

Agilent U3606A Multimeter | DC Power Supply

User's and Service Guide



Agilent Technologies

Notices

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Safety Notices

CAUTION

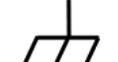
A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully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

WARNING

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

Safety Symbols

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

	Direct current (DC)		Off (supply)
	Alternating current (AC)		On (supply)
	Both direct and alternating current		Caution, risk of electric shock
	Three-phase alternating current		Caution, risk of danger (refer to this manual for specific Warning or Caution information)
	Earth (ground) terminal		Caution, hot surface
	Protective conductor terminal		Out position of a bi-stable push control
	Frame or chassis terminal		In position of a bi-stable push control
	Equipotentiality	CAT II 300 V	Category II 300 V overvoltage protection
	Equipment protected throughout by double insulation or reinforced insulation		

General Safety Information

WARNING

- Do not exceed any of the measurement limits defined in the specifications to avoid instrument damage and the risk of electric shock.
 - Do not use the 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 conditions	Requirements
Operating temperature	0 °C to 55 °C
Storage temperature	-40 °C to 70 °C
Relative humidity	Up to 80% at 30 °C RH (non-condensing)

NOTE

The U3606A Multimeter | DC Power Supply complies with the following safety and EMC requirements:

- IEC 61010-1:2001/EN61010-1:2001 (2nd Edition)
- Canada: CAN/CSA-C22.2 No. 61010-1-04
- USA: ANSI/UL 61010-1:2004
- IEC 61326-1:2005/EN61326-1:2006
- CISPR11:2003/EN55011:2007, Group 1 Class A
- Canada: ICES/NMB-001:2004
- Australia/New Zealand: AS/NZS CISPR 11:2004

Regulatory Markings

 <p>ISM 1-A</p>	<p>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.</p>	 <p>N10149</p>	<p>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.</p>
<p>ICES/NMB-001</p>	<p>ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.</p>		<p>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.</p>
 <p>C US</p>	<p>The CSA mark is a registered trademark of the Canadian Standards Association.</p>		

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 Technologies, or visit:

www.agilent.com/environment/product

for more information.

In This Guide...

1 Getting Started

This chapter prepares the U3606A Multimeter | DC Power Supply for use, and contains a brief description of the instrument front panel, display, keypad, terminals, and rear panel.

2 Digital Multimeter Operation

This chapter contains detailed information on how to take measurements using the U3606A Multimeter | DC Power Supply. It also describes the various multimeter functions and features available in the U3606A.

3 DC Power Supply Operation

This chapter contains examples on how to operate the DC power supply from the front panel. The simple examples discussed in this chapter shows you how to program the output voltage and current functions, the protection functions, and the additional source functions.

4 System Related Operation

This chapter lists the various items and settings in the utility menu. This chapter also describes how to store and recall an instrument state with the U3606A Multimeter | DC Power Supply.

5 Verification and Performance Tests

This chapter contains the procedures for verification of the instrument performance. The input connections and test setup for each verification procedure is also described in this chapter.

6 Calibration Procedures

This chapter contains the procedures for the instrument adjustment (calibration). You must first unsecure the instrument before any adjustment can be done. The steps to secure and unsecure the instrument for calibration are also described in this chapter.

7 Disassembly and Repair

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

8 Characteristics and Specifications

This chapter specifies the characteristics, environmental conditions, and specifications of the U3606A.

9 List of Error Messages

The U3606A error messages are summarized in this chapter.

Declaration of Conformity (DoC)

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

<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.

Table of Contents

1 Getting Started

Introduction	2
Measurement features	2
Output features	3
System features	3
Initial Inspection	4
Standard purchase items	4
Connecting Power to the Instrument	5
Adjusting the Handle	6
To Rack Mount the Instrument	7
Stacking the Instrument	8
Product at a Glance	9
Product dimensions	9
The front panel at a glance	10
The display at a glance	11
The keypad at a glance	14
The terminals at a glance	19
The rear panel at a glance	22

2 Digital Multimeter Operation

Making Measurements	24
Performing voltage measurements	25
Performing current measurements	29
Performing resistance (2-wire) measurements	33
Performing low-resistance (4-wire) measurements	35
Performing frequency, pulse width, and duty cycle measurements	38
Performing capacitance measurements	46
Performing continuity tests	49

Table of Contents

Performing diode tests	51
Selecting a Range	54
Setting the Resolution	55
Math Operations	56
Null	57
dBm measurements	59
dB measurements	60
MinMax	62
Limit	64
Hold	67
Triggering the Multimeter	69
Front panel triggering	70
Remote interface triggering	71
3 DC Power Supply Operation	
Basic Operation	74
Constant voltage (CV) mode	74
Constant current (CC) mode	76
Protection Functions	78
Overvoltage protection (OVP)	78
Overcurrent protection (OCP)	81
Overvoltage limit (OV)	84
Overcurrent limit (OC)	86
Square-wave Output	88
Sweep Functions	93
Ramp signal	93
Scan signal	95
Selecting a Range	97
Enabling the Output	98

Remote Sensing 99

4 System Related Operation

Using the Utility Menu 108

 Changing configurable settings 109

Utility Menu Summary 111

 Reading error messages 114

 Reading the program code revision 115

 Adjusting the display brightness 116

 Changing the power-on state 116

 Configuring the beeper 117

 Connecting to a remote interface 118

 Performing a self-test 120

 Selecting a dBm reference resistance value 121

 Setting the output protection state 122

 Configuring the ramp signal parameters 123

 Configuring the scan signal parameters 125

 Setting the smooth function 127

 Enable refresh hold 130

 Enable data hold 131

Storing and Recalling Instrument States 132

 Storing a state 132

 Recalling a stored state 133

Remote Operation 134

 Configuring and connecting the GPIB interface 135

 Configuring and connecting the USB interface 136

 SCPI commands 137

5 Verification and Performance Tests

Recommended Test Equipment 140

 General measurement techniques 143

Table of Contents

Using an electronic load	143
Connecting the current monitoring resistor	143
Test Considerations	144
Input Connections	145
Zero offset verification test setup	145
Gain verification test setup	146
Output verification test setup	147
Verification and Performance Tests Overview	152
Self-test	153
Performance Verification Tests	154
Zero offset verification test	154
Gain verification test	156
Output verification test	161
Additional Verification Tests	171
Optional capacitance gain verification test	171
Optional square-wave output verification test	172

6 Calibration Procedures

Calibration Overview	176
Closed-case electronic calibration	176
Agilent Technologies calibration services	176
Calibration interval	177
Adjustment is recommended	177
Time required for calibration	177
Recommended Test Equipment	178
Calibration Process	179
Calibration Security	180
Unsecuring the instrument for calibration	180
Changing the calibration security code	183

Resetting the security code to the factory default	183
Calibration Count	186
Calibration Message	187
Using the Front Panel for Adjustments	188
Selecting the adjustment mode	188
Entering adjustment values	188
Aborting a calibration in progress	189
General calibration procedure	190
Adjustments procedures	193
Zero offset adjustment	193
Gain adjustments	195
Output adjustments	208
Finishing the adjustments	217
7 Disassembly and Repair	
Operating Checklist	220
Cleaning	221
Fuse Replacement	221
Electrostatic Discharge (ESD) Precautions	226
Mechanical Disassembly	227
General disassembly	227
Replaceable Parts	235
To Order Replaceable Parts	236
Types of Services Available	237
Repackaging for Shipment	238
8 Characteristics and Specifications	
Product Characteristics	240

Table of Contents

Digital Multimeter Specifications	242
Specification assumptions	242
DC specifications	242
AC specifications	245
Frequency specifications	246
Duty cycle and pulse width specifications	247
Operating specifications	248
Supplementary characteristics	249
DC Power Supply Specifications	253
Safety considerations	253
Specifications assumptions	253
Performance specifications	254
Supplementary characteristics	255

9 List of Error Messages

Error Messages	260
Command errors	261
Execution errors	262
Internal errors	263
Query errors	263
Device specific errors	263
Self-test errors	264
Calibration errors	265

List of Figures

Figure 1-1	U3606A handle adjustments	6
Figure 1-2	U3606A stacking directions	8
Figure 1-3	U3606A dimensions	9
Figure 1-4	U3606A front panel	10
Figure 1-5	VFD full display with all segments illuminated	11
Figure 1-6	U3606A keypad with both multimeter and source operations	14
Figure 1-7	U3606A connector terminals	19
Figure 1-8	U3606A rear panel	22
Figure 2-1	Terminal connections for voltage measurements	25
Figure 2-2	Terminal connections for current measurements	29
Figure 2-3	Terminal connections for 2-wire resistance measurements	33
Figure 2-4	Terminal connections for 4-wire resistance measurements	36
Figure 2-5	Terminal connections for frequency, pulse width, and duty cycle measurements via the voltage path	38
Figure 2-6	Terminal connections for frequency, pulse width, and duty cycle measurement via the current path	39
Figure 2-7	Terminal connections for capacitance measurements	47
Figure 2-8	Terminal connections for continuity tests	49
Figure 2-9	Terminal connections for diode tests	51
Figure 3-1	Constant voltage mode terminal connections	74
Figure 3-2	Constant current mode terminal connections	76
Figure 3-3	Remote sensing connections	100
Figure 3-4	Local sensing connections	100
Figure 5-1	Test setup for zero offset (short) verification	145
Figure 5-2	Test setup for DC voltage, AC voltage, resistance, and capacitance gain verification	146
Figure 5-3	Test setup for DC current and AC current gain verification	146
Figure 5-4	Test setup for frequency gain verification	147
Figure 5-5	Test setup for CV programming and readback accuracy verification	147
Figure 5-6	Test setup for CV load and line regulation verification	148
Figure 5-7	Test setup for CV noise effect verification	148
Figure 5-8	Test setup for load transient response time verification	149
Figure 5-9	Test setup for CC programming and readback accuracy verification	149

List of Figures

- Figure 5-10 Test setup for CC line and load regulation verification 150
- Figure 5-11 Test setup for CC noise effect verification 150
- Figure 5-12 Test setup for square-wave output verification 151
- Figure 5-13 Load transient response time 166
- Figure 6-1 SECUR pads location 184

List of Tables

Table 1-1	U3606A display annunciators	11
Table 1-2	U3606A keypad functions	15
Table 1-3	Input terminal connections for measurement functions	20
Table 1-4	Output terminal connections for source functions	21
Table 2-1	DC voltage measurement summary	26
Table 2-2	AC voltage measurement summary	27
Table 2-3	DC current measurement summary	30
Table 2-4	AC current measurement summary	31
Table 2-5	Resistance measurement summary	34
Table 2-6	Low-resistance measurement summary	37
Table 2-7	Frequency measurement (voltage path) summary	40
Table 2-8	Frequency measurement (current path) summary	43
Table 2-9	Capacitance measurement summary	48
Table 2-10	Continuity function summary	50
Table 2-11	Diode function summary	52
Table 2-12	Math operations summary	56
Table 3-1	Available frequencies for square-wave output	90
Table 4-1	Utility menu key descriptions	108
Table 4-2	Utility menu item descriptions	111
Table 4-3	Ramp signal parameters	123
Table 4-4	Scan signal parameters	125
Table 5-1	Recommended test equipment for performance verification procedures	140
Table 5-2	Zero offset verification test	155
Table 5-3	DC voltage gain verification test	156
Table 5-4	DC current gain verification test	157
Table 5-5	AC voltage gain verification test	158
Table 5-6	AC current gain verification test	159
Table 5-7	Resistance gain verification test	159
Table 5-8	Frequency gain verification test	160
Table 5-9	Constant voltage programming and readback accuracy verification test	161
Table 5-10	Constant voltage load effect verification test	162
Table 5-11	Constant voltage source effect verification test	163
Table 5-12	Constant current programming and readback accuracy verification	

List of Tables

	test	167
Table 5-13	Constant current load effect verification test	168
Table 5-14	Constant current source effect verification test	169
Table 5-15	Optional capacitance gain verification test	171
Table 5-16	Square-wave amplitude output verification test	173
Table 5-17	Square-wave frequency output verification test	173
Table 5-18	Square-wave duty cycle output verification test	174
Table 6-1	Recommended test equipment for adjustment procedures	178
Table 6-2	Valid gain adjustment input values	196
Table 6-3	DC voltage gain adjustment	198
Table 6-4	AC voltage gain adjustment	200
Table 6-5	Frequency gain adjustment	201
Table 6-6	Resistance gain adjustment	202
Table 6-7	DC current gain adjustment	204
Table 6-8	AC current gain adjustment	205
Table 6-9	Capacitance gain adjustment	206
Table 6-10	Valid output adjustment levels	208
Table 6-11	Constant current output adjustment	210
Table 6-12	Constant voltage output adjustment	213
Table 7-1	List of replaceable parts	235
Table 8-1	DC accuracy specifications \pm (% of reading + % of range)	242
Table 8-2	AC accuracy specifications \pm (% of reading + % of range)	245
Table 8-3	Frequency accuracy specifications \pm (% of reading + % of range)	246
Table 8-4	Frequency sensitivity for voltage measurement	246
Table 8-5	Frequency sensitivity for current measurement	247
Table 8-6	Duty cycle and pulse width resolution and accuracy	247
Table 8-7	Reading speed (typical)	248
Table 8-8	DC power supply performance specifications	254
Table 8-9	Square-wave output specifications	256
Table 8-10	Scan output specifications	258
Table 8-11	Ramp output specifications	258
Table 9-1	List of command errors	261
Table 9-2	List of execution errors	262
Table 9-3	List of internal errors	263
Table 9-4	List of query errors	263
Table 9-5	List of device specific errors	263
Table 9-6	List of self-test errors	264
Table 9-7	List of calibration errors	265



1 Getting Started

Introduction	2
Measurement features	2
Output features	3
System features	3
Initial Inspection	4
Standard purchase items	4
Connecting Power to the Instrument	5
Adjusting the Handle	6
To Rack Mount the Instrument	7
Product at a Glance	9
Product dimensions	9
The front panel at a glance	10
The display at a glance	11
The keypad at a glance	14
The terminals at a glance	19
The rear panel at a glance	22

This chapter prepares the U3606A Multimeter|DC Power Supply for use, and contains a brief description of the instrument front panel, display, keypad, terminals, and rear panel.



Introduction

The Agilent U3606A Multimeter|DC Power Supply unit is a combination of a 5½ digit digital multimeter and a 30 W single output dual-range DC power supply with a square-wave generator. These two distinctive modules are able to work simultaneously (expand independently), providing an efficient, convenient, and affordable testing solution.

The U3606A has the dimensions of 2½U (rack unit) high, and provides the flexibility for bench or rack-mounted use.

The front panel controls allow you to set the measurement parameters, mathematical operations, output parameters, protection features, and instrument settings.

The rear panel includes a GPIB and USB interface connector, as well as output terminals capable of remote sensing.

When operating over the remote interface, the U3606A functions as both a listener and a talker. Using an external controller (such as a PC), you can instruct the U3606A to make a measurement, output a source, or send data back over the GPIB or USB interfaces.

Measurement features

- 5½ digit, 120000 count
- Voltage and current measurement – DC, AC (true-rms), and AC+DC
- 2-wire resistance measurement up to 100 MΩ
- 4-wire low-resistance measurement (100 mΩ to 10 Ω)
- Continuity and diode test
- Frequency, pulse width, and duty cycle measurement – via the voltage path or via the current path
- Capacitance measurement
- Auto and manual ranging
- Mathematical operations for null, decibel (dBm and dB) measurements, statistics (MinMax), limit, and hold
- Triggering for local and remote operation

Output features

- Single-output dual range – S1 (30 V/1 A) or S2 (8 V/3 A)
- Constant voltage and constant current supply
- Overvoltage and overcurrent protection
- Remote sensing to compensate for voltage drop in load leads
- Square-wave generator with selectable amplitude, frequency, duty cycle, and pulse width parameters
- Output on standby when disabled
- Ramp signal capability with fixed time for preset step and end amplitude
- Scan signal capability with preset time, step, and end amplitude
- Excellent load and line regulation
- Low ripple and noise

System features

- Highly visible vacuum-fluorescent display (VFD)
- Built-in GPIB (IEEE-488) and USB interface, I/O setup easily done from the front-panel
- USB 2.0 full speed interface – USBTMC488.2 compatible
- Compatible with Standard Commands for Programmable Instruments (SCPI)
- Automatic power-on self-test
- Error messages available from the front-panel display
- User calibration from front panel and remote interface – software calibration, no internal physical adjustments
- Sixteen storage locations for user-defined operating states
- Portable, rugged case with non-skid feet
- Kensington security slot – anti-theft system

Initial Inspection

When you receive your instrument, inspect the unit for any obvious damage such as broken terminals or cracks, dents, and scratches on the casing that may occur during shipment.

If any damage is found, notify the nearest Agilent Sales Office immediately. The front of this manual contains the warranty information.

Standard purchase items

Verify that you have received the following items with your unit. If anything is missing or damaged, please contact the nearest Agilent Sales Office.

- ✓ Power cord
- ✓ U8201A Combo test lead kit (test leads, alligator clips, SMT grabbers, fine tip test probes, mini-grabbers)
- ✓ USB Standard-A to Type-B interface cable
- ✓ Printed Agilent U3606A Multimeter|DC Power Supply Quick Start Guide
- ✓ Agilent Automation-Ready CD-ROM (contains the Agilent IO Libraries Suite)
- ✓ Agilent U3606A Product Reference CD-ROM
- ✓ Certificate of Calibration

Keep the original packaging in case the U3606A has to be returned to Agilent in the future. If you return the U3606A for service, attach a tag identifying the owner and model number. Also, include a brief description of the problem.

Adjusting the Handle

To adjust the handle, grasp the handle by the sides and pull outward. Then, rotate the handle to the desired position. The various positions available are illustrated below.

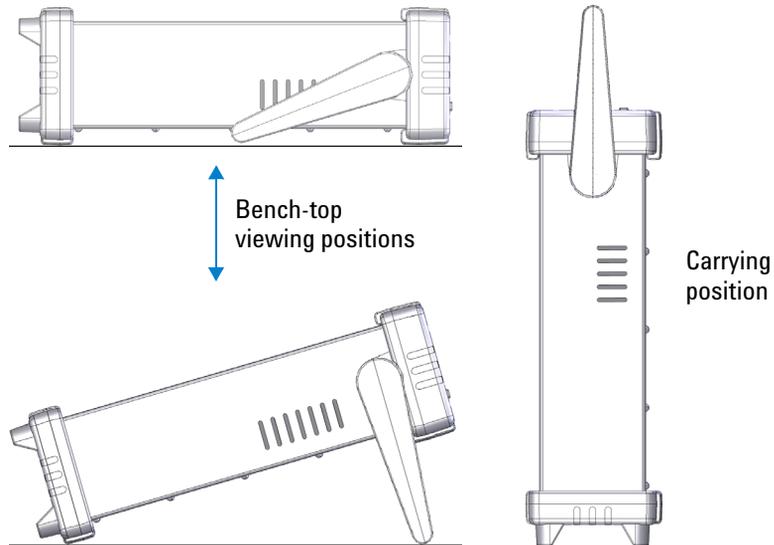
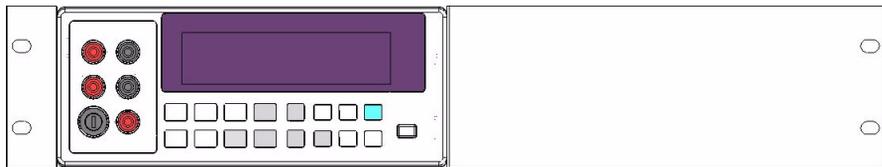


Figure 1-1 U3606A handle adjustments

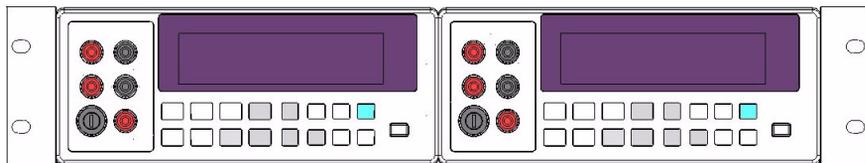
To Rack Mount the Instrument

You can mount the U3606A in a standard 19-inch rack cabinet using one of the three optional kits available. Instructions and mounting hardware are included with each rack-mounting kit. Any Agilent Technologies instrument of the same size can be rack-mounted beside the U3606A Multimeter|DC Power Supply.

- 1 Remove the carrying handle and the front and rear rubber bumpers before rack-mounting the instrument.
- 2 To remove the handle, rotate it to a vertical position and pull the ends outward.
- 3 To remove the rubber bumpers, stretch a corner and slide it off.
- 4 To rack mount a single instrument, order U3606A-ICM (adapter kit 34190A).



- 5 To rack mount two instruments side-by-side, order U3606A-ICN (lock-link kit 34194A and flange kit 34191A). Be sure to use the support rails inside the rack cabinet. This configuration only works for two U3606A side-by-side.



Stacking the Instrument

If you have purchased more than one unit of the U3606A Multimeter|DC Power Supply, you can stack the units on top of each other. The warning sign *Stackable Direction* located at the bottom side of the front and back rubber bumpers indicate the orientation of the rubber bumpers.

The rubber bumpers are uniquely designed to firmly secure the units stacked above it, preventing any unwanted movements. You may stack as many units as you want on top of each other.

