.
5 Apply the input signal shown in the "Input" column of Table 1-24.

NOTE Always complete tests in the same order as shown in Table 1-24.

6 Enter the actual applied input.
7 Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
   - An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.
8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-24.
9 Verify the DC voltage gain adjustments using the "DC voltage gain verification test" on page 43.

Table 1-24 DC voltage gain adjustment

Adjustment item	Input voltage
Short	Dual banana plug with copper wire short between the two input terminals
100.000 mV	100 mV
1.00000 V	+1 V
–1.00000 V	–1 V
10.0000 V	10 V
100.000 V	100 V
1000.00 V	1000 V

CAUTION Set the calibrator output to 0 V before disconnecting from the instrument input terminals.

AC voltage gain adjustment procedure

Review the “Test Considerations” on page 25 and “Gain adjustment considerations” on page 78 sections before beginning this procedure.

1 Press [≂V] twice to enter the AC voltage gain calibration. The AC annunciator will turn on according to your selection.

2 The display shows the uncalibrated value and the reference value of the adjustment item.

3 Configure each adjustment item shown in Table 1-25.

4 Use △ or ▽ to select the adjustment item.

5 Apply the input signal shown in the “Input” column of Table 1-25.

NOTE Always complete tests in the same order as shown in Table 1-25.

6 Enter the actual applied input.

7 Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.

- Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
- An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-25.

9 Verify the AC voltage gain adjustments using the “AC voltage verification test” on page 44.

Table 1-25 AC voltage gain adjustment

Adjustment item	Input voltage (V_{rms})	Input frequency
10.000 mV, 1 kHz	10 mV	1 kHz
100.000 mV, 1 kHz	100 mV	1 kHz
1.00000 V, 1 kHz	1 V	1 kHz
10.0000 V, 1 kHz	10 V	1 kHz
100.000 V, 1 kHz	100 V	1 kHz
750.00 V, 1 kHz	750 V	1 kHz

CAUTION Set the calibrator output to 0 V before disconnecting from the instrument input terminals.

Frequency gain adjustment procedure

Review the “Test Considerations” on page 25 and “Gain adjustment considerations” on page 78 sections before beginning this procedure.

1 Press **[Hz ms %]** to enter the frequency gain calibration.
2 The display shows the uncalibrated value and the reference value of the adjustment item.
3 Configure each adjustment item shown in Table 1-26.
4 Use △ or ▽ to select the adjustment item.
5 Apply the input signal shown in the “Input” column of Table 1-26.

NOTE Always complete tests in the same order as shown in Table 1-26.

6 Enter the actual applied input.

7 Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
   - An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-26.

9 Verify the frequency gain adjustments using the "Frequency voltage gain verification test" on page 48.

Table 1-26 Frequency gain adjustment

Adjustment item	Input frequency	Input voltage (V_{rms})
1000.00 Hz, 1 V_{rms}	1 kHz	1 V_{rms}

Resistance gain adjustment procedure

Review the "Test Considerations" on page 25 and "Gain adjustment considerations" on page 78 sections before beginning this procedure.

This procedure adjusts the gain for the two-wire resistance function. The gain for the 100 MΩ range is derived from the 10 MΩ range and does not have a separate adjustment point.

1 Press [Ω •))] to enter the resistance gain calibration.

2 The display shows the uncalibrated value and the reference value of the adjustment item.

3 Configure each adjustment item shown in Table 1-27.

NOTE If the zero offset adjustment procedure has been recently performed prior to the resistance gain calibration procedure, the adjustment items "Short" and "OPEn" can be omitted.

4 Use △ or ▽ to select the adjustment item.

5 Apply the input signal shown in the “Input” column of Table 1-27.

NOTE Always complete tests in the same order as shown in Table 1-27.

6 Enter the actual applied input.

7 Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.

- Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
- An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-27.

9 Verify the resistance gain adjustments using the “2-wire resistance gain verification test” on page 46.

Table 1-27 Resistance gain adjustment

Adjustment item	Input resistance
Short	Dual banana plug with copper wire short between the two input terminals
OPEn	Input terminals open (remove any test leads or shorting plugs from the input terminals)
10.0000 MΩ	10 MΩ
1.00000 MΩ	1 MΩ
100.000 kΩ	100 kΩ
10.0000 kΩ	10 kΩ
1000.00 Ω	1000 Ω
100.000 Ω	100 Ω

DC current gain adjustment procedure

Review the "Test Considerations" on page 25 and "Gain adjustment considerations" on page 78 sections before beginning this procedure.

1 Press [≂I] to enter the DC current gain calibration.
2 The display shows the uncalibrated value and the reference value of the adjustment item.
3 Configure each adjustment item shown in Table 1-28.

NOTE If the zero offset adjustment procedure has been recently performed prior to the DC current gain calibration procedure, the adjustment item "OPEn" can be omitted.

4 Use △ or ▽ to select the adjustment item.
5 Apply the input signal shown in the "Input" column of Table 1-28.

NOTE Always complete tests in the same order as shown in Table 1-28.