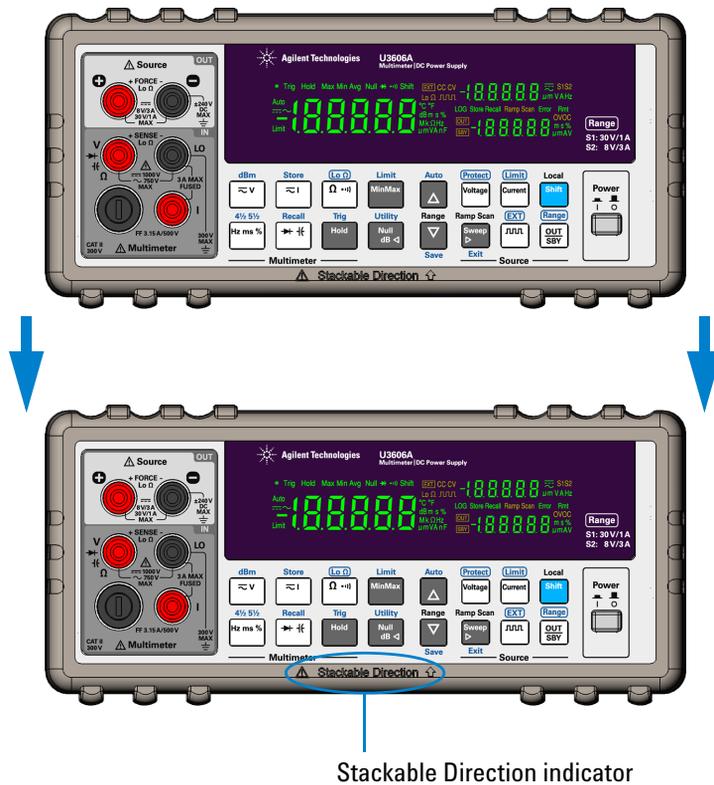


Figure 1-2 U3606A stacking directions

Product at a Glance

Product dimensions

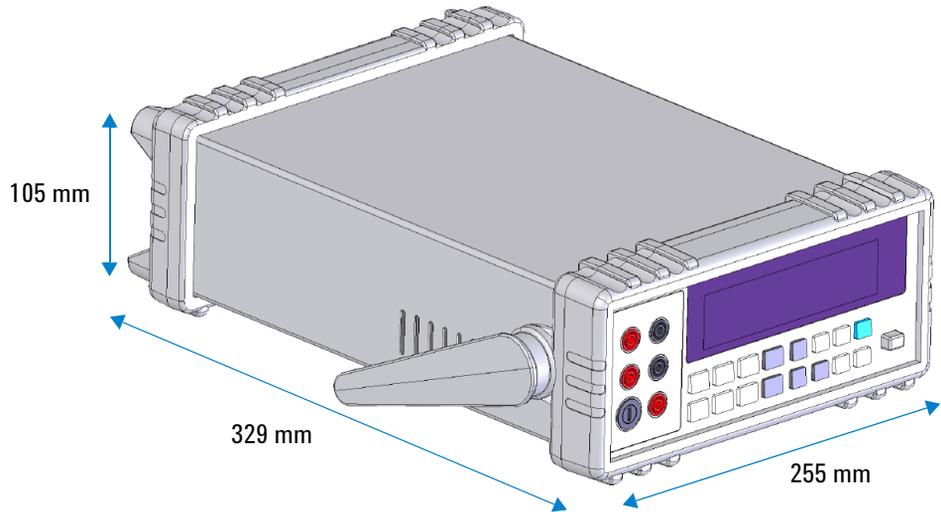


Figure 1-3 U3606A dimensions

The front panel at a glance



Figure 1-4 U3606A front panel

Item	Description
1 Source terminals	Positive (FORCE +) and negative (FORCE –) connector terminals for source operation and 4-wire low-resistance measurement.
2 VFD display	Displays the instrument settings and readings. See “The display at a glance” on page 11 for a complete list of all display annunciators.
3 Multimeter terminals	Positive (SENSE +) and negative (SENSE –) connector terminals for multimeter operation.
4 Multimeter function keys	Function keys for multimeter operation. See “Multimeter operation” on page 16 for a complete list of all multimeter key functions.
5 Autorange and manual range keys	Select a manual range for multimeter operation or enable autoranging. See “Selecting a Range” on page 54 for more information.
6 Source function keys	Function keys for source operation. See “Source operation” on page 17 for a complete list of all source key functions.
7 Local/Shift key	Perform <i>shifted</i> functions and enables front panel operation during remote lock. See “Using the Shift key” on page 14 for more information.
8 Power On/Off button	Turns the power supply on or off. See “Connecting Power to the Instrument” on page 5 for more information.

The display at a glance

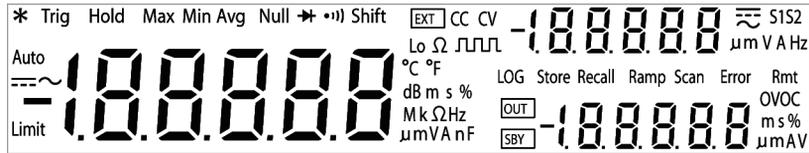


Figure 1-5 VFD full display with all segments illuminated



To view the full display (with all segments illuminated), press and hold **Hold** while powering-on the U3606A. After you are done viewing the full display, press **Hold** again to resume normal operation.

Table 1-1 U3606A display annunciators

Annunciator	Description
*	A single reading is taken from the input (+ SENSE –) terminals
Trig	Single trigger mode is active
Hold	Hold math operation enabled
MinMaxAvg	MinMax math operation enabled
Avg	When Avg is flashing, the smooth function is enabled
Null	Null math operation enabled
→ •)	Diode test function selected
Ω•)	Continuity test function selected
Ω	Resistance (2-wire) measurement selected
Shift	Shift mode selected
Limit	Limit math operation enabled
Auto	Autoranging selected
---	DC measurement selected

Table 1-1 U3606A display annunciators (continued)

Annunciator	Description
~	AC measurement selected
≡ ~	AC+DC measurement selected
°C	Celsius temperature unit (feature not applicable with the U3606A)
°F	Fahrenheit temperature unit (feature not applicable with the U3606A)
dB	Decibel unit relative to 1 dBm
dBm	Decibel unit relative to 1 mW
ms	Pulse width unit
%	Duty cycle unit
MkΩ	Resistance units: Ω, kΩ, MΩ
MkHz	Frequency units: Hz, kHz, MHz
mV	Voltage units: mV, V
mA	Current units: mA, A
μnF	Capacitance units: nF, μF
EXT	Remote sensing mode enabled
CC	Constant current mode selected
CV	Constant voltage mode selected
Lo Ω	Low-resistance (4-wire) measurement selected
⌚	Square-wave output selected
S1	Output range S1 selected — 30 V/1 A
S2	Output range S2 selected — 8 V/3 A
V	Voltage unit: V for constant voltage mode
A	Current unit: A for constant current mode
Hz	Frequency unit: Hz for square-wave output
LOG	Data logging in progress (feature not applicable with the U3606A)

Table 1-1 U3606A display annunciators (continued)

Annunciator	Description
Store	Store instrument state selected
Recall	Recall instrument state selected
Ramp	Ramp signal output selected
Scan	Scan signal output selected
Error	One or more errors available in the error queue
Rmt	Remote interface control is active
OV	Overvoltage condition active
OC	Overcurrent condition active
OUT	Output is enabled from the output (+ FORCE –) terminals and remote sense (rear output) terminals
SBY	Output is on standby (disabled)
ms	Pulse width unit for square-wave output
%	Duty cycle unit for square-wave output
V	Voltage unit: V for overvoltage protection
A	Current unit: A for overcurrent protection

The keypad at a glance

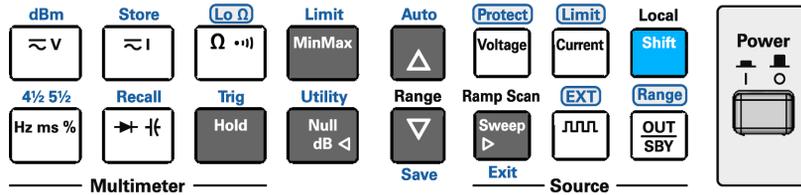


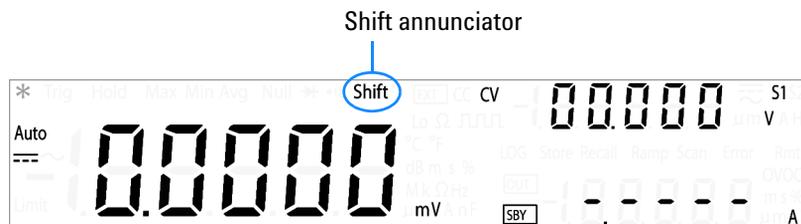
Figure 1-6 U3606A keypad with both multimeter and source operations

The operation of each key is shown below. Pressing a key changes the current operation, illuminates a related annunciator on the display, and generates a key-click sound (a beep).

Using the Shift key

The front panel has two rows of keys to select various functions and operations. Most keys have a *shifted* function printed in blue above the key. To perform a *shifted* function: first, press **Shift** (the Shift annunciator will illuminate). Then, press the key that has the desired label above it.

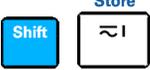
The **dBm**, **Store**, **Lo Ω**, **Limit**, **Auto**, **Protect**, **Limit**, **4½ 5½**, **Recall**, **Trig**, **Utility**, **Save**, **Exit**, **EXT**, and **Range** functions/operations can only be accessed using the **Shift** key.



As an example, to enable the limit math operation, first press **Shift**. While the Shift annunciator is illuminated, press **MinMax** (**Limit**).

If you accidentally press **Shift**, but do not want to perform a *shifted* function, just press it again to turn off the Shift annunciator. If no key-press is detected 3 seconds after **Shift** is pressed, the instrument will return to normal operation (the Shift annunciator will turn off).

Table 1-2 U3606A keypad functions

Key	Description
System related operation	
 <p>Power</p>	<p>Push Power to turn on or turn off the U3606A Multimeter DC Power Supply.</p>
 <p>Local Shift</p>	<ul style="list-style-type: none"> Press Shift to perform a <i>shifted</i> function. See “Using the Shift key” on page 14 for more information. Press Shift to unlock the front-panel keys when in remote operation lock. See “Remote Operation” on page 134 for more information.
 <p>Utility Null dB ◀</p>	<p>Press Shift > Utility to access the utility menu. See “Using the Utility Menu” on page 108 for more information.</p>
 <p>Null dB ◀ Sweep ▶</p>	<ul style="list-style-type: none"> Press ◀ or ▶ to step through items in the utility menu. Press ◀ or ▶ to move the cursor to the left or to the right. See “Using the Utility Menu” on page 108 and “Changing configurable settings” on page 109 for more information.
 <p>▲ ▼</p>	<ul style="list-style-type: none"> Press ▲ or ▼ to enter the edit mode in the utility menu for configurable settings. Press ▲ or ▼ to switch between two values, to select a value from the list, or to decrease or increase a value. See “Using the Utility Menu” on page 108 and “Changing configurable settings” on page 109 for more information.
 <p>Shift ▼ Save</p>	<p>Press Shift > Save to save the changes made in the edit mode. See “Changing configurable settings” on page 109 for more information.</p>
 <p>Shift Sweep ▶ Exit</p>	<ul style="list-style-type: none"> Press Shift > Exit to exit the edit mode or utility menu without saving. See “Changing configurable settings” on page 109 for more information. Press Shift > Exit to toggle off a math operation (Null, dBm, dB, MinMax, Limit, Hold). See “Math Operations” on page 56 for more information.
 <p>Shift ~ Store</p>	<p>Press Shift > Store to store an instrument state. See “Storing a state” on page 132 for more information.</p>

1 Getting Started

Product at a Glance

Table 1-2 U3606A keypad functions (continued)

Key	Description
 	Press Shift > Recall to recall a previously stored instrument state. See “ Recalling a stored state ” on page 133 for more information.
Multimeter operation	
	Press $\sim V$ to cycle between the DC, AC, and AC+DC voltage measurement functions. See “ Performing voltage measurements ” on page 25 for more information.
	Press $\sim I$ to cycle between the DC, AC, and AC+DC current measurement functions. See “ Performing current measurements ” on page 29 for more information.
	<ul style="list-style-type: none"> Press $\Omega \bullet\bullet$ to select the resistance (2-wire) measurement function. See “Performing resistance (2-wire) measurements” on page 33 for more information. Press $\Omega \bullet\bullet$ again to select the continuity test function. See “Performing continuity tests” on page 49 for more information.
 	Press Shift > Lo Ω to select the low-resistance (4-wire) measurement function. See “ Performing low-resistance (4-wire) measurements ” on page 35 for more information.
	Press Hz ms % to cycle between the frequency (Hz), pulse width (ms), and duty cycle (%) measurement functions related to the voltage or current path. ^[1] See “ Performing frequency, pulse width, and duty cycle measurements ” on page 38 for more information.
	<ul style="list-style-type: none"> Press $\rightarrow \{$ to select the diode test function. See “Performing diode tests” on page 51 for more information. Press $\rightarrow \{$ again to select the capacitance function. See “Performing capacitance measurements” on page 46 for more information.
	Press Null to enable the null math operation. See “ Null ” on page 57 for more information.
 	Press Shift > dBm to convert the measured voltage value to dBm. See “ dBm measurements ” on page 59 for more information.
  	Press Shift > dBm > dB to convert the measured voltage value to dB. See “ dB measurements ” on page 60 for more information.

Table 1-2 U3606A keypad functions (continued)

Key	Description
	Press MinMax to store statistical data for the current readings. See “MinMax” on page 62 for more information.
 	Press Shift > Limit to enable the limit math operation. See “Limit” on page 64 for more information.
	Press Hold to capture and hold a reading within the specified variation and threshold values. ^[2] See “Hold” on page 67 for more information.
 Range 	<ul style="list-style-type: none"> • Press  to select a higher range and disable autoranging. • Press  to select a lower range and disable autoranging. • See “Selecting a Range” on page 54 for more information.
 	Press Shift > Auto to enable autoranging and disable manual ranging. See “Selecting a Range” on page 54 for more information.
 	Press Shift > 4½ 5½ to toggle between 4½ digit and 5½ digit mode. See “Setting the Resolution” on page 55 for more information. ^[3]
 	Press Shift > Trig to enable the single trigger mode. See “Triggering the Multimeter” on page 69 for more information.
Source operation	
	Press Voltage to select CV output. Use the directional keys to select a suitable voltage value. See “Constant voltage (CV) mode” on page 74 for more information.
	Press Current to select CC output. Use the directional keys to select a suitable current value. See “Constant current (CC) mode” on page 76 for more information.

1 Getting Started

Product at a Glance

Table 1-2 U3606A keypad functions (continued)

Key	Description
	<ul style="list-style-type: none"> Press  to select the square-wave output. Use the directional keys to set the voltage amplitude. Press  again to cycle through the duty cycle, pulse width, and voltage amplitude settings. See “Square-wave Output” on page 88 for more information.
	When the  annunciator is flashing, press  or  to step through the available frequencies.
	While the  annunciator is flashing, press  or  to set the voltage amplitude, or to step through the available duty cycle values or pulse width values.
Ramp Scan 	Press Sweep to cycle through the ramp and scan sweep functions, or to disable the sweep mode for the selected output (CV or CC). ^[4] See “ Sweep Functions ” on page 93 for more information.
	Press Shift > Limit to set the overcurrent limit value for the CV output or the overvoltage limit value for the CC output. See “ Protection Functions ” on page 78 for more information.
	Press Shift > Protect to set the overcurrent protection value for the CV output or the overvoltage protection value for the CC output ^[5] . See “ Protection Functions ” on page 78 for more information.
	Press Shift > Range to toggle between range S1 (30 V/1 A) and range S2 (8 V/3 A) ^[6] . See “ Selecting a Range ” on page 97 for more information.
	Press  to toggle between source output (OUT) and source standby (SBY). See “ Enabling the Output ” on page 98 for more information.
	Press Shift > EXT to enable remote sensing. See “ Remote Sensing ” on page 99 for more information.

[1] The voltage path is the default path when you select the frequency measurement function. To switch to the current path for frequency, pulse width, and duty cycle measurements, first press , then press **Hz ms %**.

[2] The refresh hold variation and threshold values can be configured through the utility menu. See [Chapter 4](#), “System Related Operation,” starting on page 107 for more information on the utility menu.

- [3] The continuity and diode test functions have a fixed 4½ digit resolution. Capacitance measurement is fixed to 3½ digit resolution.
- [4] The sweep functions can only be accessed when the U3606A is in constant voltage or constant current mode. You cannot access the sweep functions while the U3606A is in square-wave output mode.
- [5] The overcurrent and overvoltage protection features are only active when the output protection state is enabled. See [Chapter 4](#), “Setting the output protection state,” starting on page 122 for more information.
- [6] You can only change the range when the instrument output is in the “standby” state (the SBY annunciator is illuminated).

The terminals at a glance

CAUTION

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

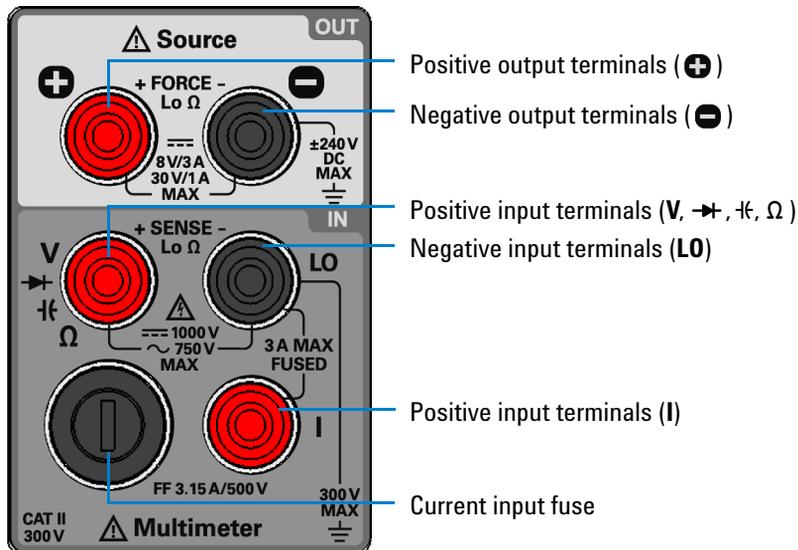


Figure 1-7 U3606A connector terminals

1 Getting Started

Product at a Glance

Table 1-3 Input terminal connections for measurement functions

Function	Input terminals (+ SENSE –)		Input protection
DC voltage measurement			1000 V _{rms} on all ranges, < 0.3 A short circuit
AC voltage measurement	V	LO	
Frequency, duty cycle, and pulse width measurement via the voltage path			750 V _{rms} on all ranges
Capacitance measurement		LO	1000 V _{rms} on all ranges, < 0.3 A short circuit
Diode test		LO	1000 V _{rms} on all ranges, < 0.3 A short circuit
Resistance (2-wire) measurement	Ω	LO	1000 V _{rms} on all ranges, < 0.3 A short circuit
Continuity test	Ω	LO	1000 V _{rms} on all ranges, < 0.3 A short circuit
Low-resistance (4-wire) measurement	Ω	LO	1000 V _{rms} on all ranges, < 0.3 A short circuit
			1000 V _{dc} on all ranges, 3.15 A/250 V FF fuse
DC current measurement			
AC current measurement	I	LO	3.15 A/500 V FF fuse
Frequency, duty cycle, and pulse width measurements via the current path			

Table 1-4 Output terminal connections for source functions

Function	Output terminals (+ FORCE -)	Maximum output
Constant voltage output		<ul style="list-style-type: none"> • Amplitude: 0 V to 30 V^[1] • OCP: <ul style="list-style-type: none"> • S1: 0 A to 1.1 A • S2: 0 A to 3.3 A • OC: <ul style="list-style-type: none"> • S1: 0 A to 1.05 A • S2: 0 A to 3.15 A
Constant current output		<ul style="list-style-type: none"> • Amplitude: 0 A to 3 A^[1] • OVP: <ul style="list-style-type: none"> • S1: 0 V to 33 V • S2: 0 V to 8.8 V • OV: <ul style="list-style-type: none"> • S1: 0 V to 31.5 V • S2: 0 V to 8.4 V
Ramp output		<ul style="list-style-type: none"> • Amplitude: <ul style="list-style-type: none"> • CV: 0 V to 30 V^[1] • CC: 0 A to 3 A^[1] • Number of steps: 1 to 10000 steps
Scan output		<ul style="list-style-type: none"> • Amplitude: <ul style="list-style-type: none"> • CV: 0 V to 31.5 V^[1] • CC: 0 A to 3.15 A^[1] • Number of steps: 1 to 100 steps • Dwelling time: 1 to 99 s
Square-wave output		<ul style="list-style-type: none"> • Amplitude: 0 V to 30 V^[1] • Frequency: 27 predefined values • Duty cycle: 256 steps • Pulse width: 256 steps

[1] Limited by range selected, S1 (30 V/1 A) or S2 (8 V/3 A). See “Selecting a Range” on page 97 for more information on how to select a suitable range.

The rear panel at a glance

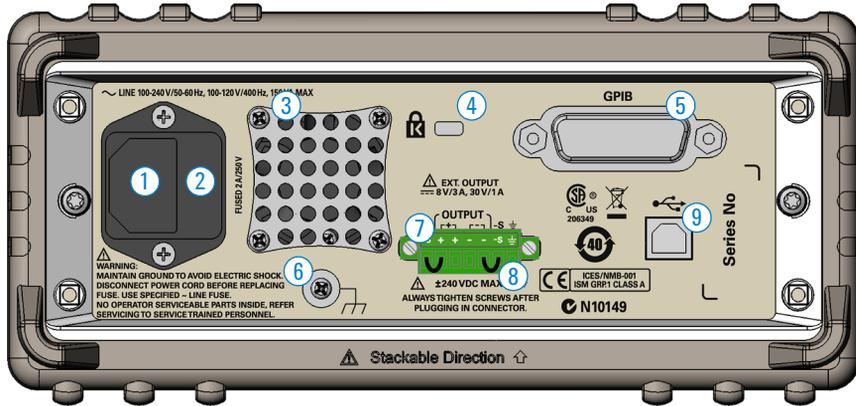
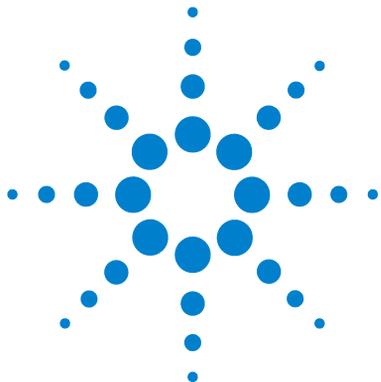


Figure 1-8 U3606A rear panel

Item	Description
1 AC power connector	Plug the power cord firmly into the power receptacle on the rear panel of the instrument. See “Connecting Power to the Instrument” on page 5 for more information.
2 AC line fuse	To maintain protection, replace this fuse only with a fuse of the specified type and rating.
3 Ventilation fan	Ventilation fan to exhaust heat and air from the instrument.
4 Kensington security slot	Anti-theft system using Kensington locks.
5 GPIB interface connector	GPIB (IEEE-488) connector physical interface. See “Configuring and connecting the GPIB interface” on page 135 for more information.
6 Chassis ground lug	Connect to earth ground or to unit chassis to eliminate noise caused by ground loops.
7 Rear output terminals	Rear panel terminals for remote sense. See “Remote Sensing” on page 99 for more information.
8 Short bar	Shorts the rear output (+ and –) and sense (+S and –S) terminals .
9 USB interface connector	Type-B USB connector physical interface. See “Configuring and connecting the USB interface” on page 136 for more information.



2 Digital Multimeter Operation

Making Measurements	24
Performing voltage measurements	25
Performing current measurements	29
Performing resistance (2-wire) measurements	33
Performing low-resistance (4-wire) measurements	35
Performing frequency, pulse width, and duty cycle measurements	38
Performing capacitance measurements	46
Performing continuity tests	49
Performing diode tests	51
Selecting a Range	54
Setting the Resolution	55
Math Operations	56
Null	57
dBm measurements	59
dB measurements	60
MinMax	62
Limit	64
Hold	67
Triggering the Multimeter	69
Front panel triggering	70
Remote interface triggering	71

This chapter contains detailed information on how to take measurements using the U3606A Multimeter | DC Power Supply. It also describes the various multimeter functions and features available in the U3606A.



Making Measurements

The following pages introduce the many types of measurements that you can make with the U3606A, and how to make the connections for each measurement.

NOTE

- Most basic measurements can be made using the instrument factory default settings.
- For remote operation, refer to the MEASure, CONFigure, and CALCulate subsystem in the *U3606A Programmer's Reference*.

CAUTION

Ensure that terminal connections are correct for that particular measurement before making any measurement. For each measurement, connect the test leads as shown. To avoid damaging the device, do not exceed the rated input limit.

Performing voltage measurements

Making the connections

Connect the test leads as shown below:

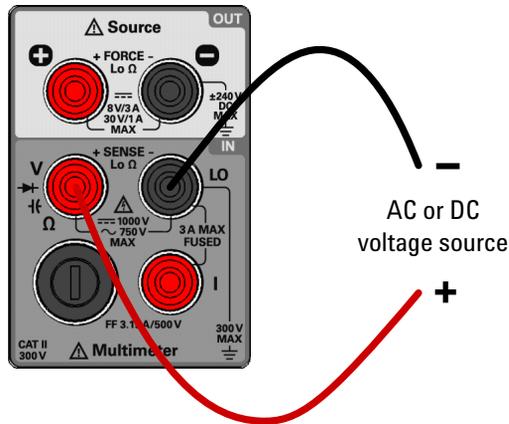


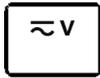
Figure 2-1 Terminal connections for voltage measurements

NOTE

- The U3606A will automatically select a suitable range for voltage measurements by default (autoranging). To manually select a range, see [“Selecting a Range”](#) on page 54 for more information.
- The U3606A resolution is set to 5½ digits by default. To change the resolution, see [“Setting the Resolution”](#) on page 55 for more information.

2 Digital Multimeter Operation

Making Measurements



Measuring DC voltage

- 1 Press $\approx V$ to make DC voltage measurements. (The DC annunciator is shown on the display.)

DC annunciator

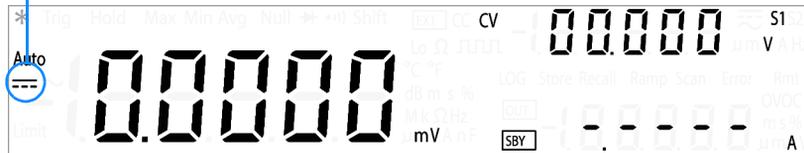


Table 2-1 DC voltage measurement summary

Item	Description
Available ranges	19.9999 mV, 100.000 mV, 1.00000 V, 10.0000 V, 100.000 V, 1000.00 V
Measurement method	Sigma Delta A-to-D converter
Input impedance	10 M Ω \pm 2% range (typical) in parallel with capacitance < 120 pF
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit

- 2 Connect the red and black test leads to input terminals **V** (red) and **LO** (black) respectively as shown in [Figure 2-1](#).
- 3 Probe the test points and read the display.



Measuring AC voltage

- 1 Press $\approx V$ again (until the AC annunciator is shown on the display) to make AC voltage measurements.

AC annunciator

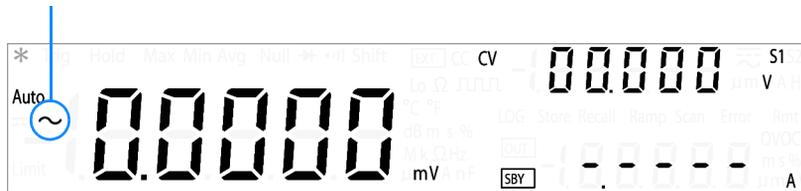


Table 2-2 AC voltage measurement summary

Item	Description
Available ranges	100.000 mV, 1.00000 V, 10.0000 V, 100.000 V, 750.00 V
Measurement method	AC coupled true rms
Input impedance	1 M Ω \pm 2% range (typical) in parallel with capacitance < 120 pF
Input protection	750 V _{rms} on all ranges
Crest factor	For < 5:1 errors included. Limited by the peak input and 100 kHz bandwidth. Maximum 3.0 at full scale.
Peak input	300% of range. Limited by maximum input.

- 2 Connect the red and black test leads to input terminals **V** (red) and **LO** (black) respectively as shown in [Figure 2-1](#).
- 3 Probe the test points and read the display.



2 Digital Multimeter Operation

Making Measurements



Measuring AC+DC voltage

The U3606A Multimeter|DC Power Supply includes a true-rms multimeter that returns an accurate rms reading not only for sine waves, but also other AC signals such as square, triangle, and staircase waveforms without any DC offset. However, you may choose to return the measured AC signal with DC offset by using the AC+DC function.

The AC+DC voltage measurement measures AC voltage with DC offset.

- 1 Press $\approx V$ again ((until the AC+DC annunciator is shown on the display) to make AC+DC voltage measurements.

AC+DC annunciator



- 2 Connect the red and black test leads to input terminals **V** (red) and **LO** (black) respectively as shown in [Figure 2-1](#).
- 3 Probe the test points and read the display.



Performing current measurements

Making the connections

Connect the test leads as shown below:

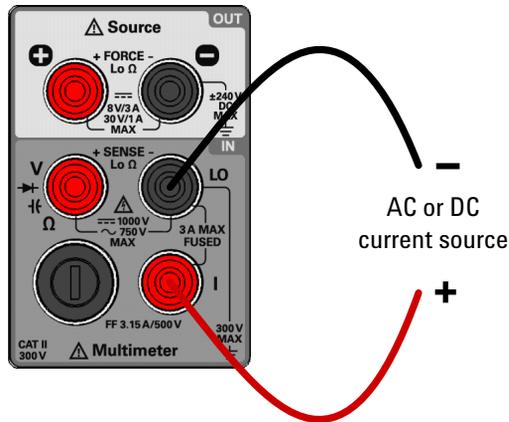


Figure 2-2 Terminal connections for current measurements

NOTE

- The U3606A will automatically select a suitable range for current measurements by default (autoranging). To manually select a range, see [“Selecting a Range”](#) on page 54 for more information.
- The U3606A resolution is set to 5½ digits by default. To change the resolution, see [“Setting the Resolution”](#) on page 55 for more information.

2 Digital Multimeter Operation

Making Measurements



Measuring DC current

- 1 Press $\approx I$ to make DC current measurement. (The DC annunciator is shown on the display.)

DC annunciator



Table 2-3 DC current measurement summary

Item	Description
Available ranges	10.0000 mA, 100.000 mA, 1.00000 A, 3.0000 A
Measurement method	Sigma Delta A-to-D converter
Burden voltage and shunt resistance	<ul style="list-style-type: none">• < 0.2 V, 10 Ω for 10 mA range• < 0.2 V, 1 Ω for 100 mA range• < 0.3 V, 0.1 Ω for 1 A range• < 0.7 V, 0.01 Ω for 3 A range
Input protection	Protected with a 3.15 A/500 V, FF fuse

- 2 Connect the red and black test leads to input terminals **I** (red) and **LO** (black) respectively as shown in [Figure 2-2](#).
- 3 Probe the test points and read the display.



Measuring AC (rms) current

- 1 Press $\approx I$ again (until the AC annunciator is shown on the display) to make AC current measurements.

AC annunciator

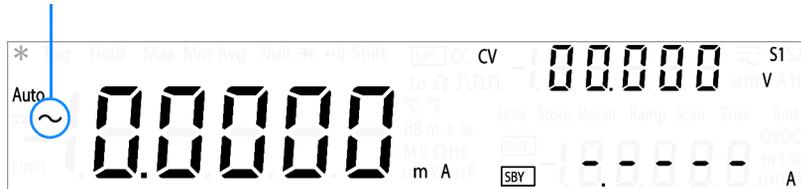


Table 2-4 AC current measurement summary

Item	Description
Available ranges	10.0000 mA, 100.000 mA, 1.00000 A, 3.0000 A
Measurement method	AC coupled true rms
Burden voltage and shunt resistance	<ul style="list-style-type: none"> • < 0.2 V/10 Ω for 10 mA range • < 0.2 V/1 Ω for 100 mA range • < 0.3 V/0.1 Ω for 1 A range • < 0.7 V/0.01 Ω for 3 A range
Input protection	Protected with a 3.15 A/500 V, FF fuse
Crest factor	For < 5:1 errors included. Limited by the peak input and 100 kHz bandwidth. Maximum 3.0 at full scale.
Peak input	300% of range. Limited by maximum input.

- 2 Connect the red and black test leads to input terminals **I** (red) and **LO** (black) respectively as shown in [Figure 2-2](#).
- 3 Probe the test points and read the display.



2 Digital Multimeter Operation

Making Measurements



Measuring AC+DC current

The U3606A Multimeter|DC Power Supply includes a true-rms multimeter that returns an accurate rms reading not only for sine waves, but also other AC signals such as square, triangle, and staircase waveforms without any DC offset. However, you may choose to return the measured AC signal with DC offset by using the AC+DC function.

The AC+DC current measurement measures AC current with DC offset.

- 1 Press $\approx|$ again (until the AC+DC annunciator is shown on the display) to make AC+DC current measurements.

AC+DC annunciator



- 2 Connect the red and black test leads to input terminals **I** (red) and **LO** (black) respectively as shown in [Figure 2-2](#).
- 3 Probe the test points and read the display.



Performing resistance (2-wire) measurements

CAUTION

Disconnect circuit power and discharge all high-voltage capacitors before measuring resistance or conductance, or testing circuit continuity, to avoid damaging the U3606A or the device under test.

Making the connections

Connect the test leads as shown below:

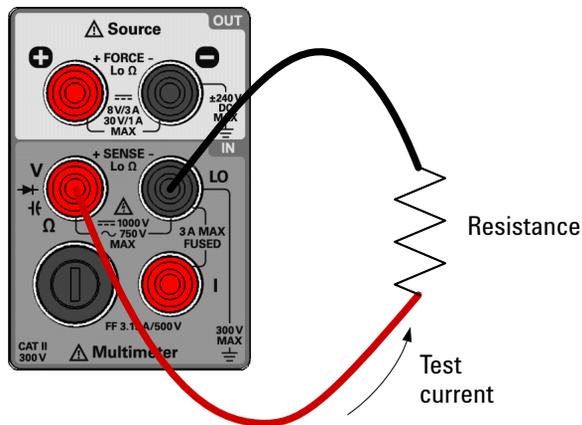


Figure 2-3 Terminal connections for 2-wire resistance measurements

NOTE

- The U3606A will automatically select a suitable range for 2-wire resistance measurements by default (autoranging). To manually select a range, see “[Selecting a Range](#)” on page 54 for more information.
- The U3606A resolution is set to 5½ digits by default. To change the resolution, see “[Setting the Resolution](#)” on page 55 for more information.

2 Digital Multimeter Operation

Making Measurements



Measuring resistance

1 Press $\Omega \text{ } \text{⊘}$ to make 2-wire resistance measurements.



Table 2-5 Resistance measurement summary

Item	Description
Available ranges	100.000 Ω , 1.00000 k Ω , 10.0000 k Ω , 100.000 k Ω , 1.00000 M Ω , 10.0000 M Ω , 100.000 M Ω
Measurement method	Two-wire, open-circuit voltage limited to < 5 V
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit

2 Connect the red and black test leads to input terminals Ω (red) and **LO** (black) respectively as shown in [Figure 2-3](#).

3 Probe the test points and read the display.



Performing low-resistance (4-wire) measurements

CAUTION

Disconnect circuit power and discharge all high-voltage capacitors before measuring resistance or conductance, or testing circuit continuity, to avoid damaging the U3606A or the device under test.

NOTE

DC power supply functions are locked

The DC power supply functions are locked when you select the low-resistance (Lo Ω) measurements. You cannot use the DC power supply module simultaneously with the digital multimeter module when you are measuring 4-wire low-resistance measurements.

To unlock the DC power supply functions, exit the low-resistance (Lo Ω) measurement by selecting another multimeter measurement.

For measuring low-resistance, a delayed response should be expected from the front panel display. For remote interface operation, increase the SCPI query timeout value. (Typically 15000 ms.)

2 Digital Multimeter Operation

Making Measurements

Making the connections

Connect the test leads as shown below:

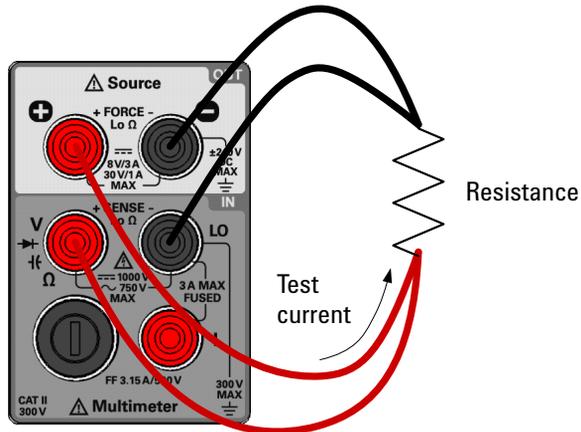
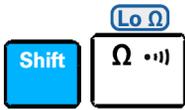


Figure 2-4 Terminal connections for 4-wire resistance measurements

NOTE

- The U3606A will automatically select a suitable range for 4-wire low-resistance measurements by default (autoranging). To manually select a range, see [“Selecting a Range”](#) on page 54 for more information.
- The U3606A resolution is set to 5½ digits by default. To change the resolution, see [“Setting the Resolution”](#) on page 55 for more information.



Measuring low-resistance

- 1 Press **Shift** > **Lo Ω** to make 4-wire low-resistance measurements. (The Lo Ω annunciator is shown on the display.)

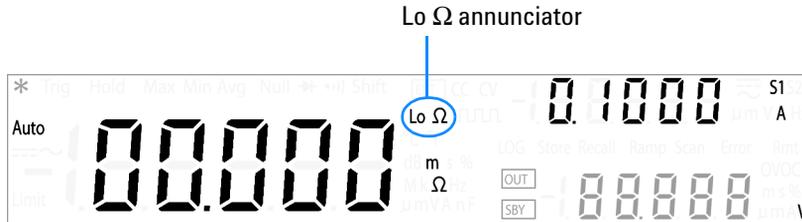
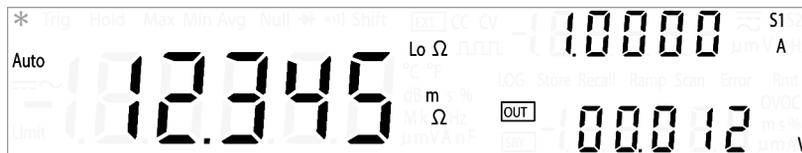


Table 2-6 Low-resistance measurement summary

Item	Description
Available ranges	100 mΩ, 1000 mΩ, 10 Ω
Measurement method	Four-wire, the test current is sent from the FORCE terminals and the resistance is measured by the SENSE terminals.
Input protection	<ul style="list-style-type: none"> • FORCE terminals: 1000 V_{dc} on all ranges, protected with a 3.15 A/250 V FF fuse • SENSE terminals: 1000 V_{rms} on all ranges, < 0.3 A short circuit

- 2 Connect the first red and black test leads to output terminals **+** (FORCE +) and **-** (FORCE -) respectively as shown in [Figure 2-4](#).
- 3 Connect the second red and black test leads to input terminals **Ω** (SENSE +) and **L0** (SENSE -) respectively as shown in [Figure 2-4](#).
- 4 Probe the test points and read the display.



Performing frequency, pulse width, and duty cycle measurements

There are two measuring paths for the frequency, pulse width, and duty cycle measurements – voltage or current. Therefore, before setting the frequency measurement, it is advisable to configure the AC voltage (see “[Measuring AC voltage](#)” on page 27) or AC current (see “[Measuring AC \(rms\) current](#)” on page 31) measurements first.

Making the connections

Connect the test leads as shown below:

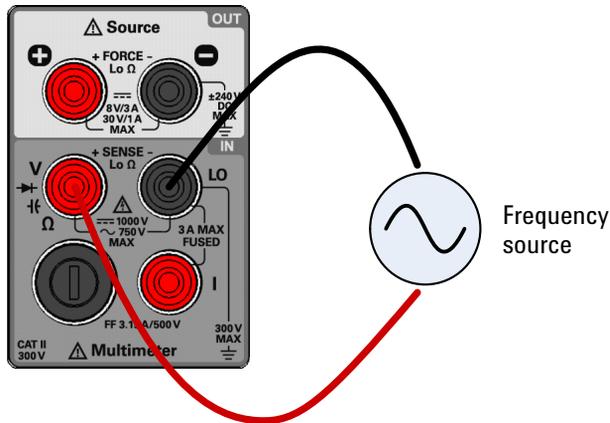


Figure 2-5 Terminal connections for frequency, pulse width, and duty cycle measurements via the voltage path

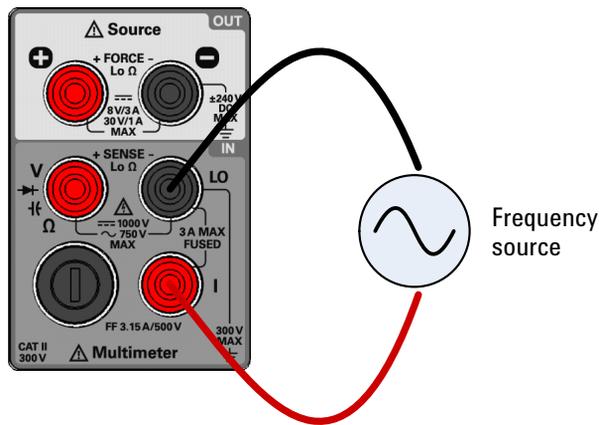


Figure 2-6 Terminal connections for frequency, pulse width, and duty cycle measurement via the current path

NOTE

- The range and resolution of the frequency, pulse width, and duty cycle measurement follows the configuration of the AC voltage or AC current measurement (dependant on the path chosen).
- The U3606A will automatically select a suitable range for AC voltage and AC current measurements by default (autoranging). To manually select a range, see [“Selecting a Range”](#) on page 54 for more information.
- The U3606A resolution is set to 5½ digits by default. To change the resolution, see [“Setting the Resolution”](#) on page 55 for more information.

CAUTION

If the frequency signal measured is below 20 Hz, you must manually set the range of the AC voltage or AC current measurement to acquire a stable reading. To manually select a range, see [“Selecting a Range”](#) on page 54 for more information.

2 Digital Multimeter Operation

Making Measurements

Hz ms %

Measuring frequency — voltage path

The range and resolution of the frequency measurement via the voltage path follows the configuration of the AC voltage measurement.

- 1 Press **Hz ms %** to make frequency measurements via the voltage path. The AC voltage measurement display will flash briefly before the frequency measurement display is shown.



Table 2-7 Frequency measurement (voltage path) summary

Item	Description
Available ranges	100.000 mV, 1.00000 V, 10.0000 V, 100.000 V, 750.00 V — range is based on the voltage level of the signal, not frequency
Measurement method	Reciprocal counting technique
Signal level	0.2 V to 1.4 V
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit

- 2 Connect the red and black test leads to input terminals **V** (red) and **LO** (black) respectively as shown in [Figure 2-5](#).
- 3 Probe the test points and read the display.



Hz ms %

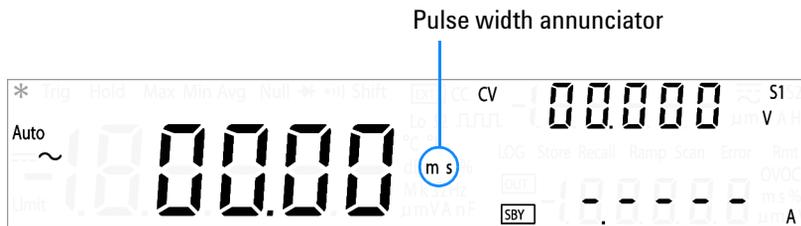
Measuring pulse width — voltage path

The range and resolution of the pulse width measurement via the voltage path follows the configuration of the AC voltage measurement.

- 1 Press **Hz ms %** to make frequency measurements via the voltage path. The AC voltage measurement display will flash briefly before the frequency measurement display is shown.



- 2 Press **Hz ms %** again (until the pulse width annunciator is shown on the display) to make pulse width measurements.



- 3 Connect the red and black test leads to input terminals **V** (red) and **LO** (black) respectively as shown in [Figure 2-5](#).
- 4 Probe the test points and read the display.



2 Digital Multimeter Operation

Making Measurements

Hz ms %

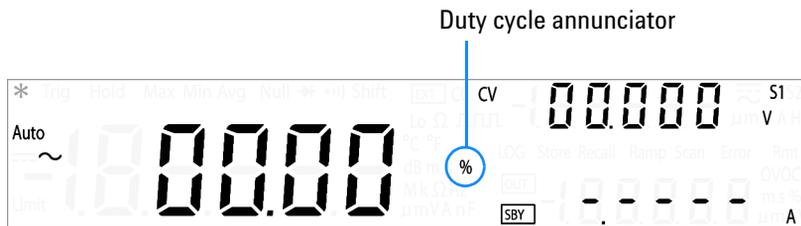
Measuring duty cycle — voltage path

The range and resolution of the duty cycle measurement via the voltage path follows the configuration of the AC voltage measurement.

- 1 Press **Hz ms %** to make frequency measurements via the voltage path. The AC voltage measurement display will flash briefly before the frequency measurement display is shown.



- 2 Press **Hz ms %** again (until the duty cycle annunciator is shown on the display) to make duty cycle measurements.



- 3 Connect the red and black test leads to input terminals **V** (red) and **LO** (black) respectively as shown in [Figure 2-5](#).
- 4 Probe the test points and read the display.





Measuring frequency — current path

The range and resolution of the frequency measurement via the current path follows the configuration of the AC current measurement.

- 1 Press \tilde{I} > Hz ms % to make frequency measurements via the current path. The AC current measurement display will flash briefly before the frequency measurement display is shown.



Table 2-8 Frequency measurement (current path) summary

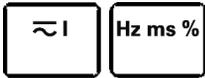
Item	Description
Available ranges	10.0000 mA, 100.000 mA, 1.00000 A, 3.0000 A — range is based on the current level of the signal, not frequency
Measurement method	Reciprocal counting technique
Signal level	0.2 V to 1.4 V
Input protection	Protected with a 3.15 A/500 V, FF fuse

- 2 Connect the red and black test leads to input terminals **I** (red) and **LO** (black) respectively as shown in [Figure 2-6](#).
- 3 Probe the test points and read the display.



2 Digital Multimeter Operation

Making Measurements



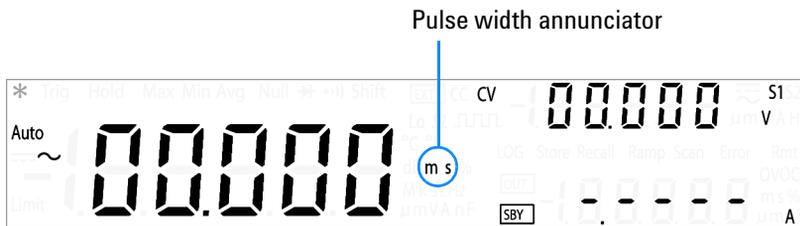
Measuring pulse width — current path

The range and resolution of the pulse width measurement via the current path follows the configuration of the AC current measurement.

- 1 Press $\approx I > \text{Hz ms } \%$ to make frequency measurements via the current path. The AC current measurement display will flash briefly before the frequency measurement display is shown.



- 2 Press **Hz ms %** again (until the pulse width annunciator is shown on the display) to make pulse width measurements.



- 3 Connect the red and black test leads to input terminals **I** (red) and **LO** (black) respectively as shown in [Figure 2-6](#).
- 4 Probe the test points and read the display.





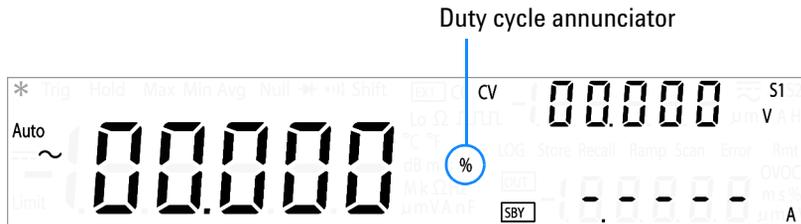
Measuring duty cycle — current path

The range and resolution of the duty cycle measurement via the current path follows the configuration of the AC current measurement.