6 Enter the actual applied input.
7 Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
   - An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.
8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-28.
9 Verify the DC current gain adjustments using the "DC current gain verification test" on page 43.

Table 1-28 DC current gain adjustment

Adjustment item	Input current
OPEn	Input terminals open (remove any test leads or shorting plugs from the input terminals)
10.0000 mA	10 mA
100.000 mA	100 mA
1000.00 mA	1000 mA

AC current gain adjustment procedure

Review the "Test Considerations" on page 25 and "Gain adjustment considerations" on page 78 sections before beginning this procedure.

1. Press [≂I] twice to enter the AC current gain calibration. The AC annunciator will turn on according to your selection.
2. The display shows the uncalibrated value and the reference value of the adjustment item.
3. Configure each adjustment item shown in Table 1-29.
4. Use △ or ▽ to select the adjustment item.
5. Apply the input signal shown in the "Input" column of Table 1-29.

NOTE Always complete tests in the same order as shown in Table 1-29.

6. Enter the actual applied input.
7. Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.

- An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-29.

9 Verify the AC current gain adjustments using the "AC current verification test" on page 45.

Table 1-29 AC current gain adjustment

Adjustment item	Input current	Input frequency
1.0000 mA, 1 kHz	1 mA	1 kHz
10.0000 mA, 1 kHz	10 mA	1 kHz
100.000 mA, 1 kHz	100 mA	1 kHz
1000.00 mA, 1 kHz	1000 mA	1 kHz

Capacitance gain adjustment procedure

Review the "Test Considerations" on page 25 and "Gain adjustment considerations" on page 78 sections before beginning this procedure.

1 Press [⇥ ⊣⊢] to enter the capacitance gain calibration.

2 The display shows the uncalibrated value and the reference value of the adjustment item.

3 Configure each adjustment item shown in Table 1-30.

NOTE

If the zero offset adjustment procedure has been recently performed prior to the capacitance gain calibration procedure, the adjustment item "OPEn" can be omitted.

4 Use △ or ▽ to select the adjustment item.

5 Apply the input signal shown in the "Input" column of Table 1-30.

NOTE

Always complete tests in the same order as shown in Table 1-30.

6 Enter the actual applied input.

7 Press OUT/SBY to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.

- Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
- An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

8 Repeat step 3 through step 7 for each gain adjustment point shown in Table 1-30.

9 Verify the capacitance gain adjustments using the "Optional capacitance gain verification test" on page 65.

Table 1-30 Capacitance gain adjustment

Adjustment item	Input capacitance
OPEn	Input terminals open (remove any test leads or shorting plugs from the input terminals)
0.400 nF	0.4 nF
1.000 nF	1 nF
10.00 nF	10 nF
100.0 nF	100 nF
1.000 µF	1 µF
10.00 µF	10 µF
100.0 µF	100 µF
1000 µF	1000 µF
10000 µF	10000 µF

Output adjustments

The instrument calculates and stores output corrections for each output level. The U3606B implements a closed loop output calibration procedure to its inherent dual function ability as a digital multimeter and a DC power supply. The output constant is computed from the calibration level set for the calibration command and from measurements made automatically during the adjustment procedure.

Adjustments for each function should be performed ONLY in the order shown.

NOTE

Front and rear terminal output adjustment The U3606B Multimeter | DC Power Supply needs to be calibrated twice — once for the front panel output terminals and again for the rear panel output terminals. When you have completed the voltage and current output adjustments for the front panel output terminals, repeat the entire adjustment procedure again for the rear panel output terminals.

Valid output adjustment levels

Output adjustment can be accomplished using the following output levels.

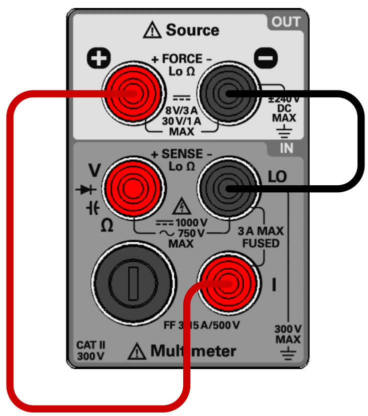
Table 1-31 Valid output adjustment levels

Function	Valid output levels	Page
Constant current	• OUt-L • OUt-H • LOAd1 [300 Ω (3 W)] • LOAd2 [1000 Ω] • LOAd3 [30 Ω (30 W)] • LOAd4 [2.67 Ω (24 W)]	Front terminal on page 92 Rear terminal on page 96
Constant voltage	• OUt-L • OUt-H • LOAd1 [30 Ω (30 W)] • LOAd2 [2.67 Ω] • LOAd3 [300 Ω (3 W)] • LOAd4 [0.33 Ω (3 W)]	Front terminal on page 94 Rear terminal on page 98

CC output adjustment procedure — front output terminals

Review the "Test Considerations" on page 25 and "Input and Output Connections" on page 26 sections before beginning this procedure.