- 1 Press $\approx I > \text{Hz ms } \%$ to make frequency measurements via the current path. The AC current measurement display will flash briefly before the frequency measurement display is shown.



- 2 Press **Hz ms %** again (until the duty cycle annunciator is shown on the display) to make duty cycle measurements.



- 3 Connect the red and black test leads to input terminals **I** (red) and **LO** (black) respectively as shown in [Figure 2-6](#).
- 4 Probe the test points and read the display.



Performing capacitance measurements

The U3606A Multimeter|DC Power Supply calculates capacitance by charging a capacitor with a known current for a period of time, and then measuring the voltage.

Measuring tips:

- For measuring capacitance values greater than 10000 μF , discharge the capacitor first, then select a suitable range for measurement. This will speed up the measurement time and also ensure that the correct capacitance value is obtained.
- For measuring capacitance values greater than 1 mF, a delayed response should be expected from the front panel display. For remote interface operation, increase the SCPI query timeout value. (Typically > 10000 ms.)
- For measuring small capacitance values, press **Null** with the test leads open to subtract the residual capacitance of the instrument and leads.

CAUTION

Disconnect circuit power and discharge all high-voltage capacitors before measuring capacitance to avoid damaging the U3606A or the device under test. To confirm that a capacitor has fully discharged, use the DC voltage measurement. See "[Measuring DC voltage](#)" on page 26 for more information.

Making the connections

Connect the test leads as shown below:

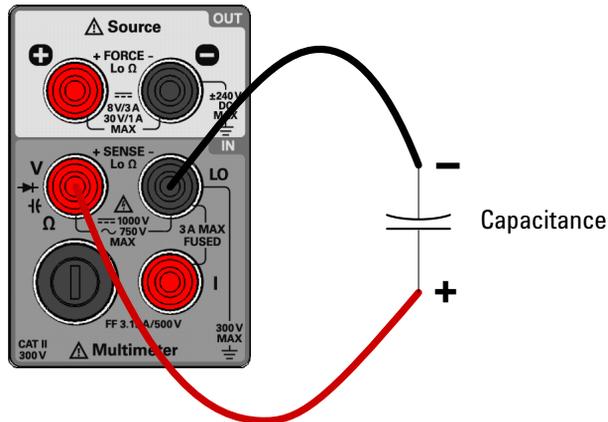


Figure 2-7 Terminal connections for capacitance measurements

NOTE

- The U3606A will automatically select a suitable range for capacitance measurements by default (autoranging). To manually select a range, see [“Selecting a Range”](#) on page 54 for more information.
- The resolution for capacitance measurement is fixed to 3½ digits.

2 Digital Multimeter Operation

Making Measurements



Measuring capacitance

1 Press  to make capacitance measurements.



Table 2-9 Capacitance measurement summary

Item	Description
Available ranges	1 nF, 10 nF, 100 nF, 1 μ F, 10 μ F, 100 μ F, 1000 μ F, 10000 μ F
Measurement method	Computed from constant current source charge time, typical 0.2 V to 1.4 V _{ac} signal level
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit

2 Connect the red and black test leads to input terminals  (red) and **LO** (black) respectively (refer to [Figure 2-7](#) on page 47).

3 Probe the test points and read the display.



Performing continuity tests

CAUTION

Disconnect circuit power and discharge all high-voltage capacitors before measuring resistance or conductance, or testing circuit continuity, to avoid damaging the U3606A or the device under test.

Making the connections

Connect the test leads as shown below:

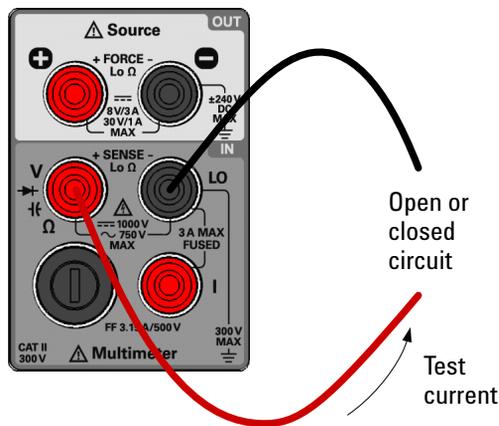


Figure 2-8 Terminal connections for continuity tests

NOTE

- The U3606A will automatically select a suitable range for continuity measurements by default (autoranging). To manually select a range, see “[Selecting a Range](#)” on page 54 for more information.
- The resolution for continuity tests is fixed to 3½ digits.

2 Digital Multimeter Operation

Making Measurements



Testing continuity

- 1 Press Ω again (until the continuity annunciator is shown on the display) to make continuity measurements.

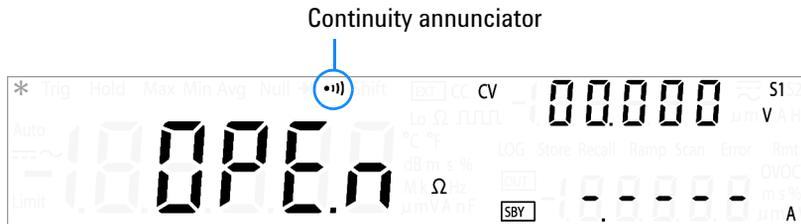


Table 2-10 Continuity function summary

Item	Description
Measurement method	0.83 mA \pm 0.2% constant current source, open-circuit voltage limited to < 5 V
Audible tone:	Continuous beep when reading is less than threshold resistance of 10 Ω at 1.0 k Ω range
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit

- 2 Connect the red and black test leads to input terminals Ω (red) and **LO** (black) respectively as shown in [Figure 2-8](#).
- 3 Probe the test points. The instrument beeps when the continuity measurement is less than or equal to the continuity threshold.



Performing diode tests

CAUTION

Disconnect circuit power and discharge all high-voltage capacitors before checking diodes to avoid damaging the U3606A or the device under test.

Making the connections

Connect the test leads as shown below:

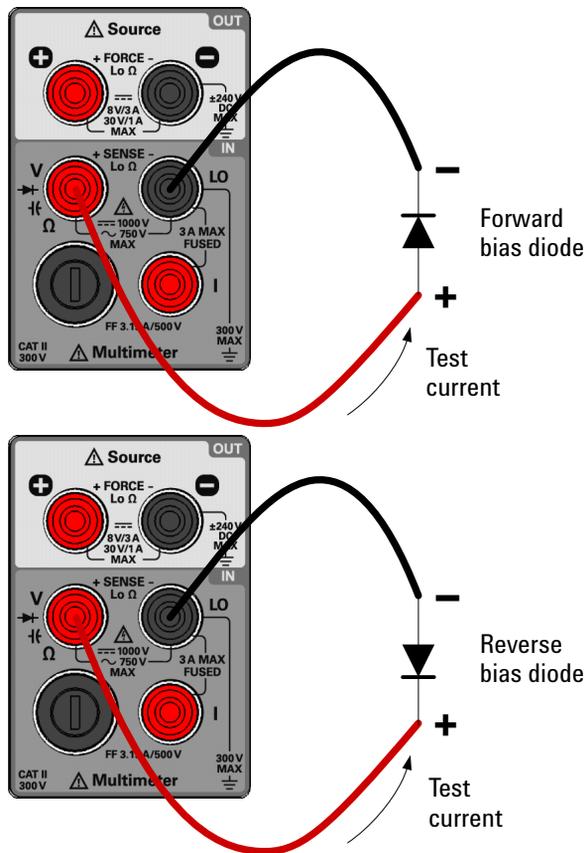


Figure 2-9 Terminal connections for diode tests

2 Digital Multimeter Operation

Making Measurements

NOTE

The resolution for diode tests is fixed to 3½ digits.



Checking diodes

- 1 Press  again (until the diode annunciator is shown on the display) to make diode measurements.

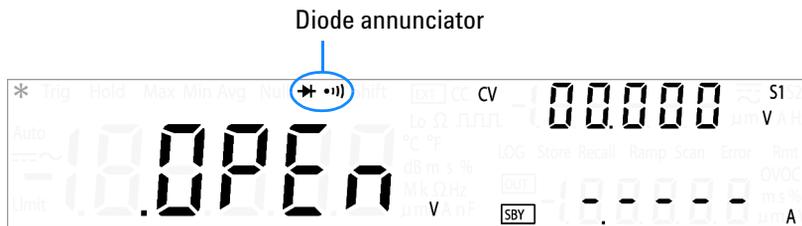


Table 2-11 Diode function summary

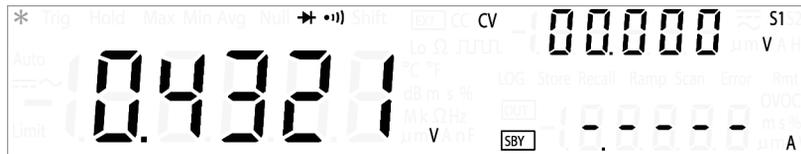
Item	Description
Measurement method	0.83 mA ± 0.2% constant current source
Audible tone:	<ul style="list-style-type: none">• Continuous beep when level is below +50 mV DC• Single tone for normal forward-biased diode or semiconductor junction where 0.3 V ≤ reading ≤ 0.8 V
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit

- 2 Connect the red and black test leads to input terminals  (red) and **LO** (black) respectively.
- 3 Connect the other end of the red test lead to the positive terminal (anode) of the diode and the black test lead to the negative terminal (cathode). Refer to [Figure 2-9](#) on page 51.

NOTE

The cathode of a diode is indicated with a band.

- 4 Read the display.

**NOTE**

The U3606A can display diode forward bias of up to approximately 1.2 V. The forward bias of a typical diode is within the range of 0.3 V to 0.8 V.

- 5 Reverse the probes and measure the voltage across the diode again (refer to [Figure 2-9](#) on page 51). Assess the diode according to the following guidelines:
 - A diode is considered good if the multimeter displays “OPEn” in reverse bias mode.
 - A diode is considered shorted if the multimeter displays approximately 0 V in both forward and reverse bias modes, and the U3606A beeps continuously.
 - A diode is considered open if the multimeter displays “OPEn” in both forward and reverse bias modes.

Selecting a Range

You can allow the U3606A to automatically select the range using autoranging, or you can select a fixed range using manual ranging.

Autoranging is convenient because the U3606A automatically selects the appropriate range for sensing and displaying each measurement. However, manual ranging results in better performance, since the U3606A does not have to determine which range to use for each measurement.

Key	Description
	Press ▲ to select a higher range and disable autoranging.
Range 	Press ▼ to select a lower range and disable autoranging.
 Shift  Auto	Press Shift > Auto to enable autoranging and disable manual ranging.

- Autoranging is selected at default factory power-on and after a remote reset.
- Manual ranging – If the input signal is greater than can be measured on the selected range, the multimeter provides these overload indications: “OL” from the front panel or “±9.9E+37” from the remote interface.
- For frequency, pulse width, and duty cycle measurements, ranging applies to the input voltage or input current of the signal, not its frequency.
- The range is fixed for diode ($1 V_{dc}$ range) tests.
- The U3606A remembers the selected ranging method (auto or manual) and the selected manual range for each measurement function.
- Autorange thresholds – The U3606A shifts ranges as follows:
 - Down range at $< 10\%$ of current range
 - Up range at $> 120\%$ of current range

Setting the Resolution

You can select either 4½ digit or 5½ digit resolution for the AC voltage, DC voltage, AC+DC voltage, AC current, DC current, AC+DC current, 2-wire resistance, and 4-wire low-resistance measurements.

- 5½ digit readings have the best accuracy and noise rejection.
- 4½ digit readings provide for faster readings.
- The range and resolution of the frequency, pulse width, and duty cycle measurements follows the configuration of the AC voltage or the AC current function.
- Continuity and diode tests have a fixed 4½ digit display.
- Capacitance measurements have a fixed 3½ digit display.

Key	Description
 	Press Shift > 4½ 5½ to toggle between 4½ digit and 5½ digit mode.

Math Operations

The U3606A Multimeter|DC Power Supply provides six math operations: null measurements, dB measurements, dBm measurements, statistics (MinMax) for accumulated readings, limit testing, and a hold function. The table below describes the math operations that can be used with each measurement function.

Table 2-12 Math operations summary

Measurement functions	Allowed math operations					
	Null	dBm	dB	MinMax	Limit	Hold
DC voltage	✓	✓	✓	✓	✓	✓
DC current	✓	-	-	✓	✓	✓
AC voltage	✓	✓	✓	✓	✓	✓
AC current	✓	-	-	✓	✓	✓
Resistance (2-wire)	✓	-	-	✓	✓	✓
Low-resistance (4-wire)	✓	-	-	✓	✓	✓
Frequency	✓	-	-	✓	✓	✓
Pulse width	✓	-	-	✓	✓	✓
Duty cycle	✓	-	-	✓	✓	✓
Capacitance	✓	-	-	✓	✓	✓
Continuity	-	-	-	-	-	-
Diode	-	-	-	-	-	-

- All math operations can be toggled off by pressing **Shift** > **Exit**.
- All math operations are automatically turned-off when changing measuring functions.
- Range changing is allowed for all math operations.
- For remote operation, refer to the CALCulate subsystem in the *U3606A Programmer's Reference*.

Null

When making null measurements, also called relative, each reading is the difference between a stored (selected or measured) null value and the input signal. One possible application is to increase the accuracy of a 2-wire resistance measurement by nulling the test lead resistance. Nulling the leads is also particularly important prior to making capacitance measurements. The formula used for calculating null measurements is:

$$\text{Result} = \text{reading} - \text{null value}$$

The null value is adjustable, you can set it to any value between 0 and $\pm 120\%$ of the highest range, for the present function.

NOTE

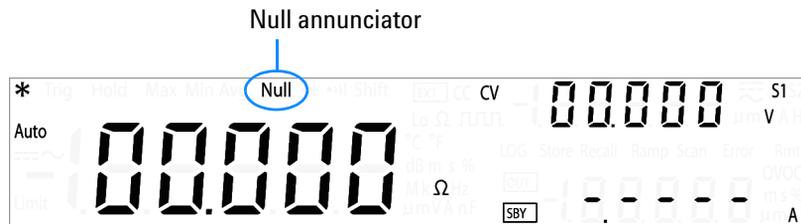
Null can be set for both auto and manual range settings, but not in the case of an overload.

Null
dB ◀

Enabling the null operation

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

The Null annunciator is illuminated and the null operation is enabled.



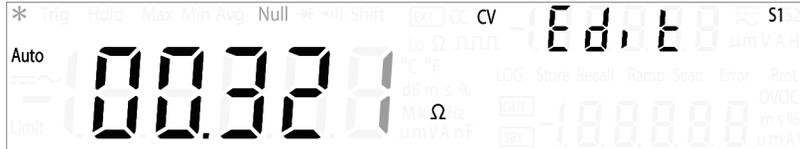
Press **Shift** > **Exit** to exit the null mode.

2 Digital Multimeter Operation

Math Operations

Editing the null value

- 1 Press **Null** again to view and edit the null value.



- 2 Press **◀** or **▶** to select which digit position or range to be changed.
- 3 Press **▲** or **▼** to increase or decrease the value.
- 4 Press **Shift > Save** to save the changes. “donE” will be briefly displayed in the upper secondary display. The display will then return to normal.
- 5 Press **Shift > Exit** to exit the edit mode without saving.

NOTE

- In resistance measurement, the U3606A will read a non-zero value even when the two test leads are in direct contact, because of the resistance of these leads. Use the null function to zero-adjust the display.
- In DC voltage measurement mode, the thermal effect will influence the accuracy. Short the test leads and press **Null** once the displayed value is stable to zero-adjust the display.

dBm measurements

The logarithmic dBm (decibels relative to 1 mW) scale is often used in RF signal measurements. The U3606A takes a measurement and calculates the power delivered to a reference resistance (typically 50 Ω, 75 Ω, or 600 Ω). Voltage measurement is then converted to dBm.

NOTE

This math operation applies to voltage measurements only.

The dBm function is logarithmic, and is based on a calculation of power delivered to a reference resistance, relative to 1 mW. The formula used for calculating dBm measurements is:

$$dBm = 10 \times \log_{10}(\text{reading}^2 / (\text{reference resistance}) / (1 \text{ mW}))$$

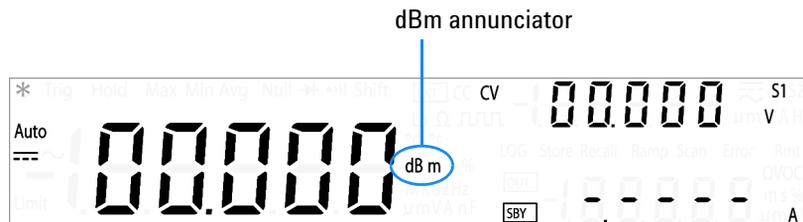
You can select the reference resistance value through the utility menu. The default settings is 600 Ω. See “[Selecting a dBm reference resistance value](#)” on page 121 for more information.



Enabling the dBm operation

Press **Shift** > **dBm** to enable the dBm operation.

The dBm annunciator is illuminated and the dBm function is enabled.



Press **Shift** > **dBm** again or **Shift** > **Exit** to exit the dBm mode.

Editing the relative value

1 Press **dB** again to view and edit the relative value.



- 2 Press \triangleleft or \triangleright to select which digit position or range to be changed.
- 3 Press \triangle or ∇ to increase or decrease the value.
- 4 Press **Shift** > **Save** to save the changes. “donE” will be briefly displayed in the upper secondary display. The display will then return to normal.
- 5 Press **Shift** > **Exit** to exit the edit mode without saving.

MinMax

The MinMax operation stores the minimum and maximum values, the average, and the number of readings during a series of measurements. From the front panel, you can view the following statistical data for any set of readings: average or mean (Avg), maximum (Max), and minimum (Min).

NOTE

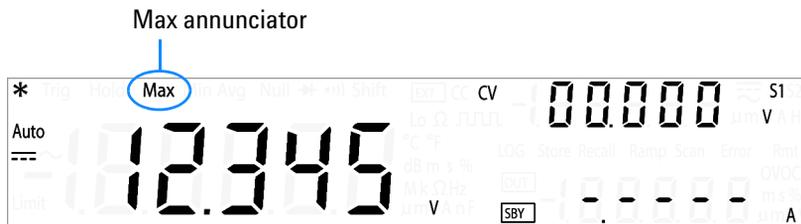
- This math operation applies to all measurement functions except continuity and diode test.
- The stored statistical data are cleared when statistics are enabled, when the `CALCulate:FUNCTION` command is sent while the `CALCulate:STATE` is ON, when the power is turned off, after a Factory Reset (`*RST` command), after an Instrument Preset (`SYSTEM:PRESet` command), or after a measurement function change.
- The average function can be restarted by pressing **MinMax** for more than one second.



Enabling the MinMax operation

Press **MinMax** to enable the MinMax operation.

The Max annunciator is illuminated and the U3606A begins accumulating various statistics about the readings being displayed.



Press **MinMax** again to step through the maximum reading (the Max annunciator is illuminated), minimum reading (the Min annunciator is illuminated), average reading (the Avg annunciator is illuminated), or present reading (the MaxMinAvg annunciator is illuminated).

Each time a new minimum, maximum, or average value is stored, the instrument beeps once (if the beeper is enabled). The U3606A calculates the average of all readings and records the number of readings taken since the MinMax function was enabled.

Accumulated statistics are:

- Max: maximum reading since the MinMax function was enabled
- Min: minimum reading since the MinMax function was enabled
- Avg: average of all readings since the MinMax function was enabled
- MaxMinAvg: present reading (actual input signal value)

Press **Shift** > **Exit** to exit the MinMax mode.

2 Digital Multimeter Operation

Math Operations

Limit

The limit test function enables you to perform pass or fail testing to upper and lower limits that you specify. You can set the upper and lower limits to any value between 0 and $\pm 120\%$ of the highest range for the present measurement function. The upper limit value you select must be larger than the lower limit value. The initial factory settings for both values is zero.

NOTE

- This math operation applies to all measurement functions except continuity and diode test.
- The instrument clears all limits after a Factory Reset (*RST command) or an Instrument Preset (SYSTEM:PRESet command), or when a measurement function is changed.



Enabling the limit operation

Press **Shift** > **Limit** to enable the limit operation.

The Limit annunciator is illuminated and the limit function is enabled.

Limit annunciator



The primary display briefly shows “PASS” when readings are within the specified limits, “HI” when the reading is above the high limit, and “LO” when the reading is below the low limit.



Each time the input value transitions from “PASS” to “HI” or from “PASS” to “LO”, or when transitioning directly from “HI” to “LO” or “LO” to “HI”, the instrument beeps once (if the beeper is enabled).

Press **Shift** > **Exit** to exit the limit mode.

2 Digital Multimeter Operation

Math Operations

Editing the upper and lower limit values

- 1 Press **Shift** > **Limit** again to view and edit the upper (HI) and lower (LO) limit values.



- 2 Press Δ or ∇ to toggle between the upper (HI) limit value and the lower (LO) limit value



- 3 Press \triangleleft or \triangleright to begin editing the upper or lower limit value selected.
- 4 Press \triangleleft or \triangleright to select which digit position or range to be changed. You may also toggle between the upper (HI) and lower (LO) limit values by positioning your cursor on the "HI" or "LO" message shown in the lower secondary display.
- 5 Press Δ or ∇ to increase or decrease the value.
- 6 Press **Shift** > **Save** to save the changes. The display will automatically revert to the next limit display.
For example, if you press **Shift** > **Save** after editing the upper limit (HI) value, the instrument will save your specified value, and switch to the lower limit (LO) display. Pressing **Shift** > **Save** again will once again save your specified value, and switch the display back to the upper limit (HI) display.
- 7 Press **Shift** > **Exit** to exit the edit mode. The display will also return to normal after a few seconds of inactivity.

Hold

The refresh hold feature allows you to capture and hold a reading, within the specified variation and threshold values, on the front panel display. This is useful in situations when you want to take a reading, remove the test probes, and have the reading remain on the display.

When a stable reading is detected, the instrument beeps once (if the beeper is enabled), and holds the reading on the primary display. You can select the variation through the utility menu. The default settings is 10% of the full scale.

A new reading value is updated in the primary display when the variation of the measured value exceeds the variation preset in the utility menu. The instrument beeps once (if the beeper is enabled) when a reading value is updated. See [“Enable refresh hold”](#) on page 130 for more information on configuring the refresh hold settings.

For voltage, current, and capacitance measurements, the reading value will not be updated when the reading falls below the threshold preset in the utility menu.

For continuity and diode tests, the reading value will not be updated when an open state is detected.

NOTE

If the reading value is unable to reach a stable state (when exceeding the preset variation), the reading value will not be updated.

Set the variation to “OFF” in the utility menu to enable data hold. See [“Enable data hold”](#) on page 131 for more information. In data hold mode, the reading is not updated even if the input signal value changes. The reading held will remain on the display until you exit the hold mode.

2 Digital Multimeter Operation

Math Operations



Enabling the hold operation

Press **Hold** to enable the hold operation.

The Hold annunciator is illuminated and the hold function is enabled.



Press **Hold** again or **Shift** > **Exit** to exit the hold mode.

Triggering the Multimeter

The U3606A Multimeter|DC Power Supply triggering system allows you to generate triggers either automatically or manually via the **Trig** key on the front panel or the *TRG command via the remote interface.

From the front panel (local interface), the multimeter always auto-triggers by default. Auto triggering takes continuous readings at the fastest rate possible for the selected measurement configuration.

You can enable the single trigger function to manually trigger the U3606A readings. See “[Front panel triggering](#)” on page 70 for more information on the single trigger function.

From the remote interface, triggering the U3606A is a three-step process:

- 1** Configure the U3606A for measurement by selecting the function, range, resolution, and so on.
- 2** Specify the U3606A trigger source. The U3606A Multimeter|DC Power Supply will accept a software (bus) command or an immediate (continuous) trigger.
- 3** Ensure that the U3606A is ready to accept a trigger from the specified source (called the “wait-for-trigger” state).

See “[Remote interface triggering](#)” on page 71 for more information on the software (bus) or immediate triggering source.

2 Digital Multimeter Operation

Triggering the Multimeter

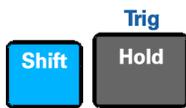
Front panel triggering

Single triggering

The U3606A takes one reading each time you press **Trig**.

NOTE

The single trigger mode is available from the local interface only.



Press **Shift** > **Trig** once to enable the single trigger mode.

The Trig annunciator is illuminated and the single trigger function is enabled.

Trig annunciator



A single reading is taken, and another reading is taken each time you press **Trig**. (You do not need to press **Shift** again.)

Press **Shift** > **Trig** again to exit the single trigger mode.

Remote interface triggering

Immediate triggering

In the immediate trigger mode, the trigger signal is always present. When you place the multimeter in the wait-for-trigger state, the trigger is issued immediately. This is the default trigger source for the U3606A Multimeter|DC Power Supply.

NOTE

The immediate trigger mode is available from the remote interface only.

Remote interface operation:

- The `TRIGger:SOURce IMMEDIATE` command selects the immediate trigger source:
- After selecting the trigger source, you must place the instrument in the “wait-for-trigger” state using the `INITiate[:IMMEDIATE]` or `READ?` command. A trigger will not be accepted from the selected trigger source until the instrument is in the “wait-for-trigger” state.

Refer to the *U3606A Programmer’s Reference* for the syntax and complete descriptions for these commands.

Software (bus) triggering

The bus trigger mode corresponds in function as the [Single triggering](#) mode, except the trigger is initiated by sending a bus trigger command, after selecting `BUS` as the trigger source.

NOTE

The bus trigger mode is available from the remote interface only.

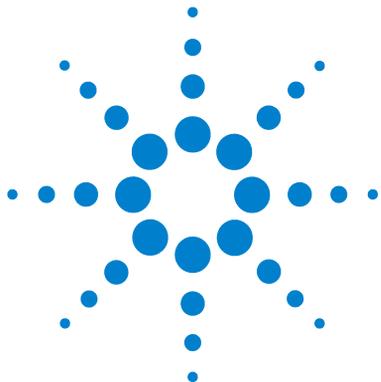
2 Digital Multimeter Operation

Triggering the Multimeter

Remote interface operation:

- The `TRIGger:SOURce BUS` command selects the bus trigger source.
- The `MEASure?` command overwrites the bus trigger and triggers the U3606A and returns a measurement.
- The `READ?` command does not overwrite the bus trigger, and if selected, generates an error. It will only trigger the instrument and return a measurement when the `IMMEdiate` trigger is selected.
- The `INITiate` command only initiates the measurement and needs a trigger (`*TRG` command) to make the actual measurement.

Refer to the *U3606A Programmer's Reference* for the syntax and complete descriptions for these commands.



3 DC Power Supply Operation

Basic Operation	74
Constant voltage (CV) mode	74
Constant current (CC) mode	76
Protection Functions	78
Overvoltage protection (OVP)	78
Overcurrent protection (OCP)	81
Overvoltage limit (OV)	84
Overcurrent limit (OC)	86
Square-wave Output	88
Sweep Functions	93
Ramp signal	93
Scan signal	95
Selecting a Range	97
Enabling the Output	98
Remote Sensing	99

This chapter contains examples on how to operate the DC power supply from the front panel. The simple examples discussed in this chapter shows you how to program the output voltage and current functions, the protection functions, and the additional source functions.



Basic Operation

The U3606A has two basic operating modes: constant voltage and constant current mode. In constant voltage mode, the U3606A regulates the output voltage at the selected value, while the load current varies as required by the load. In constant current mode, the U3606A regulates the output current at the selected value, while the voltage varies as required by the load.

The U3606A is also capable of generating square waves with selectable frequency, pulse width, and duty cycle values.

Constant voltage (CV) mode

Making the connections

Connect the load as shown below:

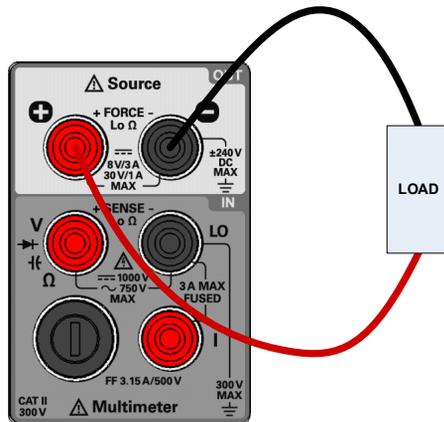
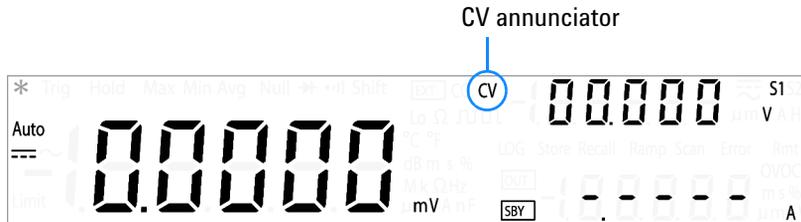


Figure 3-1 Constant voltage mode terminal connections

Voltage

Supplying constant voltage

- 1 Press **Voltage** to select the constant voltage mode. When the U3606A is operating in constant voltage mode, the CV annunciator on the front panel is illuminated.



- 2 The output voltage can be programmed when the output is enabled (OUT) or disabled (SBY). Ensure that the CV annunciator is flashing. (Press **Voltage** again if it is not.)



- 3 Press \triangleleft or \triangleright to select which digit position to be changed.
- 4 Press \triangle or ∇ to increase or decrease the value.
- 5 Press **Voltage** again, **Shift** > **Save**, or **Shift** > **Exit** to save the changes and exit the edit mode.
- 6 Press $\frac{OUT}{SBY}$ to regulate the output voltage.

NOTE

The output voltage is limited by the range selected. Press **Shift** > **Range** to select an appropriate range. You can only select a range when the output is disabled (the SBY annunciator is illuminated).

Constant current (CC) mode

Making the connections

Connect the load as shown below:

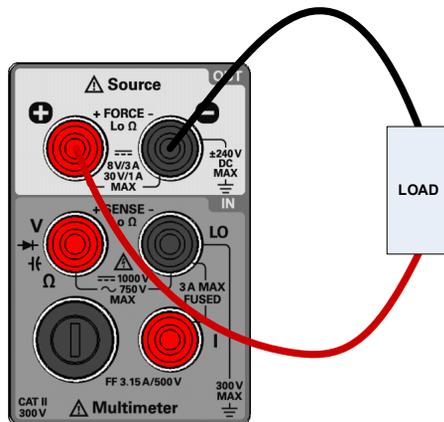


Figure 3-2 Constant current mode terminal connections

Protection Functions

Overvoltage protection (OVP)

In constant current mode, the U3606A regulates the output current at the selected value, while the voltage varies as required by the load. The overvoltage protection protects against overvoltage conditions on the output. If the load attempts to draw more voltage than required, such that it exceeds the programmed protection value, the overvoltage protection circuit will protect the load by disabling the output.

The following steps shows you how to set the OVP trip level, how to check OVP operation, and how to clear the OVP condition.

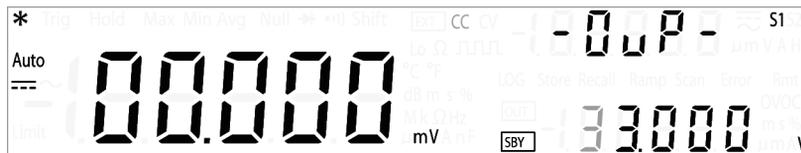
NOTE

Setting the OVP trip level will not activate the OVP feature. To activate the OVP feature, you will need to enable the output protection state from the utility menu. See [Chapter 4](#), “Setting the output protection state,” starting on page 122 for more information.



Setting the OVP trip level

- 1 The OVP trip level can be programmed when the output is enabled (OUT) or disabled (SBY). Ensure that the U3606A is operating in constant current mode. (The CC annunciator is illuminated.) Press **Shift** > **Protect** to enter the OVP edit menu.



- 2 Press \triangleleft or \triangleright to select which digit position to be changed.
- 3 Press \triangle or ∇ to increase or decrease the value. The OVP value is set to the maximum protection limits by default.
 - 33.000 V when range S1 is selected, and
 - 8.8000 V when range S2 is selected.

- 4 Press **Shift** > **Save** or **Voltage (Protect)** to save the changes. “donE” will be briefly displayed in the upper secondary display. The display will then return to normal.
- 5 Alternatively, press **Shift** > **Exit** or **Shift** > **Protect** to exit the edit mode without saving.

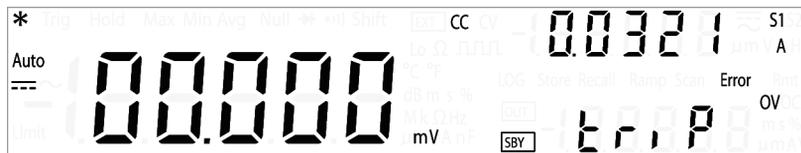
NOTE

- The OVP feature is always enabled by default whenever you select constant current mode. You can disable the OVP feature by disabling the output protection state from the utility menu. See [Chapter 4](#), “Setting the output protection state,” starting on page 122 for more information.
- If the OVP value is set to a lesser value than the OV value, the OV value will be adjusted to equal the OVP value.
- The OVP value is not applicable for square-wave output.
- The OVP value is limited by the range selected. Press **Shift** > **Range** to select an appropriate range. You can only select a range when the output is disabled (the SBY annunciator is illuminated).

Checking the OVP operation

To check OVP operation, raise the regulated output current slowly. Watch the voltage drawn by the load as it reaches near the trip point. Then very gradually increase the output current using the directional keys until the OVP circuit trips. This will disable the U3606A output, cause the CC annunciator to flash, and the OV and Error annunciator to illuminate.

The “triP” message appears on the display after a few seconds of inactivity.



NOTE

Error number 510, “Voltage output over protection” will be recorded in the error queue when the OVP circuit trips. To read and clear the error message, see “[Reading error messages](#)” on page 114. For a complete list of all error messages, see [Chapter 9](#), “List of Error Messages,” starting on page 259.

Resetting the OVP condition

Use one of the following methods to reset the OVP circuit after it activates. If the condition that caused the overvoltage shutdown is still present, the OVP circuit will turn the output off again.

- 1 When the OVP circuit trips, the U3606A will immediately prompt you to change the OVP trip level. Use the directional keys to select a higher OVP trip level and press **Shift** > **Save** or **Voltage (Protect)** to save the changes.
- 2 Alternatively, press **Shift** > **Exit** or **Shift** > **Protect** to exit the edit mode without changing the OVP trip level.
- 3 You may read and clear the error message by accessing the utility menu. See “[Reading error messages](#)” on page 114 for more information.
- 4 Press $\frac{\text{OUT}}{\text{SBY}}$ to turn the output on.
- 5 If the OVP continues to trip, try lowering the regulated output current, or raising the OVP trip level.

Overcurrent protection (OCP)

In constant voltage mode, the U3606A regulates the output voltage at the selected value, while the load current varies as required by the load. The overcurrent protection will disable the output if the load effect exceeds the programmed protection value. This protection is useful when the load is sensitive to an overcurrent condition.

The following steps shows you how to set the OCP trip level, how to check OCP operation, and how to clear the OCP condition.

NOTE

Setting the OCP trip level will not activate the OCP feature. To activate the OCP feature, you will need to enable the output protection state from the utility menu. See [Chapter 4](#), “Setting the output protection state,” starting on page 122 for more information.



Setting the OCP trip level

- 1 The OCP trip level can be programmed when the output is enabled (OUT) or disabled (SBY). Ensure that the U3606A is operating in constant voltage mode. (The CV annunciator is illuminated.) Press **Shift** > **Protect** to enter the OCP edit menu.



- 2 Press **◀** or **▶** to select which digit position to be changed.
- 3 Press **▲** or **▼** to increase or decrease the value. The OCP value is set to the maximum protection limits by default.
 - 1.1000 A when range S1 is selected, and
 - 3.3000 A when range S2 is selected.
- 4 Press **Shift** > **Save** or **Voltage (Protect)** to save the changes. “donE” will be briefly displayed in the upper secondary display. The display will then return to normal.
- 5 Alternatively, press **Shift** > **Exit** or **Shift** > **Protect** to exit the edit mode without saving.

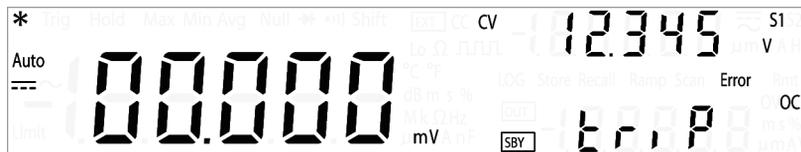
NOTE

- The OCP feature is always enabled by default whenever you select constant voltage mode. You can disable the OCP by disabling the output protection state from the utility menu. See [Chapter 4](#), “Setting the output protection state,” starting on page 122 for more information.
- If the OCP value is set to a lesser value than the OC value, the OC value will be adjusted to equal the OCP value.
- The OCP value is not applicable for square-wave output.
- The OCP value is limited by the range selected. Press **Shift** > **Range** to select an appropriate range. You can only select a range when the output is disabled (the SBY annunciator is illuminated).

Checking the OCP operation

To check OCP operation, raise the regulated output voltage slowly. Watch the current drawn by the load as it reaches near the trip point. Then very gradually increase the output voltage using the directional keys until the OCP circuit trips. This will disable the U3606A output, cause the CV annunciator to flash, and the OC and Error annunciator to illuminate.

The “triP” message appears on the display after a few seconds of inactivity.



NOTE

Error number 511, “Current output over protection” will be recorded in the error queue when the OCP circuit trips. To read and clear the error message, see [“Reading error messages”](#) on page 114. For a complete list of all error messages, see [Chapter 9](#), “List of Error Messages,” starting on page 259.

Resetting the OCP condition

Use one of the following methods to reset the OCP circuit after it activates. If the condition that caused the overcurrent shutdown is still present, the OCP circuit will turn the output off again.

- 1 When the OCP circuit trips, the U3606A will immediately prompt you to change the OCP trip level. Use the directional keys to select a higher OCP trip level and press **Shift** > **Save** or **Voltage (Protect)** to save the changes.
- 2 Alternatively, press **Shift** > **Exit** or **Shift** > **Protect** to exit the edit mode without changing the OCP trip level.
- 3 You may read and clear the error message by accessing the utility menu. See “[Reading error messages](#)” on page 114 for more information.
- 4 Press $\frac{\text{OUT}}{\text{SBY}}$ to turn the output on.
- 5 If the OCP continues to trip, try lowering the regulated output current, or raising the OCP trip level.

Overvoltage limit (OV)

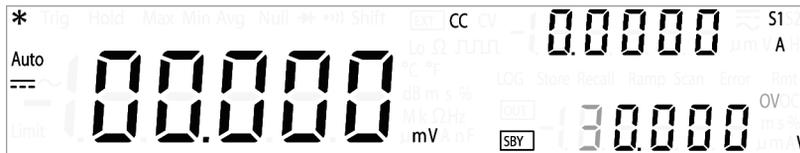
The overvoltage limit prevents the output voltage present across the load to change beyond the programmed overvoltage limit. If the load effect exceeds the programmed overvoltage limit, the CC output will be lowered to maintain the output power across the load. The combination of the OV and OVP features create a closed loop circuit protection for sensitive load behaviors.



Setting the OV level

The OV level can be programmed when the output is enabled (OUT) or disabled (SBY). Ensure that the U3606A is operating in constant current mode. (The CC annunciator is illuminated.)

1 Press **Shift** > **Limit** to enter the OV edit menu.



2 Press **◀** or **▶** to select which digit position to be changed.

3 Press **▲** or **▼** to increase or decrease the value. The OV value is set to the maximum protection limits by default.

- 30.000 V when range S1 is selected, and
- 8.000 V when range S2 is selected.

4 Press **Shift** > **Save** or **Current (Limit)** to save the changes. “donE” will be briefly displayed in the upper secondary display. The display will then return to normal.

5 Alternatively, press **Shift** > **Exit** or **Shift** > **Limit** to exit the edit mode without saving.

NOTE

- The OV limit feature is always enabled by default whenever you select constant current mode. You cannot disable the OV limit feature.
 - If the OV value is set to a greater value than the OVP value, the OVP value will be adjusted to equal the OV value.
 - If the OV value is set to zero, this will result in the output current being dropped to zero for limiting.
 - The OV value is not applicable for square-wave output.
 - The OV value is limited by the range selected. Press **Shift** > **Range** to select an appropriate range. You can only select a range when the output is disabled (the SBY annunciator is illuminated).
-

Overcurrent limit (OC)

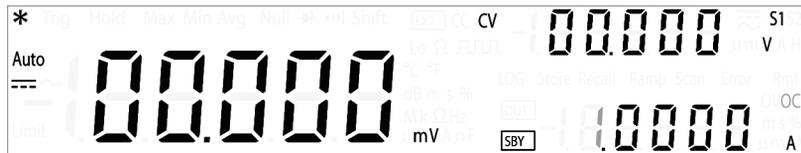
The overcurrent limit prevents the output current flowing through the load to change beyond the programmed overcurrent limit. If the load effect exceeds the programmed overcurrent limit, the CV output will be lowered to maintain the output power across the load. The combination of the OC and OCP features create a closed loop circuit protection for sensitive load behaviors.



Setting the OC level

The OC level can be programmed when the output is enabled (OUT) or disabled (SBY). Ensure that the U3606A is operating in constant voltage mode. (The CV annunciator is illuminated.)

1 Press **Shift** > **Limit** to enter the OC edit menu.



- 2 Press **◀** or **▶** to select which digit position to be changed.
- 3 Press **▲** or **▼** to increase or decrease the value. The OC value is set to the maximum protection limits by default.
 - 1.0000 A when range S1 is selected, and
 - 3.0000 A when range S2 is selected.
- 4 Press **Shift** > **Save** or **Current (Limit)** to save the changes. “donE” will be briefly displayed in the upper secondary display. The display will then return to normal.
- 5 Alternatively, press **Shift** > **Exit** or **Shift** > **Limit** to exit the edit mode without saving.

NOTE

- The OC limit feature is always enabled by default whenever you select constant voltage mode. You cannot disable the OC limit feature.
 - If the OC value is set to a greater value than the OCP value, the OCP value will be adjusted to equal the OC value.
 - If the OC value is set to zero, this will result in the output voltage being dropped to zero for limiting.
 - The OC value is not applicable for square-wave output.
 - The OC value is limited by the range selected. Press **Shift** > **Range** to select an appropriate range. You can only select a range when the output is disabled (the SBY annunciator is illuminated).
-

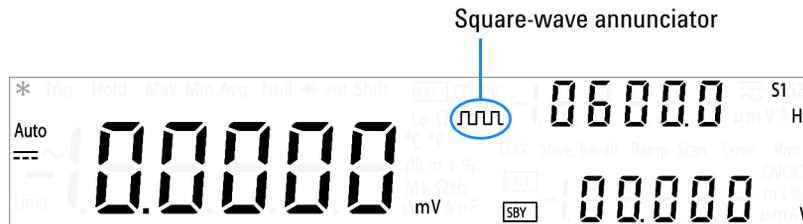
Square-wave Output



Square-wave output is a unique function for many applications, such as pulse width modulation (PWM) output, adjustable voltage control, and synchronous clock (baud rate generator). You can also use this function to check and calibrate flow-meter displays, counters, tachometers, oscilloscopes, frequency converter, frequency transmitter, and other frequency input devices.

Selecting square-wave output

- 1 Press to select the square-wave mode. When the U3606A is operating in the square-wave mode, the square-wave annunciator () on the front panel is illuminated.



- 2 The default frequency is 600 Hz, as shown on the upper secondary display. Press again to cycle through the amplitude, duty cycle, and pulse width values. (The default amplitude is 0 V, the default duty cycle is 50%, and the default pulse width is 0.8333 ms.)
- 3 The square-wave amplitude, frequency, pulse width, and duty cycle can be set when the output is enabled (OUT) or disabled (SBY). Ensure that the square-wave annunciator () is flashing to edit the amplitude, frequency, pulse width, and duty cycle values. (Press again if it is not.)



Setting the amplitude

- 1 To set the square-wave amplitude, press \square until the amplitude value is displayed in the lower secondary display. Ensure that the square-wave annunciator (\square) on the front panel is flashing. (Press \square again if it is not.)



- 2 Press \triangleleft or \triangleright to select which digit position to be changed.
- 3 Press \triangle or ∇ to increase or decrease the value.
- 4 Press \square again or **Shift** > **Save** to save the changes.

NOTE

- Pressing \square again will save the changes, and display the next square-wave parameter. (While still in the edit mode.)
- Pressing **Shift** > **Save** will save the changes, and exit the edit mode.
- The square-wave amplitude is limited by the range selected. Press **Shift** > **Range** to select an appropriate range. You can only select a range when the output is disabled (the SBY annunciator is illuminated).

3 DC Power Supply Operation

Square-wave Output

Setting the frequency

- 1 To set the square-wave frequency, press \square until the duty cycle or pulse width value is displayed in the lower secondary display. Ensure that the square-wave annunciator (\square) on the front panel is flashing. (Press \square again if it is not.)



- 2 Press \triangleleft or \triangleright to step through the available frequencies. (There are 27 frequencies choose from.)

Table 3-1 Available frequencies for square-wave output

Frequency (Hz)
0.5, 2, 5, 6, 10, 15, 25, 30, 40, 50, 60, 75, 80, 100, 120, 150, 200, 240, 300, 400, 480, 600, 800, 1200, 1600, 2400, 4800

- 3 Press \square again or **Shift** > **Save** to save the changes.

NOTE

- Pressing \square again will save the changes, and display the next square-wave parameter. (While still in the edit mode.)
- Pressing **Shift** > **Save** will save the changes, and exit the edit mode.
- Changing the square-wave frequency value will affect the square-wave duty cycle and pulse width values as they are inter-related.

Setting the duty cycle

- 1 To set the square-wave duty cycle, press \square until the duty cycle value is displayed in the lower secondary display. Ensure that the square-wave annunciator (\square) on the front panel is flashing. (Press \square again if it is not.)



- 2 Press Δ or ∇ to step through the available duty cycle values.
The duty cycle can be stepped through 256 steps, where each step is 0.390625% more than the previous step. The best resolution the display can offer is 0.001%.
- 3 Press \square again or **Shift** > **Save** to save the changes.