1 Turn off the instrument and connect the front panel ⊕ (red) and ⊖ (black) output terminals to the **I** (red) and **LO** (black) input terminals.



2 Turn on the instrument. Press **Current** to enter the constant current output calibration.

3 The display shows the uncalibrated value and the reference value of the adjustment item.

4 Configure each adjustment item shown in Table 1-32.

5 Use △ or ▽ to select the adjustment item.

NOTE Always complete tests in the same order as shown in Table 1-32.

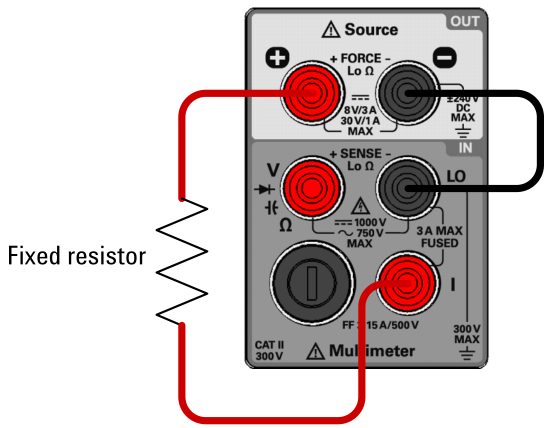
6 Press **OUT/SBY** to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.

- Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.

- An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

7 Repeat step 3 through step 6 for each output adjustment item shown in Table 1-32.

For adjustment item “LOAd1”, “LOAd2”, “LOAd3”, and “LOAd4” connect an additional fixed resistor across the front panel ⊕ (red) output terminal and the **I** (red) terminal according to the fixed resistors value on Table 1-32. Leave the ⊖ (black) terminal and **LO** (black) terminal connected.



8 Verify the constant current adjustments using the “CC programming and readback accuracy” on page 58.

Table 1-32 Constant current output adjustment

Adjustment item	Output current
OUt-L	AUTO calibration
OUt-H	AUTO calibration
LOAd1[1]	100 mA with additional 300 Ω (3 W) fixed resistor
LOAd2[1][2]	6 mA with additional 1000 Ω fixed resistor

Table 1-32 Constant current output adjustment (continued)

Adjustment item	Output current
LOAd3[1]	1 A with additional 30 Ω (30 W) fixed resistor
LOAd4[1]	3 A with additional 2.67 Ω (24 W) fixed resistor

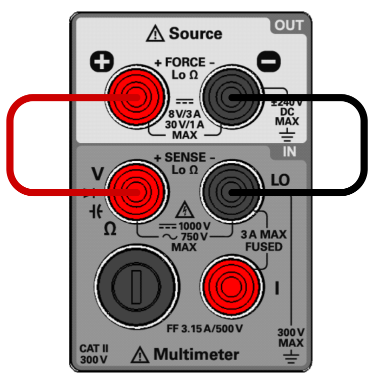
[1] See step 7 for information on how to connect the LOAd adjustment item.

[2] LO RES load.

CV output adjustment procedure — front output terminals

Review the "Test Considerations" on page 25 and "Input and Output Connections" on page 26 sections before beginning this procedure.

1 Turn off the instrument and connect the front panel ⊕ (red) and ⊖ (black) output terminals to the **V** (red) and **LO** (black) input terminals.



2 Turn on the instrument. Press **[Voltage]** to enter the constant voltage output calibration.

3 The display shows the uncalibrated value and the reference value of the adjustment item.

4 Configure each adjustment item shown in Table 1-33.

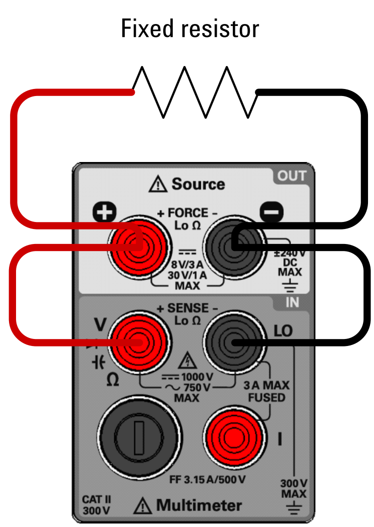
5 Use △ or ▽ to select the adjustment item.

NOTE Always complete tests in the same order as shown in Table 1-33.

6 Press [OUT/SBY] to start the adjustment. The word CALib starts flashing to indicate that the calibration is in progress.
   - Successful completion of the adjustment is indicated by a short beep and the display briefly showing PASS.
   - An adjustment failure is indicated by a long beep, the display showing FAiL along with a calibration error number. Correct the problem and repeat this procedure.

7 Repeat step 3 through step 6 for each output adjustment item shown in Table 1-33.

   For adjustment item “LOAd1”, “LOAd2”, “LOAd3”, and “LOAd4”, connect an additional fixed resistor the front panel ⊕ (red) and ⊖ (black) output terminals according to the fixed resistors value on Table 1-33. Leave the connections from the output terminals (⊕ and ⊖) to the input terminals (**V** and **LO**) intact.



8 Verify the constant voltage adjustments using the "CV programming and readback accuracy" on page 50.

Table 1-33 Constant voltage output adjustment

Adjustment item	Output voltage
OUt-L	AUTO calibration
OUt-H	AUTO calibration
LOAd1[1]	30 V with additional 30 Ω (30 W) fixed resistor
LOAd2[1]	8 V with additional 2.67 Ω (24 W) fixed resistor
LOAd3[1][2]	8 V with additional 300 Ω (3 W) fixed resistor
LOAd4[1]	1000 mV with additional 0.33 Ω (3 W) fixed resistor

[1] See step 7 for information on how to connect the LOAd adjustment item.

[2] S2 range with a lighter load.

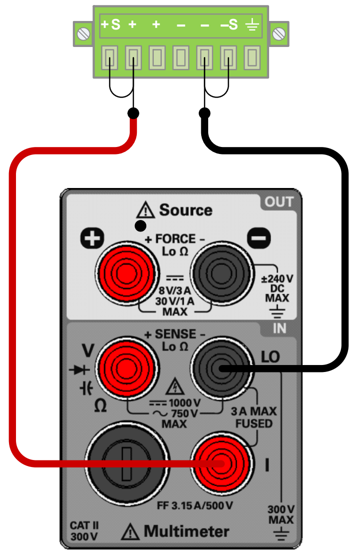
CC output adjustment procedure — rear output terminals

Review the "Test Considerations" on page 25 and "Input and Output Connections" on page 26 sections before beginning this procedure.

1 Turn off the instrument and connect the rear panel **+** and – output terminals to the **I** (red) and **LO** (black) input terminals.

NOTE

Ensure that the rear panel sense terminals (+S and –S) are shorted to the rear panel output (+ and –) terminals. See *Chapter 3 of the U3606B User's Guide, "Remote sensing connections," starting on page 116* for more information on how to connect the load leads.



2 Press **[Shift]** > **[EXT]** to enable remote sensing. When the U3606B is operating in remote sensing mode, the **EXT** annunciator on the front panel is turned on.

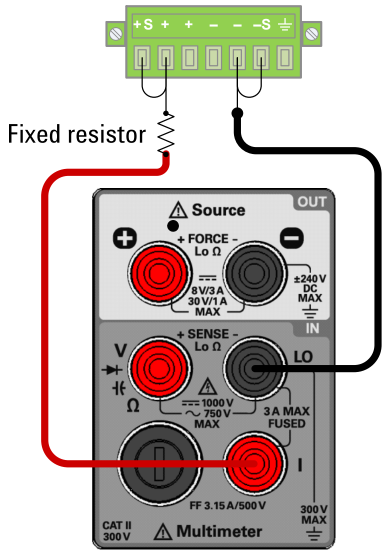
3 Perform step 2 through step 6 of the "CC output adjustment procedure – front output terminals" on page 92. Refer to Table 1-32 on page 93 for the constant current output adjustment items.

4 Repeat step 3 through step 6 for each output adjustment item shown in Table 1-32.

For adjustment item "LOAd1", "LOAd2", "LOAd3", and "LOAd4", connect an additional fixed resistor across the front panel + rear output terminal and the **I** (red) terminal according to the fixed resistors value on Table 1-32. Leave the – rear terminal and **LO** (black) terminal connected.

NOTE

Do not remove the short bar between the rear panel sense terminals (+S and –S) are the rear panel output (+ and –) terminals. See *Chapter 3 of the U3606B User's Guide, "Remote sensing connections," starting on page 116* for more information on how to connect the load leads.



5 Verify the constant current adjustments using the "CC programming and readback accuracy" on page 58.

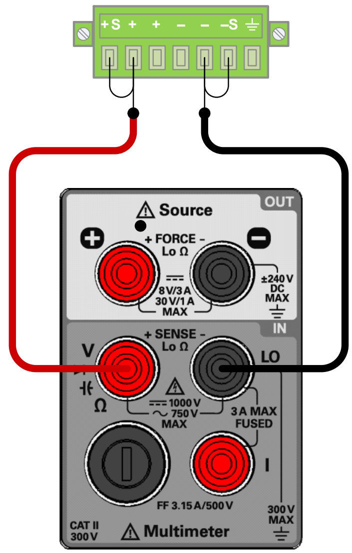
CV output adjustment procedure — rear output terminals

Review the "Test Considerations" on page 25 and "Input and Output Connections" on page 26 sections before beginning this procedure.

1 Turn off the instrument and connect the rear panel **+** and – output terminals to the **V** (red) and **LO** (black) input terminals.

NOTE

Ensure that the rear panel sense terminals (+S and –S) are shorted to the rear panel output (+ and –) terminals. See *Chapter 3 of the U3606B User's Guide, "Remote sensing connections," starting on page 116* for more information on how to connect the load leads.