NOTE

- Pressing \square again will save the changes, and display the next square-wave parameter. (While still in the edit mode.)
- Pressing **Shift** > **Save** will save the changes, and exit the edit mode.
- Changing the square-wave duty cycle value will affect the square-wave frequency and pulse width values as they are inter-related.

3 DC Power Supply Operation

Square-wave Output

Setting the pulse width

- 1 To set the square-wave pulse width, press  until the pulse width value is displayed in the lower secondary display. Ensure that the square-wave annunciator () on the front panel is flashing. (Press  again if it is not.)



- 2 Press Δ or ∇ to step through the available duty cycle values.
The pulse width can be stepped through 256 steps, where each step is $1/(256 \times \text{frequency})$ more than the previous step. The display will automatically adjust to a 5 digit resolution (ranging from 9.9999 ms to 9999.9 ms)
- 3 Press  again or **Shift** > **Save** to save the changes.

NOTE

- Pressing  again will save the changes, and display the next square-wave parameter. (While still in the edit mode.)
- Pressing **Shift** > **Save** will save the changes, and exit the edit mode.
- Changing the square-wave pulse width value will affect the square-wave frequency and duty cycle values as they are inter-related.

When all the appropriate parameters have been set, press **OUT**/**SBY** to generate the square wave.

Sweep Functions

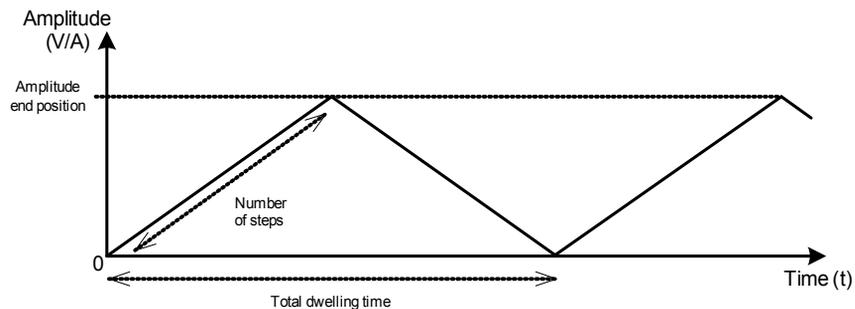
The U3606A Multimeter|DC Power Supply is equipped with ramp and scan capability. Use the ramp function to generate a ramp signal with its end amplitude position and number of steps based on the preset input parameters, and the scan function to generate a scan signal with its end amplitude position, step dwelling time, and number of steps based on the preset input parameters.

Ramp signal

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

- the amplitude end position, and
- the number of steps required to reach the amplitude end position.

You can configure the ramp signal parameters in the utility menu. See [“Configuring the ramp signal parameters”](#) on page 123 for detailed instructions on setting the amplitude end position and number of steps.



The ramp dwelling time will be set to the fastest of the instrument capability (typically ~300 ms per step). A higher number of steps provides a more linear ramp signal. This however will result in an increase in the total dwelling time. A lower number of steps will result in a shorter total dwelling time and a more stepped ramp signal.

3 DC Power Supply Operation

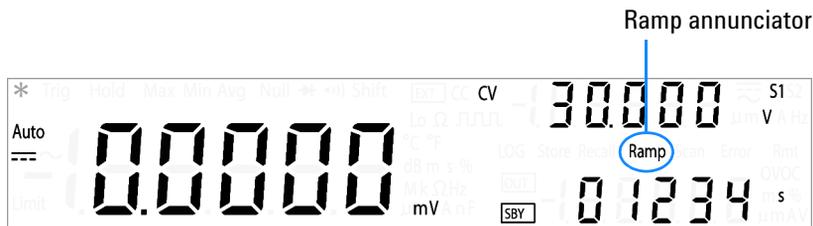
Sweep Functions

Ramp Scan



Generating a ramp signal

- 1 Select your desired output mode by pressing **Voltage** to enable constant voltage operation or **Current** to enable constant current operation. (The respective annunciator – CV or CC – will illuminate accordingly.)
- 2 Select an appropriate range by pressing **Shift** > **Range**. The maximum amplitude end position will be limited by the range selected. (The respective annunciator – S1 or S2 – will illuminate accordingly.)
- 3 If you want to fine-tune the ramp signal parameters, press **Shift** > **Utility** to access the utility menu. See “[Configuring the ramp signal parameters](#)” on page 123 for more information on configuring the ramp signal parameters. Press **Shift** > **Save** to save the changes and **Shift** > **Exit** to exit the utility menu.
- 4 Press **Ramp Scan** to select the ramp function. Ensure that the Ramp annunciator is shown on the display.



- 5 Press **OUT**/**SBY** to generate the ramp signal.

NOTE

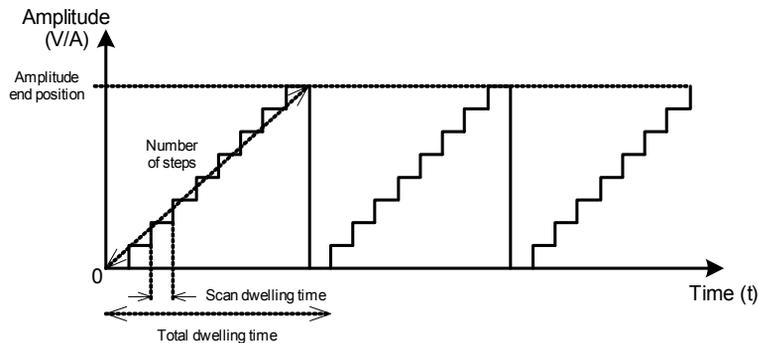
The typical ramp dwelling time per step in the U3606A is measured at 300 ms. A longer delay time should be expected if a high number of steps is programmed. As an example, a 1000 step ramp signal will yield a 10 minute ($1000 \times 300 \text{ ms} \times 2$) total dwelling time.

Scan signal

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

- the amplitude end position,
- the number of steps required to reach the amplitude end position, and
- the dwelling time length for each step.

You can configure the scan signal parameters in the utility menu. See [“Configuring the scan signal parameters”](#) on page 125 for detailed instructions on setting the amplitude end position, number of steps, and dwelling time length.



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

NOTE

The scan dwell time also affects the first step at amplitude 0. An initial delay, the length of the preset scan dwell time, is expected for each complete scan signal sweep.

3 DC Power Supply Operation

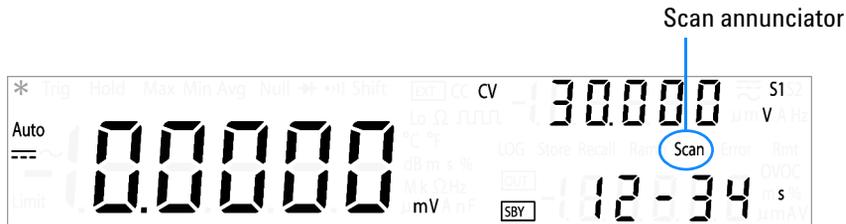
Sweep Functions

Ramp Scan



Generating a scan signal

- 1 Select your desired output mode by pressing **Voltage** to enable constant voltage operation or **Current** to enable constant current operation. (The respective annunciator – CV or CC – will illuminate accordingly.)
- 2 Select an appropriate range by pressing **Shift > Range**. The maximum amplitude end position will be limited by the range selected. (The respective annunciator – S1 or S2 –will illuminate accordingly.)
- 3 If you want to fine-tune the scan signal parameters, press **Shift > Utility** to access the utility menu. See “[Configuring the scan signal parameters](#)” on page 125 for more information on configuring the ramp signal parameters. Press **Shift > Save** to save the changes and **Shift > Exit** to exit the utility menu.
- 4 Press **Ramp Scan** to select the scan function. Ensure that the Scan annunciator is shown on the display.



- 5 Press **OUT**/**SBY** to generate the scan signal.

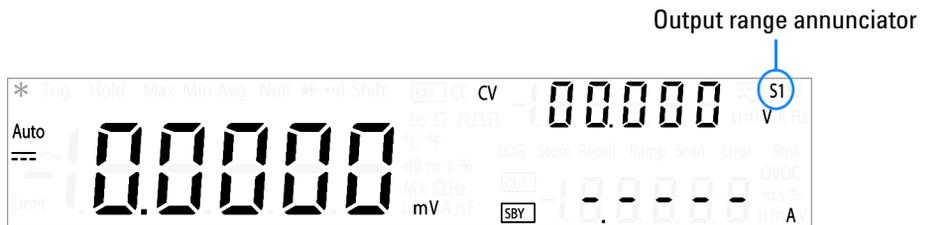
Selecting a Range



The U3606A Multimeter|DC Power Supply has the functionalities of a single-output dual range power supply. You select to either operate the U3606A in the 30 V/1 A range (S1) or the 8 V/3 A range (S2) for all output operations (CV mode, CC mode, square-wave output, and sweep functions).

- The S1 range has a higher voltage range, but a lower current output.
- The S2 range provides for a higher current output, but has a lower voltage range.

Press **Shift** > **Range** to toggle between range S1 and S2. The output range (S1 and S2) annunciators will illuminate respectively when selected.



NOTE

- The S1 range is selected by default. You cannot change the range when the output is enabled (OUT). The output should always be on stand-by (SBY) before the range or output function can be changed. See [“Enabling the Output”](#) on page 98 for more information on enabling or disabling the output.
- The protection and limit values will always be set to the maximum value with respect to the range selected when the range is changed. See [“Protection Functions”](#) on page 78 for more information on the protection functions available in the U3606A.

3 DC Power Supply Operation

Enabling the Output

Enabling the Output



The $\frac{\text{OUT}}{\text{STBY}}$ key controls turn the U3606A output on or off.

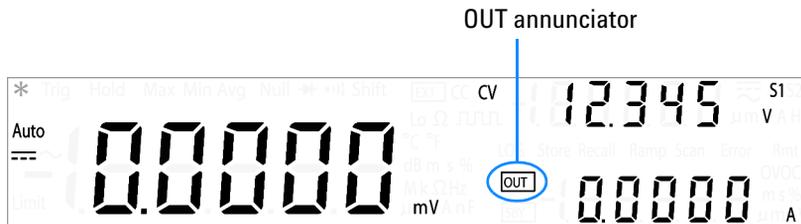
With the output off, adjustments can be made to the U3606A or the load without shutting off power to the instrument.

The $\frac{\text{OUT}}{\text{STBY}}$ key can be pressed at any time to enable or disable the U3606A output.

- When the output is disabled, the output voltage and current go to zero, and the STBY annunciator is illuminated.



- When the output is enabled, the U3606A regulates the output voltage and current at the selected value, and the OUT annunciator is illuminated.



The $\frac{\text{OUT}}{\text{STBY}}$ key is also used to generate the square-wave output at the selected amplitude, frequency, pulse width, and duty cycle.

The output state is stored in volatile memory; the output is always disabled when power has been turned off or after a remote interface reset.

Remote Sensing

Remote sensing is used to maintain regulation at the load and reduce degradation of regulation that would occur due to the voltage drop in the leads between the power supply and the load. Use remote sensing in applications where load regulation at the load is critical.

Remote sensing is especially useful in constant voltage mode with load impedances that vary or have significant lead resistance. It has no effect in constant current mode. Because sensing is independent of other U3606A functions, it can be used regardless of how the U3606A is programmed. With remote sensing, voltage readback monitors the load voltage at the remote sense points.

By connecting the power supply for remote voltage sensing, voltage is sensed at the load rather than at the U3606A output terminals (+ FORCE -). This will allow the U3606A to automatically compensate for the voltage drop in applications with long lead lengths as well as to accurately read back the voltage across the load.

Refer to [Chapter 8](#), “Characteristics and Specifications,” starting on page 239 for the maximum allowable voltage drop on the load wires.

Use twisted or shielded wires to minimize noise pick-up. If shielded wires are used, the shield should be connected to the ground at one point, either at the power supply chassis or the load ground. The optimal point for the shield ground should be determined by experimentation.

NOTE

During remote sensing setup, it is strongly recommended to power off (by pressing the Power On/Off button) the instrument to avoid undesirable damage to the load or the U3606A.

3 DC Power Supply Operation

Remote Sensing

Remote sensing connections

Remote sensing requires connecting the load leads from the rear output terminals to the load as shown below. Observe the polarity when connecting the sensing leads to the load.

NOTE

The metal shorting bars should be removed from the rear output and sense terminals for remote sensing connections. For local voltage sensing connections, the sense leads must be connected to the output terminals.

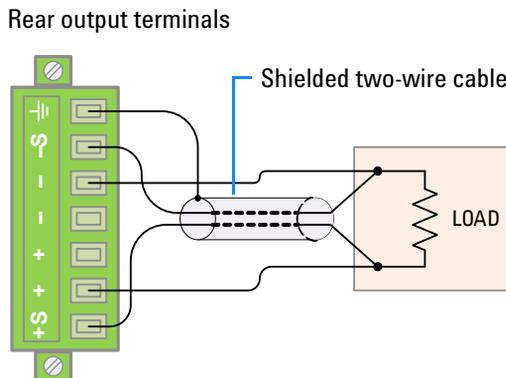


Figure 3-3 Remote sensing connections

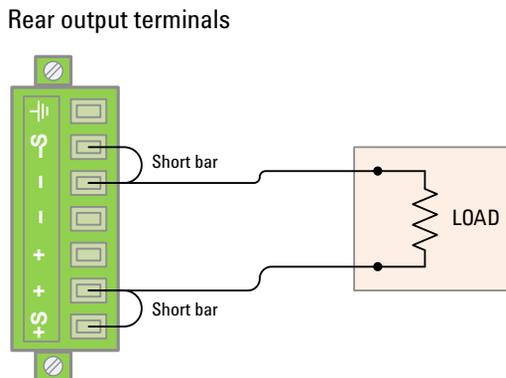


Figure 3-4 Local sensing connections

Connecting the load leads to the rear terminal block

- 1 Turn off the power. Remove all connections between the front output terminals and the load. Remove any metal shorting bars connected to the rear output terminals.
- 2 Loosen the two captive screws in the rear output terminal block with a Phillips screwdriver.



- 3 Gently pull the rear output terminal block out.



3 DC Power Supply Operation

Remote Sensing

- 4 Loosen the top screws with a Phillips screw driver and connect the rear output terminal block sensing (S+ and S-) and output (+ and -) terminals to the load as shown in [Figure 3-3](#) using a shielded two-wire cable.

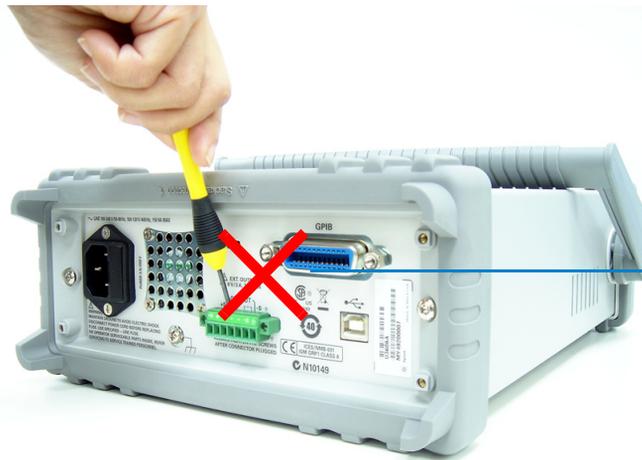


Do not use the shield as one of the sensing conductors. Ground the shield at the U3606A end only. The other end of the shield should be left unconnected. Observe the polarity when connecting the sensing leads to the load. You can connect the output leads to either one of the two + or - terminals. They are internally shorted.

NOTE

The sensing outputs (S+ and S-) must not be left unconnected. It must be connected locally ([Figure 3-4](#)) or remotely ([Figure 3-3](#)).

- 5 Tighten the top screws of the rear output terminal block to firmly secure the sensing and output connections.
- 6 Place the rear output terminal block back in place and tighten the two captive screws again.



Do not loosen the top screws of the rear output terminal block at a tilted angled.

CAUTION

Avoid connecting the load leads from the rear terminal block to the load as shown above. Loosening the top screws at an inclined angle will damage the terminal block screws. See [“Connecting the load leads to the rear terminal block”](#) on page 101 for the proper steps to connect the load leads from the rear terminal block to the load.

3 DC Power Supply Operation

Remote Sensing



Enable remote sensing

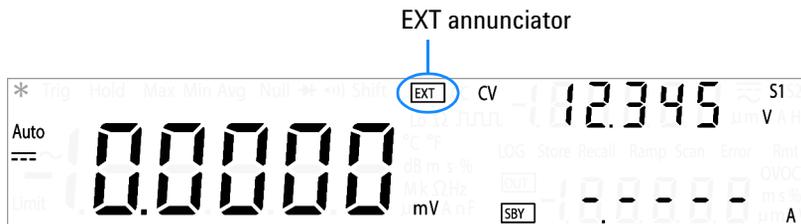
To configure the U3606A for remote sensing:

- 1 Turn off the U3606A.
- 2 Remove the connections between the U3606A sensing (S+ and S-) and output (+ and -) terminals. Using a shielded two-wire cable, connect the U3606A sensing terminals to the load as shown in [Figure 3-3](#). Observe the polarity when connecting the sensing leads to the load.

CAUTION

Do not use the shield as one of the sensing conductors. The other end of the shielded two-wire cable should be left unconnected.

- 3 Turn on the U3606A.
- 4 Press **Voltage** to select the constant voltage mode. Use the directional keys to select the appropriate constant voltage value. See “[Constant voltage \(CV\) mode](#)” on page 74 for more information.
- 5 Press **Shift** > **EXT** to enable remote sensing. When the U3606A is operating in remote sensing mode, the EXT annunciator on the front panel is illuminated.



- 6 Press **OUT** **SBY** to regulate the output voltage.
- 7 Press **Shift** > **EXT** again to disable remote sensing.

NOTE

If the power supply is operated with remote sensing and either the positive or negative load wire is not connected, an internal protection circuit will activate and shut down the power supply. To resume operation, turn the power supply off, connect the open load wire, and turn on the power supply.

Stability

Using remote sensing under certain combinations of load lead lengths and large load capacitances may cause your application to form a filter, which becomes part of the voltage feedback loop. The extra phase shift created by this filter can degrade the instrument stability, resulting in poor transient response or loop instability. In severe cases, it may cause oscillations.

To minimize this possibility, keep the load leads as short as possible and twist them together. As the sense leads are part of the instrument programming feedback loop, accidental open-connections of sense or load leads during remote sensing operation have various unwanted effects. Provide secure and permanent connections.

CV regulation

The voltage load regulation specification in [Chapter 8](#), “Characteristics and Specifications,” starting on page 239 applies at the output terminals of the U3606A. When remote sensing, add 5 mV to this specification for each 1 V drop between the positive sensing point (S+) and output terminals (+) due to the change in load current. Because the sense leads are part of the U3606A feedback path, keep the resistance of the sense leads at or below 0.5 Ω per lead to maintain the above specified performance.

Output rating

The rated output voltage and current specifications in [Chapter 8](#), “Characteristics and Specifications,” starting on page 239 apply at the output terminals of the power supply. With remote sensing, any voltage dropped in the load leads must be added to the load voltage to calculate maximum output voltage. The performance specifications are not guaranteed when the maximum output voltage is exceeded.

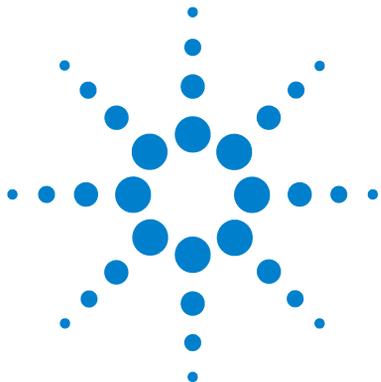
Output noise

Any noise picked up on the sense leads also appears at the output of the U3606A and may adversely affect the voltage load regulation. Twist the sense leads to minimize external noise pickup and run them parallel and close to the load leads. In noisy environments it may be necessary to shield the sense leads. Ground the shield at the U3606A end only. Do not use the shield as one of the sense conductors.

3 DC Power Supply Operation

Remote Sensing

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4 System Related Operation

Using the Utility Menu	108
Changing configurable settings	109
Utility Menu Summary	111
Reading error messages	114
Reading the program code revision	115
Adjusting the display brightness	116
Changing the power-on state	116
Configuring the beeper	117
Connecting to a remote interface	118
Performing a self-test	120
Selecting a dBm reference resistance value	121
Setting the output protection state	122
Configuring the ramp signal parameters	123
Configuring the scan signal parameters	125
Setting the smooth function	127
Enable refresh hold	130
Enable data hold	131
Storing and Recalling Instrument States	132
Storing a state	132
Recalling a stored state	133
Remote Operation	134
Configuring and connecting the GPIB interface	135
Configuring and connecting the USB interface	136
SCPI commands	137

This chapter lists the various items and settings in the utility menu. This chapter also describes how to store and recall an instrument state with the U3606A Multimeter|DC Power Supply.



Using the Utility Menu

The utility menu allows you to customize a number of nonvolatile instrument configurations. Modifying these settings affects the operation of your instrument across several functions. Select the setting you want to edit to do the following:

- Switch between two values, such as on or off.
- Select a value from the list.
- Decrease or increase a value by using the directional keys.

The utility menu also displays error messages and hardware revision codes. The contents of the utility menu are summarized in [Table 4-2](#) on page 111.

Table 4-1 Utility menu key descriptions

Key	Description
 	Press Shift > Utility to access the utility menu.
 	Press ◀ or ▶ to step through the menu items.
 	Press ▲ or ▼ to switch between two values, to select a value from the list, or to decrease or increase a value.
 	Press Shift > Save to save a setting.
 	Press Shift > Exit to exit the edit mode without saving or to exit the utility menu.

4 System Related Operation

Using the Utility Menu

Editing values

Some items in the utility menu allows you to select your desired value by decreasing or increasing a digit. Press Δ or ∇ to define the setting. The digit currently being edited will flash.



Digit currently being edited

Use these keys to position the cursor on a digit:

Key	Description
	Press \blacktriangleleft to move the cursor to the left.
	Press \blacktriangleright to move the cursor to the right.

When the cursor is positioned on a digit, use these keys to edit the value:

Key	Description
	Press Δ to increment the digit.
	Press ∇ to decrement the digit.

When you are done editing, save the new value by pressing **Shift** > **Save**.
(Or press **Shift** > **Exit** to exit the edit mode without saving.)

Utility Menu Summary

The utility menu items are summarized in the table below. For further explanations on the various items in the utility menu, see the respective menu item headings.

Table 4-2 Utility menu item descriptions

Item	Available settings			Description
Error	nonE	(-)Er.NNN		<ul style="list-style-type: none"> Review the last recorded error message (up to 20 error messages). Review all the recorded error messages to clear the Error annunciator. See “Reading error messages” on page 114 for more information.
P.CodE	NN.NN IOb	NN.NN Sb	NN.NN Mb	<ul style="list-style-type: none"> Select “IOb” to view interface board program code revision. Select “Sb” to view source board program code revision. Select “Mb” to view measurement board program code revision. See “Reading the program code revision” on page 115 for more information.
diSP	L-03	L-02	L-01	<ul style="list-style-type: none"> Cycle through the VFD display brightness levels. See “Adjusting the display brightness” on page 116 for more information.
P-on	rESEt	LAsT		<ul style="list-style-type: none"> Set “LAsT” to recall the last known power-off state when power is turned on. Set “rESEt” to recall the default factory power-on state when power is turned on. See “Changing the power-on state” on page 116 for more information.
bEEP	2400 Hz	3840 Hz	OFF	<ul style="list-style-type: none"> Set the beep driving frequency to “2400 Hz” or “3840 Hz”. Set “OFF” to disable the beep tone. See “Configuring the beeper” on page 117 for more information.