2 Press **[Shift]** > **[EXT]** to enable remote sensing. When the U3606B is operating in remote sensing mode, the **EXT** annunciator on the front panel is turned on.

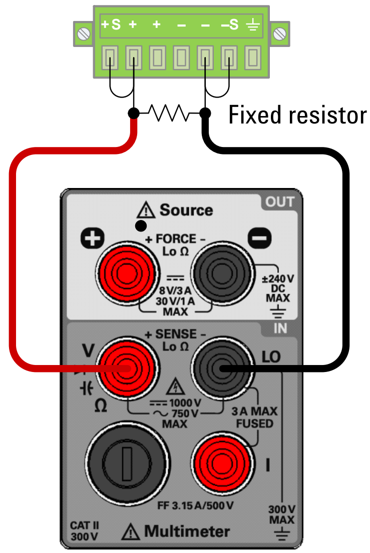
3 Perform step 2 through step 6 of the “CV output adjustment procedure — front output terminals” on page 94. Refer to Table 1-33 on page 96 for the constant voltage output adjustment items.

4 Repeat step 3 through step 6 for each output adjustment item shown in Table 1-33.

   For adjustment item “LOAd1”, “LOAd2”, “LOAd3”, and “LOAd4”, connect an additional fixed resistor across the rear panel **+** and **–** output terminals according to the fixed resistors value in Table 1-33. Leave the connections from the output terminals (+ and –) to the input terminals (**V** and **LO**) intact.

NOTE

Do not remove the short bar between the rear panel sense terminals (+S and –S) are the rear panel output (+ and –) terminals. See *Chapter 3 of the U3606B User’s Guide, “Remote sensing connections,” starting on page 116* for more information on how to connect the load leads.



5 Verify the constant voltage adjustments using the “CV programming and readback accuracy” on page 50.

Finishing the adjustments

1 Remove all shorting plugs and connections from the instrument.

2 Reset the calibration message (“Calibration Message” on page 102).

3 Record the new calibration count (“Calibration Count” on page 101).

4 Press **[Shift]** > **[Exit]** or **[Shift]** + **[≂V]** to exit the adjustment mode.

5 The instrument will be secured and returns to normal operation.

Calibration Count

The calibration count feature provides an independent "serialization" of your calibrations. You can query the instrument to determine how many calibrations 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 calibration count increments up to a maximum of 32767 after which it rolls over to 0. Since the value increments by one for each calibration point, a complete calibration may increase the value by many counts.
- The calibration count is stored in the nonvolatile memory, and does not change when power has been turned off, after a Factory Reset (`*RST` command), or after an Instrument Preset (`SYSTem:PRESet` command).

1 In adjustment mode, press **[MinMax]** to view the calibration count.

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

3 The instrument will return to the calibration operation after a few seconds of inactivity.

Calibration Message

The instrument allows you to store a message in calibration memory. For example, you can store information such as the date when the last calibration was performed, the date when the next calibration is due, the instrument serial number, or even the name and phone number of the person to contact for a new calibration. The calibration message may contain up to 40 characters.

- You can record a calibration message only when the instrument is unsecured.
- You can read the calibration message (from the remote interface only) whether the instrument is secured or unsecured.

To store a calibration message use the `CALibration:STRing` and `CALibration:STRing?` commands from the remote interface.

→ `CAL:STR "LAST CAL: 27 November 2013, by AT."`	*This command stores a message in the calibration memory.*
→ `CAL:STR?`	*This query returns the message currently stored in calibration memory (the quotes are also returned).*
← `"LAST CAL: 27 November 2013, by AT."`	

See the *U3606B Programmer's Reference* for more information on the `CALibration` subsystem.

Calibration Error Codes

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

Table 1-34 List of calibration errors

Error code	Error message
701	Cal security pads short
702	Cal secured
703	Invalid secure code
704	Secure code too long
705	Cal aborted
706	Cal value out of range
707	Cal signal measurement out of range
708	Cal signal frequency out of range
709	Cal source unfinished
710	EEPROM write failure
720	Cal DCV offset out of range
721	Cal DCI offset out of range
722	Cal RES offset out of range
723	Cal CAP offset out of range
726	Cal RES open out of range
742	Cal checksum failed, DCV corrections
743	Cal checksum failed, DCI corrections
744	Cal checksum failed, RES corrections
745	Cal checksum failed, ACV corrections
746	Cal checksum failed, ACI corrections
747	Cal checksum failed, FREQ correction

Table 1-34 List of calibration errors (continued)

Error code	Error message
748	Cal checksum failed, CAP corrections
750	Source board failed on reading
751	Source board failed on sense

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.

Operating Checklist

Before returning your instrument to Agilent for service or repair, do a check on the following items:

Is the instrument inoperative?

- ❑ Verify that the power cord is connected to the instrument and to the AC line power.
- ❑ Verify that the front-panel power switch has been pushed.
- ❑ Verify that the power-line fuse is installed and not open.
- ❑ Verify the power-line voltage setting.

Does the instrument fail self-test?

- ❑ Remove all test connections to the instrument and run the self-test again.

  Errors may be induced by AC signals present on the input terminals of the instrument during the self-test. Long test leads can act as an antenna causing pick-up of AC signals.

- ❑ Remove all load connections to the output terminals.

  Ensure that all terminal connections are removed while the self-test is performed.

Is the instrument current input inoperative?

- ❑ Verify the current input fuse.

Cleaning

Clean the outside of the instrument with a soft, lint-free, slightly dampened cloth. Disassembly is not required or recommended for cleaning.

Dirt or moisture in the terminals can distort readings.

Cleaning procedures are as follows:

1 Turn the instrument off and remove the test leads.

2 If possible, turn the instrument over and shake out any dirt that may have accumulated in the terminals.

3 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 cotton swab moistened with alcohol.

Fuse Replacement

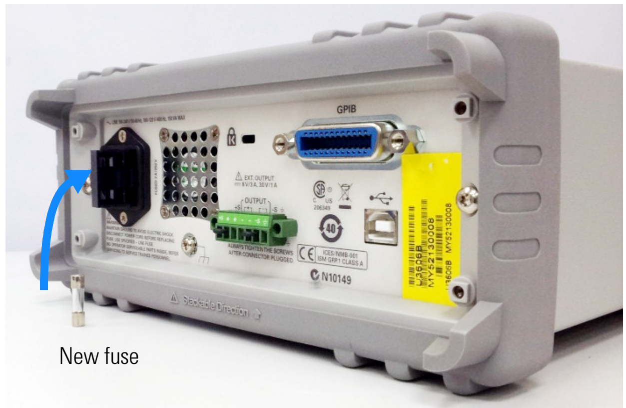
To replace the power line fuse

The power line fuse is located within the U3606B fuse-holder assembly on the rear panel. The U3606B is shipped from the factory with a power-line fuse installed. The supplied fuse is a time-lag, low-breaking, 2 A/250 V, S/B 5×20 mm fuse, Agilent part number A02-62-25026-2U. If you are certain that the fuse is faulty, replace it with one of the same size and rating.

1 Disconnect power cord. Using a flat blade screwdriver, gently pry open the fuse holder assembly as shown below.

2 Remove the fuse holder assembly from the front panel.

3 Remove the faulty power line fuse and replace it with a new power line fuse in the fuse holder assembly.



4 Re-insert the fuse holder assembly into the rear panel.

To replace the current input fuse

The current input terminal is fuse protected. The fuse for the current input terminal is located on the front panel. The fuse is a 3.15 A/500 V F/B 6.3×32 mm fuse, Agilent part number A02-62-25657-1U. If you are certain that the fuse is faulty, replace it with one of the same size and rating.

1 Disconnect all input terminal connections. Place a flat blade screwdriver on the fuse holder assembly as shown below and push in.

2 Turn the screwdriver anti-clockwise to remove the fuse holder assembly from the front panel.

3 Remove the faulty current input fuse and replace a new current input fuse into the fuse holder assembly.

4 Re-insert the fuse holder assembly into the front panel. Turn the screwdriver clockwise to fasten the fuse holder assembly in place.

Electrostatic Discharge (ESD) Precautions

Electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 V.

The following guidelines will help prevent ESD damage when servicing the instrument or any electronic device.

- Disassemble instruments only in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.
- Use only anti-static solder suckers.

Mechanical Disassembly

For procedures in this section, the following tools are required for disassembly:

- T20 Torx driver (most disassembly)
- T10 Torx driver
- Flat blade screwdriver
- Phillips (+) screwdriver

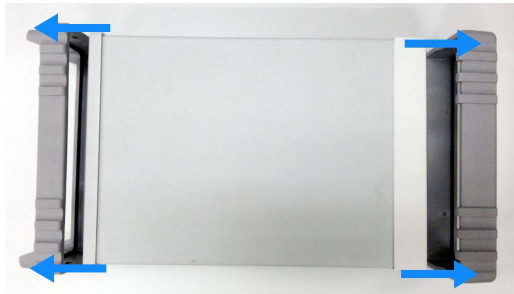
WARNING **SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should remove the instrument covers. To avoid electrical shock and personal injury, make sure to disconnect the power cord from the instrument before removing the covers. Some circuits are active and have power applied even when the power switch is turned off.**

General disassembly

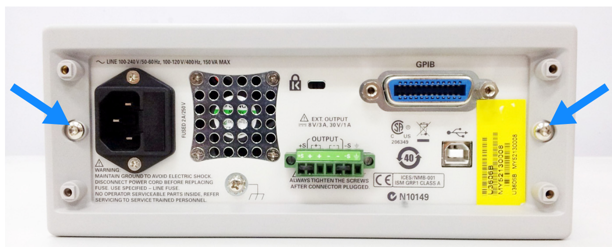
1 Turn off the power. Remove all cables from the instrument.

2 **Remove the carry handle.** Rotate the handle upright and pull out from the sides of the instrument.