4 System Related Operation

Utility Menu Summary

Table 4-2 Utility menu item descriptions (continued)

Item	Available settings			Description
IOb	GPib	U-CdC	U-tMC	<ul style="list-style-type: none"> Select “GPib”, “U-tMC”, or “U-CdC” as the desired remote interface connection. “USB-tMC” simulates the USB interface according to USB-TMC standard. “USB-CdC” is used to simulate the communication port. See “Connecting to a remote interface” on page 118 and “Remote Operation” on page 134 for more information.
	NN			<ul style="list-style-type: none"> Set the GPIB address from 1 to 30. See “Configuring and connecting the GPIB interface” on page 135 for more information.
SELF.t	no	YES		<ul style="list-style-type: none"> If “YES” is selected, the instrument exits the utility menu and immediately executes the self-test. After the self-test completes, the instrument returns to normal operation. See “Performing a self-test” on page 120 for more information.
db.rEF	NNNN	Ω		<ul style="list-style-type: none"> Set dB reference impedance value from 1 Ω to 9999 Ω. See “Selecting a dBm reference resistance value” on page 121 for more information.
triP Sby	YES	no		<ul style="list-style-type: none"> Select “YES” to enable the output protection or “no” to disable the output protection. The factory default for the output protection state is “YES”. See “Setting the output protection state” on page 122 for more information.
rAMP	CV	CC		<ul style="list-style-type: none"> Press Voltage to select ramp setup for CV. Press Current to select ramp setup for CC.
	S1/S2	S1/S2		Press Shift > Range to toggle between range S1 (30 V/1 A) or S2 (8 V/3 A)
	NN.NNN V	N.NNNN A	NNNNN S	<ul style="list-style-type: none"> The increment of each step will be the amplitude end position (NN.NNN V/N.NNNN A) divided by the number of steps (NNNNN). The ramp dwelling time will be fastest of output capability (typically ~300 ms per step). See “Configuring the ramp signal parameters” on page 123 for more information.

Table 4-2 Utility menu item descriptions (continued)

Item	Available settings		Description
SCAn	CV	CC	<ul style="list-style-type: none"> Press Voltage to select scan setup for CV. Press Current to select scan setup for CC.
	S1/S2	S1/S2	Press Shift > Range to toggle between range S1 (30 V/1 A) or S2 (8 V/3 A)
	NN.NNN V	N.NNNN A	NNN-NN s
SMoTh	oF	on	Select “oF” to disable the smooth function, or “on” to enable the smooth function.
	FC-N.N %		<ul style="list-style-type: none"> Set the fluctuation count from 0.0 % to 9.9 %. Set the count to 0.0 % to disable the fluctuation function. See “Setting the smooth function” on page 127 for more information.
	NNNN.		<ul style="list-style-type: none"> Set the number of points from 2 to 1999. See “Setting the smooth function” on page 127 for more information.
rHoLd	t - NNN %	nH - N.N %	<ul style="list-style-type: none"> Set the refresh hold variation (t - NNN %) in percentage. When the variation of the measuring value exceeds the preset setting, the refresh hold will be ready to trigger. Set variation to “OFF” to enable data hold mode. Set the refresh hold threshold (nH - N.N %) in percentage for voltage, current, and capacitance measurements. The reading value will not be updated when the reading falls below the threshold value. See “Enable refresh hold” on page 130 and “Enable data hold” on page 131 for more information.

Reading error messages

The following procedure shows you how to read error messages from the front panel. For remote interface operation, refer to the `SYSTEM:ERROR?` command in the *U3606A Programmer's Reference*.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 If there are no errors in the error queue, the primary display shows “nonE”.



- 4 If there are one or more errors, “total” is shown in the primary display and “NN” is shown in the lower secondary display (where “NN” is the total number of errors in the error queue). For example, if there are seven errors in the queue, “07” will be shown in the lower secondary display.



- 5 Errors are numbered and stored in the queue in the order they occurred.
- 6 If there are errors in the error queue, press **▽** to read the first error. The error number in the queue is shown in the primary display, “(-)Er.NNN”, where “NNN” is the actual error number.



- 7 Repeat [step 6](#) for all errors in the error queue.
- 8 After reading all errors, press **Shift** > **Exit** to exit the utility menu.
- 9 The error queue is automatically cleared when all errors have been read (primary display shows “nonE”).

**NOTE**

See [Chapter 9, “List of Error Messages,”](#) starting on page 259 for a list of all error numbers and their respective message string.

Reading the program code revision

The following procedure shows you how to read the program code revision from the front panel.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀**. The next menu item (P.CodE) will be shown in the upper secondary display.



- 4 Press **Δ** or **▽** to cycle between the interface board (IOb), source board (Sb), and measurement board (Mb) program code revisions.
- 5 After reading the program code revisions, press **Shift** > **Exit** to exit the utility menu.

Adjusting the display brightness

The following procedure shows you how to adjust the brightness level of the VFD display from the front panel.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “diSP” is shown in the upper secondary display.



- 4 Press **▲** or **▼** to cycle between the available brightness levels (L-01, L-02, or L-03).
- 5 After setting the appropriate brightness level, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 6 Press **Shift** > **Exit** to exit the utility menu.

Changing the power-on state

The following procedure shows you how to enable or disable the automatic recall of the power-off state when the power is turned on. For remote interface operation, refer to the `MEMory:STATE:RECall:AUTO` command in the *U3606A Programmer's Reference*.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “P-on” is shown in the upper secondary display.

- 4 Press Δ or ∇ to change the power-on state.
 - a Select “rESEt” to automatically reset the instrument to the factory default state when the power is turned on.



- b Select “LAST” to automatically recall the last power-off state of the instrument when the power is turned on.



- 5 After selecting the appropriate power-on state, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 6 Press **Shift** > **Exit** to exit the utility menu.

Configuring the beeper

Normally, the U3606A beeps whenever certain conditions are met (for example, the U3606A beeps when a stable reading is captured in reading hold mode). The beep driving frequency is set to “3840 Hz” by default, but may be disabled through the front panel.

When the beep driving frequency is set to “2400 Hz” or “3840 Hz”, a single beep occurs for the following cases (turning the beeper “OFF” disables the beep for the following cases):

- When a new minimum (Min) or maximum (Max) value is stored.
- When a new stable reading is updated on display for hold operation.
- When a measurement exceeds the high (HI) or low (LO) limit value.
- When a forward-biased is measured in the diode function.



- 4 Press Δ or ∇ to change the remote interface connection (GPIB, U-CdC, or U-tMC).
- 5 To change the GPIB address, press Δ or ∇ until the menu item "GPIB" is flashing.
- 6 Press \blacktriangleright to position the cursor on the GPIB address number. Use the directional keys to select an appropriate GPIB address from 1 to 30. See "Editing values" on page 110 for more information.
- 7 After selecting the appropriate remote interface connection, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 8 Press **Shift** > **Exit** to exit the utility menu.

NOTE

See "Remote Operation" on page 134 for more information on the available remote interface connections.

Performing a self-test

A power-on self-test occurs immediately when you turn on the instrument. This limited test assures you that the U3606A is operational.

The following procedure shows you how to perform a more extensive self-test. A complete self-test performs a series of internal tests, and may take up to 30 seconds to complete. For remote interface operation, refer to the *TST command in the *U3606A Programmer's Reference*.

CAUTION

Before performing the complete self-test, ensure that all test leads are removed from the input and output terminals.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “SELFt” is shown in the upper secondary display.



- 4 Press **Δ** or **▽** to select “YES”.



- 5 Press **Shift** > **Save** to save. The instrument will automatically exit the utility menu and execute the self-test.
- 6 If the self-test is successful, the U3606A will return to normal operation.

If the power-on or complete self-test fails, the Error annunciator illuminates, and an error is stored in the error queue. See “[Reading error messages](#)” on page 114 and “[Self-test](#)” on page 153 for more information on resolving the error.

Selecting a dBm reference resistance value

The dBm function is logarithmic, and is based on a calculation of power delivered to a reference resistance, relative to 1 mW. The following procedure shows you how to select an appropriate dBm reference resistance value.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “db.rEF” is shown in the upper secondary display. The factory default dBm reference resistance value is 600 Ω .



- 4 Press **▲** or **▼** to change the dBm reference resistance value (0001 Ω to 9999 Ω). See “[Editing values](#)” on page 110 for more information.
- 5 After selecting an appropriate dBm reference resistance value, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 6 Press **Shift** > **Exit** to exit the utility menu.

Setting the output protection state

The OVP and OCP protection features depend on the output protection state function. The output protection state must be enabled for the OVP and OCP protection features to be active in the circuit. Disabling the output protection state will deactivate both the OVP and OCP protection features even if a trip level is set for either the OVP or OCP. See [Chapter 3, “Protection Functions,”](#) starting on page 78 for more information.

NOTE

The output protection state does not affect the overvoltage and overcurrent limits.

CAUTION

Disabling the output protection state may result in equipment damage if an overvoltage or overcurrent condition occurs. It is recommended to have the output protection state enabled.



The following steps shows you how to enable or disable the output source protection.

- 1 Press **Shift** > **Utility** to access the utility menu.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “triP Sby” is shown in the secondary display as shown in the figure below.



- 4 Press **△** or **▽** to switch between “YES” and “no”. Select “YES” to enable the output protection state or “no” to disable the output protection state.



- 5 Press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the mode without saving.
- 6 Press **Shift** > **Exit** to exit the utility menu.

Configuring the ramp signal parameters

The following procedure shows you how to configure the ramp signal parameters.

Table 4-3 Ramp signal parameters

Ramp signal	Output			
	Constant Voltage		Constant Current	
Items	S1	S2	S1	S2
Range	S1	S2	S1	S2
Amplitude end position ^[1]	0 V to 30.000 V	0 V to 8.400 V	0 A to 1.0000 A	0 A to 3.0000 A
Number of steps	1 step to 10000 steps			
Dwelling time	Fastest of the instrument output capability ^[2]			

[1] Amplitude start position is fixed at 0 (V or A) by default.

[2] Typically ~300 ms per step.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “rAMP” is shown in the upper secondary display.

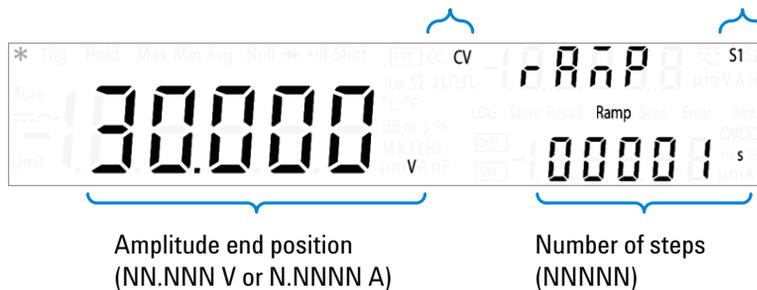
4 System Related Operation

Utility Menu Summary



- 4 Press **Voltage** or **Current** if you wish to configure the ramp signal parameters for CV or CC output. (The CV or CC annunciator illuminates respectively when selected.)
- 5 Select an appropriate output range by pressing **Shift** > **Range**. The ramp signal amplitude end position is limited by the range selected. (The S1 or S2 annunciator illuminates respectively when selected.)

CV/CC ramp signal parameters Ramp signal range



- 6 Press Δ or ∇ to change the ramp signal amplitude end position. See “Editing values” on page 110 for more information.
- 7 Press \triangleleft or \triangleright until the cursor is position on the ramp signal number of steps. Press Δ or ∇ to change the number of steps for the ramp signal to increment from zero to the amplitude end position. See “Editing values” on page 110 for more information.

NOTE

- The increment of each step in the ramp signal will be the amplitude end position divided by the number of steps. For example, a 15 V amplitude end position divided by 100 steps gives an increment of 0.15 V per step.
- The ramp dwelling time selected will be fastest of the instrument output capability. (Typically ~300 ms per step.)

- 8 After configuring the ramp signal parameters, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 9 Press **Shift** > **Exit** to exit the utility menu.

Configuring the scan signal parameters

The following procedure shows you how to configure the scan signal parameters.

Table 4-4 Scan signal parameters

Scan signal	Output			
	Constant Voltage		Constant Current	
Items	S1	S2	S1	S2
Range	S1	S2	S1	S2
Amplitude end position ^[1]	0 V to 31.500 V	0 V to 8.400 V	0 A to 1.0500 A	0 A to 3.1500 A
Number of steps	1 step to 100 steps			
Dwelling time	1 s to 99 s			

[1] Amplitude start position is fixed at 0 (V or A) by default.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “SCAN” is shown in the upper secondary display.

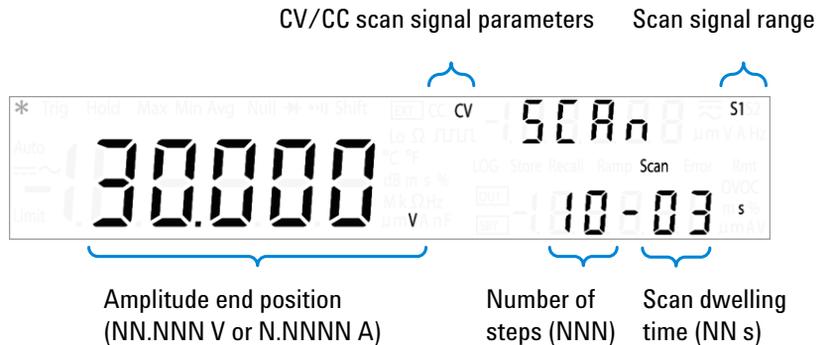


- 4 Press **Voltage** or **Current** if you wish to configure the scan signal parameters for CV or CC output. (The CV or CC annunciator illuminates respectively when selected.)

4 System Related Operation

Utility Menu Summary

- 5 Select an appropriate output range by pressing **Shift** > **Range**. The scan signal amplitude end position is limited by the range selected. (The S1 or S2 annunciator illuminates respectively when selected.)



- 6 Press Δ or ∇ to change the scan signal amplitude end position. See “Editing values” on page 110 for more information.
- 7 Press \triangleleft or \triangleright until the cursor is position on the scan signal number of steps. Press Δ or ∇ to change the number of steps for the scan signal to increment from zero to the amplitude end position. See “Editing values” on page 110 for more information.
- 8 Press \triangleleft or \triangleright until the cursor is position on the scan signal dwelling time. Press Δ or ∇ to change the scan signal dwelling time. See “Editing values” on page 110 for more information.

NOTE

- The increment of each step in the scan signal will be the amplitude end position divided by the number of steps. For example, a 15 V amplitude end position divided by 100 steps gives an increment of 0.15 V per step.
- The scan signal will “dwell” in the present step for the length of time stated in the scan dwelling time before incrementing to the next step.

- 9 After configuring the scan signal parameters, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 10 Press **Shift** > **Exit** to exit the utility menu.

Setting the smooth function

The smooth function is a special short-term average that differs from the average function of the MinMax operation. The smooth function filters noise and stabilizes readings. The average function of the MinMax operation is considered as a long-term average as it uses all of the readings to perform averaging.

The smooth function has a fixed number of readings that will be used for averaging. This fixed number is known as the number of points which you can set from the utility menu. The smooth function also includes a fluctuation count which limits the range of the readings that can be used for the averaging. Smoothed readings obtained using the smooth function are easier to read as the readings are stabilized.

The smooth function and the average function of the MinMax operation are independent functions and mutually exclusive in which they cannot occur at the same time.

When the smooth function is enabled, the AVG annunciator will be flashing to indicate its ON state. The smooth function will start its calculations using the parameters set in the utility menu.

NOTE

The smooth function calculation can be restarted by pressing **MinMax** for more than one second.

The following procedures will show you how to enable or disable the smooth function, and set the parameters for the fluctuation counts and number of points of the smooth function.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “SMoth” is shown in the upper secondary display.



4 System Related Operation

Utility Menu Summary

- 4 Press Δ or ∇ to enable or disable the smooth function, or “on” or “oF” respectively.



- 5 To set the fluctuation count, press \triangleright until the cursor position is on the fluctuation count at the secondary display. Press \triangleleft or \triangleright to change the cursor position and Δ or ∇ to change the value for the fluctuation count. See “Editing values” on page 110 for more information.

NOTE

- The range of values for the fluctuation count is from 0.0% to 9.9%, with the default value at 1.0%.
- If the input raw signal readings are higher or lower than the fluctuation count of the previous smoothed signal readings, the smooth function calculations will reset.
For example, a smooth function with a 5 V signal and a fluctuation count of 1.0% will only smooth the input raw signal to the existing smooth calculation if the input signal is between 4.9 V and 5.1 V. The next input signal will then be compared to the newly smoothed signal. If the input signal is out of the set fluctuation count range of the smoothed signal, the smooth function calculation will reset and restart at the out-of-range signal.
- The smooth function will also reset if the range of the signal changes when the smooth calculation is running. For example, when the signal range jumps to the 100 V range from the 10 V range.
- You can also manually restart the smooth function by pressing **MinMax** for more than one second.
- Setting the fluctuation count to 0.0% will disable the fluctuation count. It is recommended that the fluctuation count is enabled.

- 6 To set the number of points, press \triangleleft until the cursor position is on the number of points on the primary display. Press \triangleleft or \triangleright to change the cursor position and \triangle or ∇ to change the values for the number of points. See “Editing values” on page 110 for more information.

NOTE

- The range of values for the number of points is from 2 to 1999, with the default value at 10.
- The number of readings used to perform the smooth function calculation depends on the number of points set. For example, if the number of points is set to 10 ($N = 10$), the smooth function will only use a maximum of 10 readings for averaging instead of an incremental value as used in the average function of the MinMax operation. When the instrument reaches the 11th reading or more, it will take the previous averaged value multiply by $(N-1)$, and the current value to perform the averaging. Note the difference given below between the smooth function and average function for a x number of readings:

Smooth function

$$V_1 = r_1$$

$$V_2 = (r_1 + r_2)/2$$

$$V_3 = (r_1 + r_2 + r_3)/3$$

...

$$V_{10} = (r_1 + r_2 + \dots + r_{10})/10$$

$$V_{11} = (V_{10} * 9 + r_{11})/10$$

$$V_{12} = [(V_{11} * 9) + r_{12}]/10$$

...

$$V_{x-1} = [(V_{x-2} * 9) + r_{x-1}]/10$$

$$V_x = [(V_{x-1} * 9) + r_x]/10$$

Average function

$$V_1 = r_1$$

$$V_2 = (r_1 + r_2)/2$$

$$V_3 = (r_1 + r_2 + r_3)/3$$

...

$$V_{10} = (r_1 + r_2 + \dots + r_{10})/10$$

$$V_{11} = (r_1 + r_2 + \dots + r_{10} + r_{11})/11$$

$$V_{12} = (r_1 + r_2 + \dots + r_{11} + r_{12})/12$$

...

$$V_{x-1} = [r_1 + r_2 + \dots + r_{x-2} + r_{x-1}]/(x-1)$$

$$V_x = [r_1 + r_2 + \dots + r_{x-1} + r_x]/x$$

- 7 After setting the smooth function, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 8 Press **Shift** > **Exit** to exit the utility menu.

Enable refresh hold

The following procedure shows you how to enable and configure the refresh hold variation.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “rHoLd” is shown in the upper secondary display.



- 4 Press **▲** or **▼** to change the refresh hold variation (001% to 100%). See “[Editing values](#)” on page 110 for more information.
- 5 Press **◀** or **▶** until the cursor is position on the refresh hold threshold (nH - N.N%). Press **▲** or **▼** to change the refresh hold threshold (0.1% to 9.9%) for voltage, current, and capacitance measurements. See “[Editing values](#)” on page 110 for more information.

NOTE

- If the variation of the measured value exceeds the preset percentage, the refresh hold will be ready to trigger.
- For voltage, current, and capacitance measurements, the reading value will not be updated when the reading falls below the threshold value.

- 6 After configuring the refresh hold variation, press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 7 Press **Shift** > **Exit** to exit the utility menu.

Enable data hold

The following procedure shows you how to enable the data hold mode.

- 1 To access the utility menu, press **Shift** > **Utility**.
- 2 The first utility menu item (Error) will be shown in the upper secondary display.
- 3 Press **◀** or **▶** until the menu item “rHoLd” is shown in the upper secondary display.



- 4 Press **▲** or **▼** to change the refresh hold variation to “OFF”. See “Editing values” on page 110 for more information.



NOTE

- To enable refresh hold again, enter a value for the refresh hold variation.
- The threshold (nH) is not applicable in the data hold mode.

- 5 Press **Shift** > **Save** to save or press **Shift** > **Exit** to exit the edit mode without saving.
- 6 Press **Shift** > **Exit** to exit the utility menu.

Storing and Recalling Instrument States

You can save and recall complete instrument states including all front panel settings, all math registers, all utility menu settings, and all bus specific settings.

There are sixteen user storage registers numbered 1 through 16. An additional state, state 0, is managed by the instrument and stores the last power-down state. The instrument automatically saves the complete instrument configuration to State 0 whenever a power-down event occurs.

For remote operation, refer to the `MEMory:STATe:RECall:AUTO`, `*SAV`, and `*RCL` commands in the *U3606A Programmer's Reference*.

Storing a state



To store an instrument state:

- 1 Press **Shift** > **Store**. The Store annunciator will begin flashing.

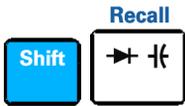


- 2 Press **Δ** or **∇** until the state number (01 to 16) you want to store to is shown on the primary display.
- 3 Press **Store** or **Shift** > **Save** to store to the selected state. The upper secondary display briefly shows “donE” when the state is successfully saved.
- 4 The instrument will then return to normal operation.

NOTE

If you use state 00 to store your current instrument state, it will be overwritten with the instrument last power-down state when the power is cycled.

Recalling a stored state



To recall an instrument state:

- 1 Press **Shift** > **Recall**. The Recall annunciator will begin flashing.



- 2 Press **Δ** or **∇** until the state number (01 to 16) you want to recall from is shown on the primary display.
- 3 Press **Recall** or **Shift** > **Save** to recall the selected state. The upper secondary display briefly shows “donE” when the state is successfully recalled.
- 4 The instrument will then return to normal operation.

NOTE

Select state 00 to recall the instrument last power-down state.

Remote Operation

The U3606A is shipped with both a GPIB (IEEE-488) interface and a USB 2.0 interface on the rear panel. Only one interface can be enabled at a time. The GPIB interface is selected by default when the U3606A is shipped from the factory.

The remote interface can be selected from the front-panel only.

- The interface selection is stored in the nonvolatile memory, and does not change when power is turned off or after a remote interface reset.
- If you select the GPIB interface you must select a unique address for the U3606A. The current address for the U3606A is displayed on the lower secondary display in the utility menu.
- You can select between two USB class, USB-TMC or USB-CDC. USB-TMC is the default USB 2.0 full speed communication protocol interface that is compliant to USB standards, while USB-CDC is simulates a serial communication (RS-232) interface at the PC through the physical USB port connection.