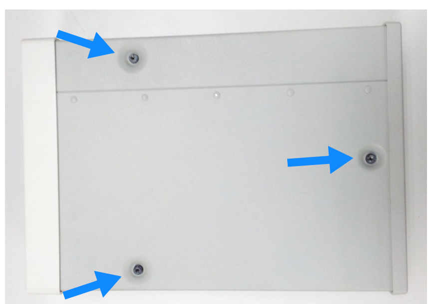
3 **Remove the instrument bumpers.** Pull from a corner and stretch the bumpers off the instrument.



4 **Remove the rear bezel.** Loosen the two captive screws in the rear bezel with a T10 Torx driver and remove the rear bezel.



5 **Remove the cover.** Remove the screws in the bottom of the cover with a T20 Torx driver.



6 Slide the cover off the instrument.

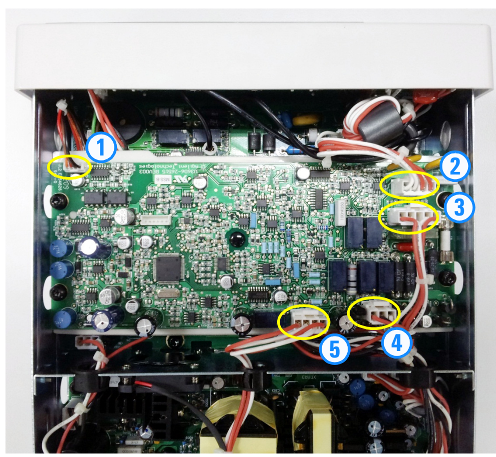
Front panel removal

7 Remove the push rod and disconnect the display cable.

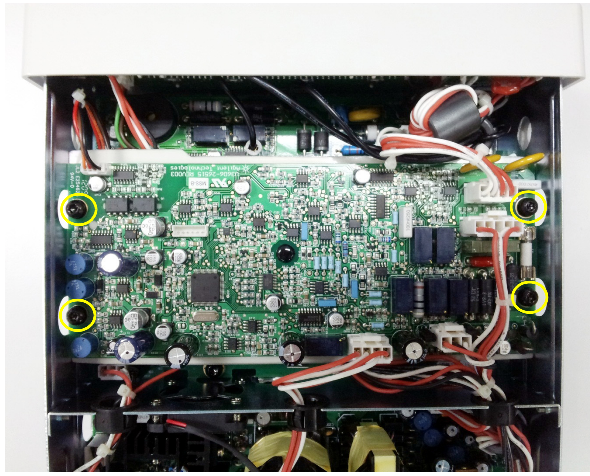
i Turn the instrument over and gently move the power switch push rod towards the front of the instrument to disengage it from the switch. Be careful not to twist or bend the push rod.

ii Disconnect the two ribbon cable connectors from the front panel.

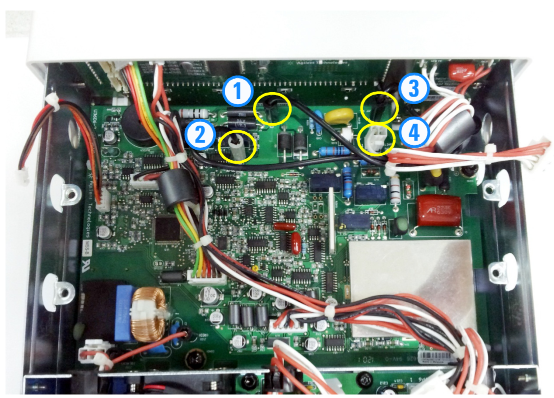
iii Disconnect the individual wires from the top layer circuit board as shown below.



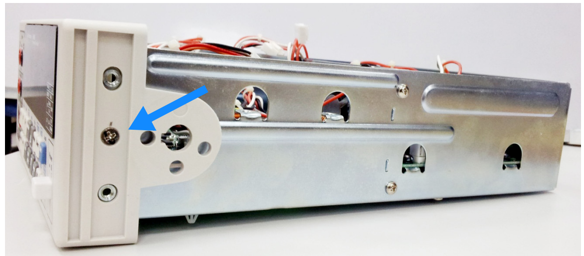
8 **Remove the top layer circuit board.** Loosen the four captive screws in the top layer circuit board with a T20 Torx driver and remove the top layer circuit board. Remove the protective metal sheet as well.



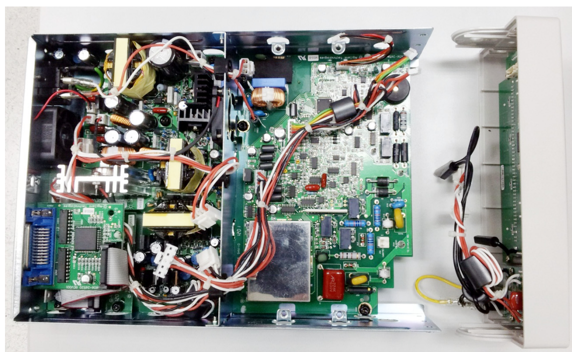
9 Disconnect the individual wires from the bottom layer circuit board as shown below.



10 Remove the two screws holding the front panel with a Phillips (+) screwdriver.

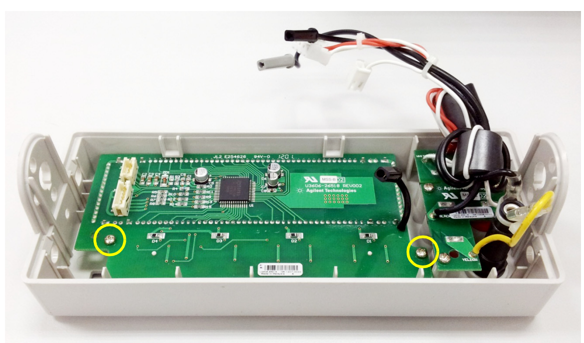


11 You can now pry the side of the front panel from the chassis and remove it.

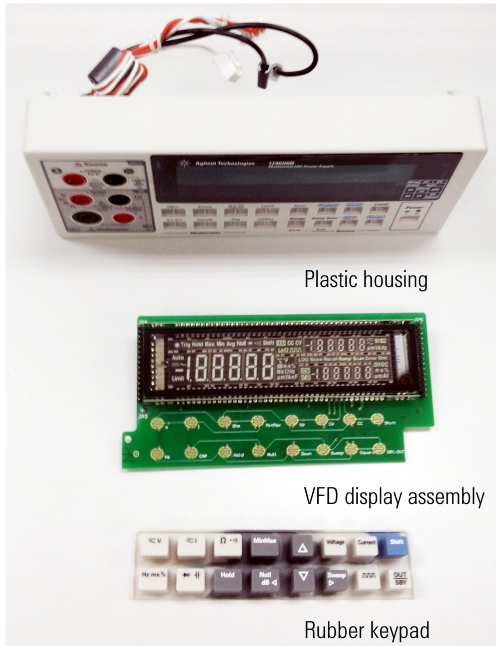


Front panel disassembly

12 Loosen the two captive screws with a Phillips (+) screwdriver and remove the keypad and display assembly.



13 **Remove the keypad and display assembly.** The rubber keypad and VFD display assembly can now be pulled out from the plastic housing.



14 To reassemble all the modules again, just follow the disassembly procedure reverse order.

Replaceable Parts

This section contains information for ordering replacement parts for your instrument. The parts lists are divided into the following sections.

Parts are listed in alphanumeric order according to their reference designators. The parts lists includes a brief description of each part with applicable Agilent part number.

Table 2-1 List of replaceable parts

Part number	Description
A02-1-25373-1	Cover
A02-15-25200-1	Rear bezel
A02-15-25453-1	Push knob
A02-62-25026-2U	Fuse 2 A/250 V S/B 5×20 mm
A02-62-25604-1	FUSE CARRIER 20A/250V FOR 6×31 mm BLK
A02-62-25657-1U	Fuse 3.15 A/500 V F/B 6.3×32 mm
U3401-40001	Rubber bumper kit (front and rear)
U3606-60200	Front panel assembly
U3606-40004	Keypad
U3606-45001	Carry handle
U3606-60034	Shorting bar
U3606-60035	External terminal block assembly

To order replaceable parts

You can order replaceable parts from Agilent using the Agilent part number. Note that not all parts listed in this chapter are available as field-replaceable parts. To order replaceable parts from Agilent, do the following:

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

Types of Services Available

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

Extended Service Contracts

Many Agilent 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, Agilent Technologies 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 Agilent Technologies 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 Agilent Technologies 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 Agilent worldwide:
  - www.agilent.com/find/assist
- Or contact your Agilent Technologies representative.

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

Repackaging for Shipment

If the unit is to be shipped to Agilent for service or repair, be sure to:

- attach a tag to the unit identifying the owner and indicating the required service or repair (include the model number and full serial number),
- place the unit in its original container with appropriate packaging material for shipping, and
- secure the container with strong tape or metal bands.

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 Agilent suggests that you always insure shipments.

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Contact us

To obtain service, warranty, or technical assistance, contact us at the following phone or fax numbers:

United States:
(tel) 800 829 4444 (fax) 800 829 4433
Canada:
(tel) 877 894 4414 (fax) 800 746 4866
China:
(tel) 800 810 0189 (fax) 800 820 2816
Europe:
(tel) 31 20 547 2111
Japan:
(tel) (81) 426 56 7832 (fax) (81) 426 56 7840
Korea:
(tel) (080) 769 0800 (fax) (080) 769 0900
Latin America:
(tel) (305) 269 7500
Taiwan:
(tel) 0800 047 866 (fax) 0800 286 331
Other Asia Pacific Countries:
(tel) (65) 6375 8100 (fax) (65) 6755 0042

Or visit Agilent World Wide Web at:
www.agilent.com/find/assist

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