Local



The instrument automatically enters the remote state whenever SCPI commands are received over the GPIB or USB interface. The Rmt annunciator is illuminated and the front panel keys are locked when in the remote state. Press **Local** to return the U3606A to front panel operation.

Configuring and connecting the GPIB interface

The GPIB (IEEE-488) connector on the rear panel connects your U3606A to the computer and other GPIB devices. A GPIB system can be connected together in any configuration (star, linear, or both) as long as the following rules are observed.

- The total number of devices including the computer is no more than 15.
- The total length of all the cables used is no more than 2 meter times the number of devices connected together, up to a maximum of 20 meters.

NOTE

IEEE-488 states that you should exercise caution if your individual cable lengths exceed 4 meters.

Do not stack more than three connector blocks together on any GPIB connector. Make sure that all connectors are fully seated and that the lock screws are firmly finger tightened.

GPIB address

Each device on the GPIB interface must have a unique address. You can set the U3606A address to any value between 0 and 30. The current address is displayed on the secondary display at the bottom left. The address is set to “01” when the U3606A is shipped from the factory.

The GPIB address can be set from the front panel only.

- The address is stored in the nonvolatile memory, and does not change when power is turned off or after a remote interface reset.
- Your GPIB bus controller has its own address. Be sure to avoid using the bus controller address for any instrument on the interface bus. Agilent Technologies controllers generally use the address “21”.

Configuring and connecting the USB interface

Select the appropriate USB class for communication from the utility menu.

- USB-TMC stands for USB Test and Measurement Class. USB-TMC is a protocol built on top of USB that allows GPIB-like communication with USB devices.
- USB-CDC stands for USB Communications Device Class. USB-CDC is a composite Universal Serial Bus device class. It provides a single device class, but there may be more than one interface implemented such as a custom control interface, data interface, audio, or mass storage related interfaces. To install the USB-CDC driver, see the *USB-CDC Driver Installation Guide* in the *U3606A Product Reference CD-ROM*.

Then, connect the instrument to your PC using the USB 2.0 cable included with the instrument.

NOTE

- To easily configure and verify an interface connection between the U3606A Multimeter|DC Power Supply and your PC, refer to the *USB/LAN/GPIB Interfaces Connectivity Guide*, located in the *Agilent Automation-Ready CD-ROM*, which is shipped with your instrument.
 - This CD includes the Agilent IO Libraries Suite and the Agilent Connection Expert application. For more information about Agilent's I/O connectivity software, visit www.agilent.com/find/iolib.
-

SCPI commands

The U3606A complies with the syntax rules and conventions of SCPI (Standard Commands for Programmable Instruments).

NOTE

For a complete discussion of all the U3606A SCPI syntax available, refer to the *U3606A Programmer's Reference*. This document is provided on the *U3606A Product Reference CD-ROM* that came with your instrument.

SCPI language version

You can determine the SCPI language version of the instrument by sending the `SYSTem:VERSion?` command from the remote interface.

- You can query the SCPI version from the remote interface only.
- The SCPI version is returned in the form “YYYY.V”, where “YYYY” represents the year of the version, and “V” represents a version number for that year (for example, 1994.0).

SCPI query timeout

The SCPI query timeout represents the absolute time period (in milliseconds) that the resource waits for the device to respond before this operation returns an error (default value is 5000 milliseconds).

Some measurements may result in a delayed response time in the U3606A Multimeter|DC Power Supply. It is recommended that you increase the SCPI query timeout to 15000 milliseconds or longer to avoid SCPI query timeout errors.

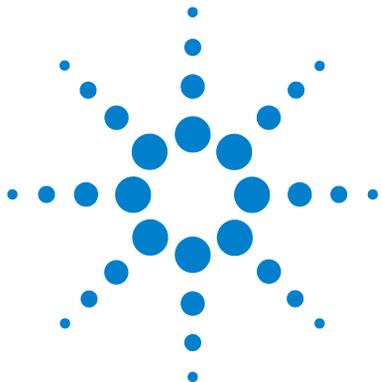
Remote programming using SCPI commands

During remote programming, various SCPI commands are stringed together in a single programming module. As the programming module executes each SCPI command sequentially, a 1 millisecond interval between each subsequent SCPI command is recommended to allow the U3606A Multimeter|DC Power Supply sufficient command processing time.

4 System Related Operation

Remote Operation

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5 Verification and Performance Tests

Recommended Test Equipment	140
General measurement techniques	143
Using an electronic load	143
Connecting the current monitoring resistor	143
Test Considerations	144
Input Connections	145
Zero offset verification test setup	145
Gain verification test setup	146
Output verification test setup	147
Verification and Performance Tests Overview	152
Self-test	153
Performance Verification Tests	154
Zero offset verification test	154
Gain verification test	156
Output verification test	161
Optional capacitance gain verification test	171
Optional square-wave output verification test	172
Additional Verification Tests	171

This chapter contains the procedures for verification of the instrument performance. The input connections and test setup for each verification procedure is also described in this chapter.



Recommended Test Equipment

The test equipment recommended for the performance verification procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Table 5-1 Recommended test equipment for performance verification procedures

Application	Recommended equipment		Recommended accuracy requirements
Zero offset and gain verification procedures			
Zero calibration	Shorting plug — Dual banana plug with copper wire short between the two input terminals		
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
Resistance	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification
Frequency	Function/Arbitrary waveform generator	Agilent 33250A	< 20% of instrument 1 year specification
Capacitance	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	<ul style="list-style-type: none"> • Voltage range: 30 V_{dc} • Current range: 5 A • Open and short switches

Table 5-1 Recommended test equipment for performance verification procedures (continued)

Application	Recommended equipment		Recommended accuracy requirements
Constant voltage source effect (line regulation)	Digital multimeter	Agilent 3458A	8½ digit resolution
	Electronic load	Agilent 6060B	<ul style="list-style-type: none"> • Voltage range: 30 V_{dc} • Current range: 5 A • Open and short switches
	AC voltage source	Agilent 6813B	Capable of supplying 90 V _{ac} to 250 V _{ac}
Constant voltage noise effect	Fix resistive load		30 Ω 50 W, 2.5 Ω, 50 W
	Differential amplifier	Lecroy DA1855A	<ul style="list-style-type: none"> • Bandwidth > 20 MHz • AC coupling • Amplifier × 10
	50 Ω feed-thru termination	Pomona	-
	Oscilloscope	Agilent DS08064A or Infiniium equivalent	<ul style="list-style-type: none"> • Sensitivity: 1 mV • Bandwidth limit: 20 MHz • Probe: 1:1 with RF tip; 10:1 with RF tip for > 50 V
	RMS voltmeter	R&S URE3 or equivalent	20 Hz to 20 MHz
Load transient response time	Oscilloscope	Agilent DS08064A or Infiniium equivalent	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Voltage range: 30 V_{dc} • Current range: 5 A • Open and short switches
Constant current programming and readback	Digital multimeter	Agilent 3458A	8½ digit resolution
	Current monitoring resistor (shunt)	ISOTEK Co. model A-H	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Voltage range: 30 V_{dc} • Current range: 5 A • Open and short switches
	Current monitoring resistor (shunt)	ISOTEK Co. model A-H	<ul style="list-style-type: none"> • 0.01 Ω ± 0.1% • TCR less than 20 ppm/°C

5 Verification and Performance Tests

Recommended Test Equipment

Table 5-1 Recommended test equipment for performance verification procedures (continued)

Application	Recommended equipment	Recommended accuracy requirements	
Constant current source effect (line regulation)	Digital multimeter	Agilent 3458A	8½ digit resolution
	Electronic load	Agilent 6060B	<ul style="list-style-type: none"> Voltage range: 30 V_{dc} Current range: 5 A Open and short switches
	AC voltage source	Agilent 6813B	Capable of supplying 90 V _{ac} to 250 V _{ac}
	Current monitoring resistor (shunt)	ISOTEK Co. model A-H	<ul style="list-style-type: none"> 0.01 Ω ± 0.1% TCR less than 20 ppm/°C
Constant current noise effect	AC/DC current converter	Tektronix TCP305 and Tektronix TCPA300	-
	Fix resistive load		30 Ω 50 W, 2.5 Ω, 50 W
	Differential amplifier	Lecroy DA1855A	<ul style="list-style-type: none"> Bandwidth > 20 MHz AC coupling Amplifier × 10
	50 Ω feed-thru termination × 2	Pomona	-
	Oscilloscope	Agilent DSO8064A or Infiniium equivalent	<ul style="list-style-type: none"> Sensitivity: 1 mV Bandwidth limit: 20 MHz Probe: 1:1 with RF tip; 10:1 with RF tip for > 50 V
	RMS voltmeter	R&S URE3 or equivalent	20 Hz to 20 MHz
Square wave	Oscilloscope	Agilent DSO8064A or Infiniium equivalent	<ul style="list-style-type: none"> Sensitivity: 1 mV Bandwidth limit: 20 MHz Probe: 1:1 with RF tip; 10:1 with RF tip for > 50 V
	Universal frequency counter	Agilent 53131A	-

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 pick-up of AC signals.

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

- Assure that the calibration ambient temperature (T_{cal}) is stable and between 18 °C and 28 °C. Ideally the calibration should be performed at 23 °C \pm 2 °C.
- Assure 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 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.

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.

[1] 120-minute warm-up period for instrument adjustments (calibration). See [Chapter 6](#), “Calibration Procedures,” starting on page 175 for more information on the calibration procedures.

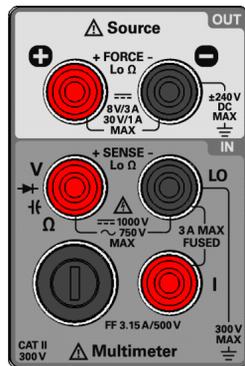
Input Connections

Test connections to the instrument are best accomplished by using the dual banana plug with 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 U3606A. Cable shields should be earth ground referenced.

This configuration is recommended for optimal noises and settling time performance during calibration.

Zero offset verification test setup



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

Figure 5-1 Test setup for zero offset (short) verification

Gain verification test setup

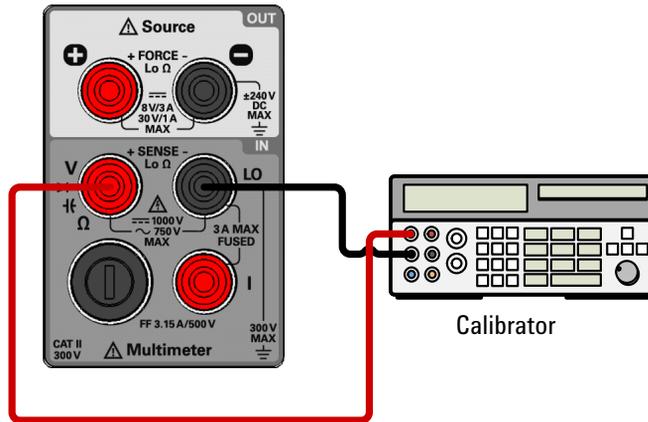


Figure 5-2 Test setup for DC voltage, AC voltage, resistance, and capacitance gain verification

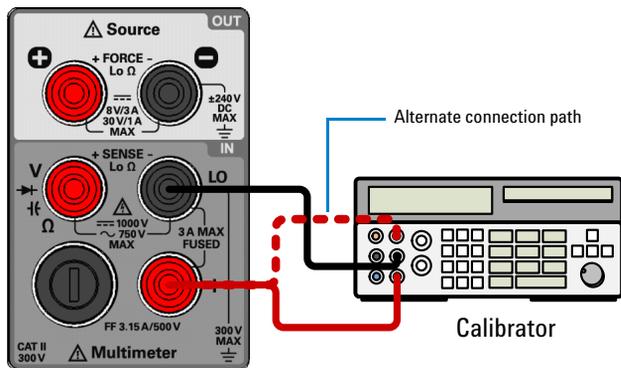


Figure 5-3 Test setup for DC current and AC current gain verification

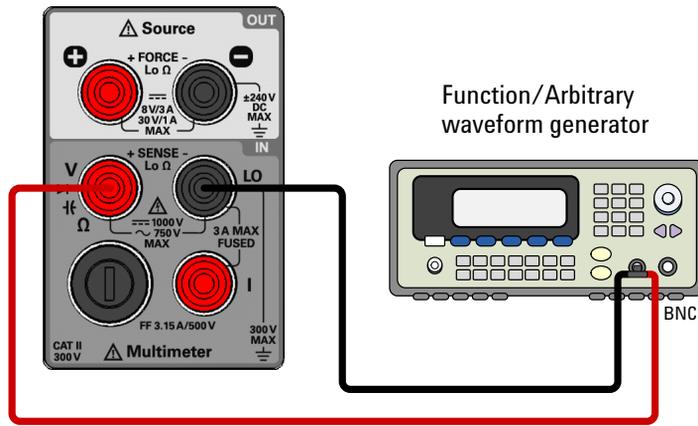


Figure 5-4 Test setup for frequency gain verification

Output verification test setup

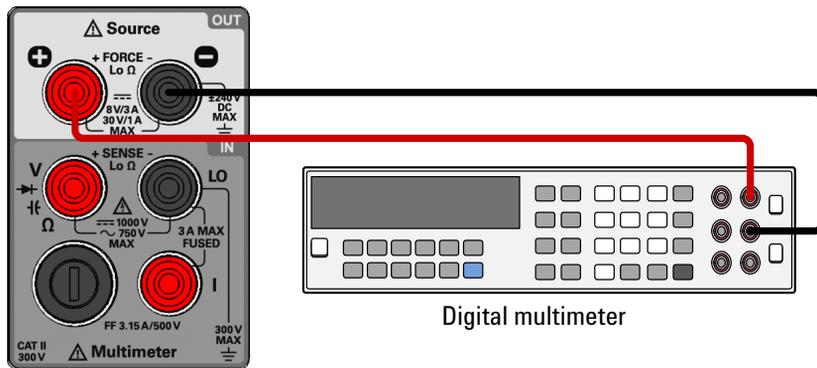


Figure 5-5 Test setup for CV programming and readback accuracy verification

5 Verification and Performance Tests

Input Connections

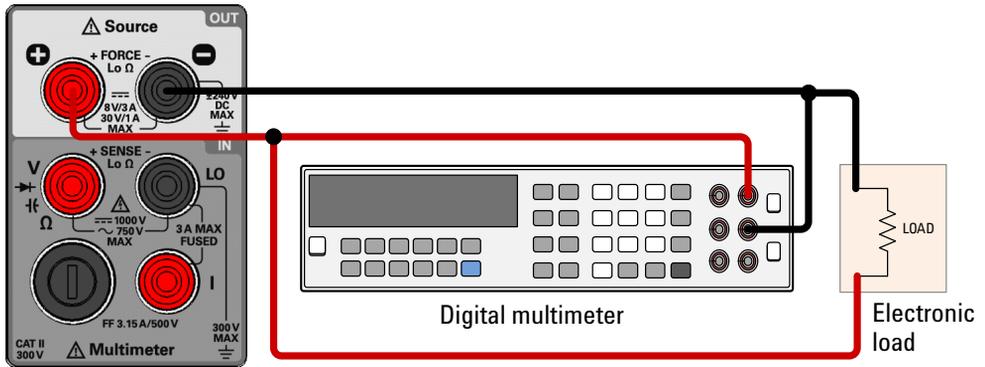


Figure 5-6 Test setup for CV load and line regulation verification

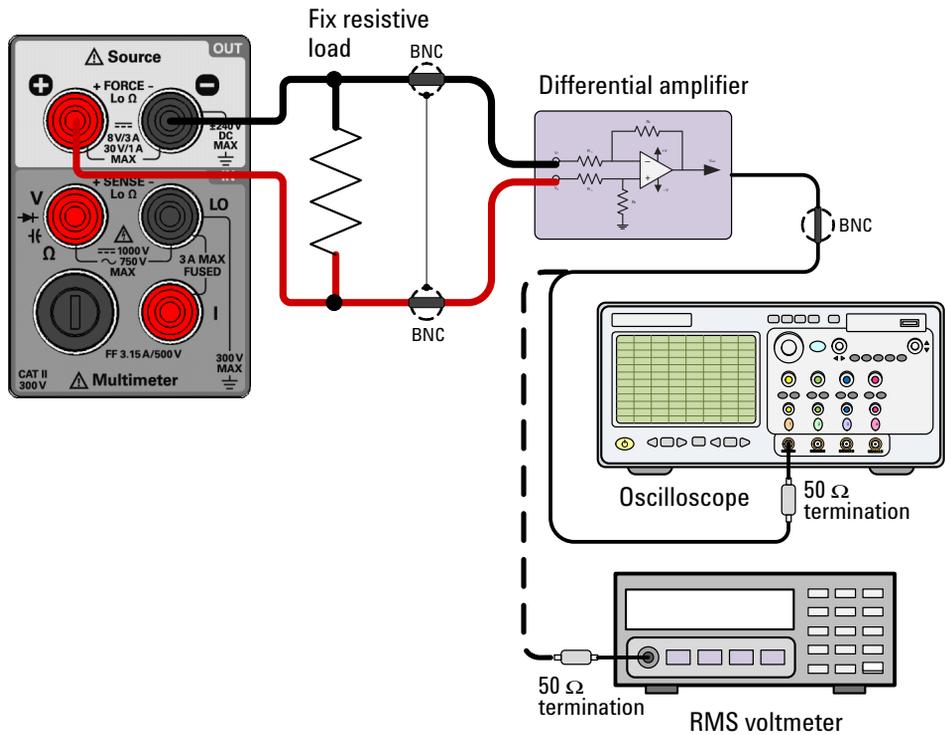


Figure 5-7 Test setup for CV noise effect verification

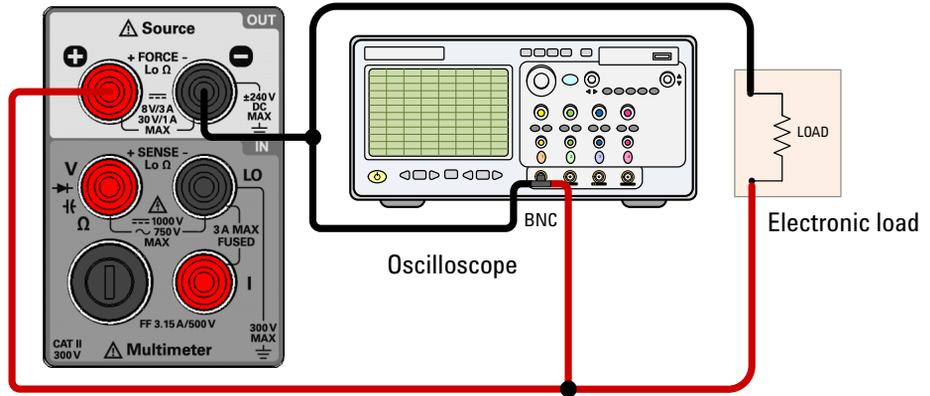


Figure 5-8 Test setup for load transient response time verification

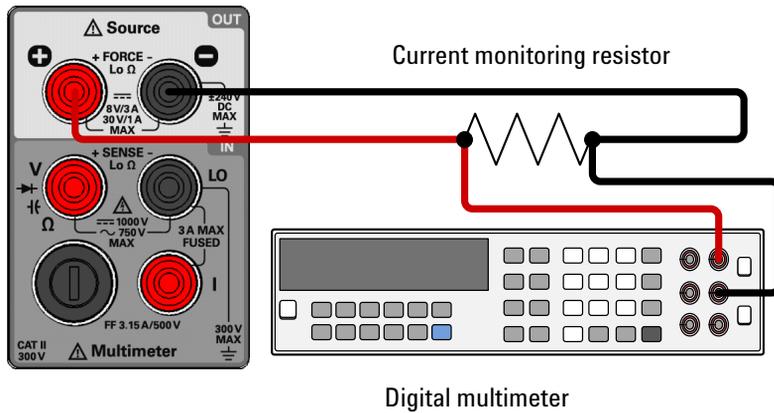


Figure 5-9 Test setup for CC programming and readback accuracy verification

5 Verification and Performance Tests

Input Connections

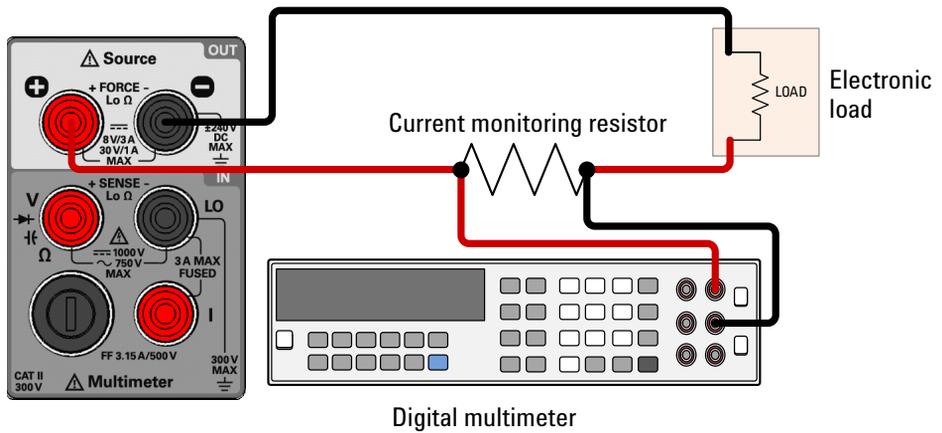


Figure 5-10 Test setup for CC line and load regulation verification

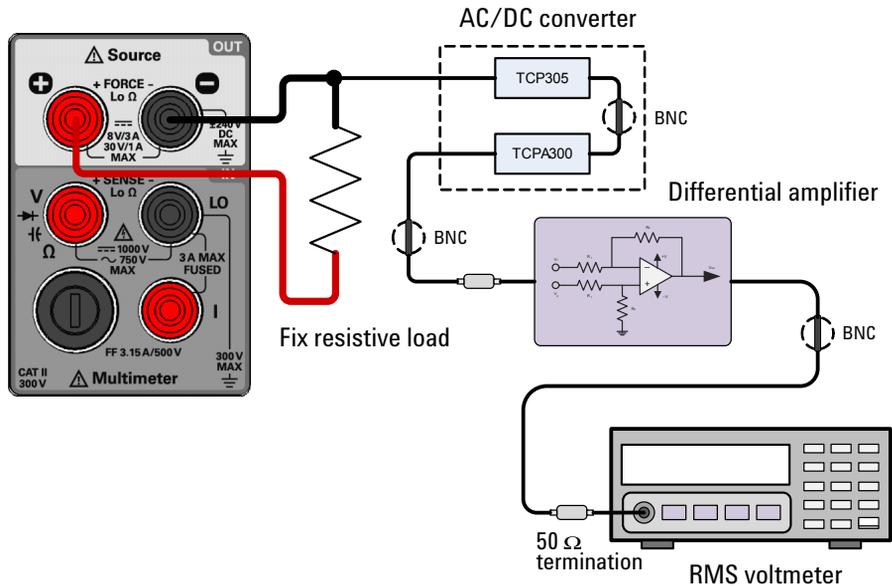


Figure 5-11 Test setup for CC noise effect verification

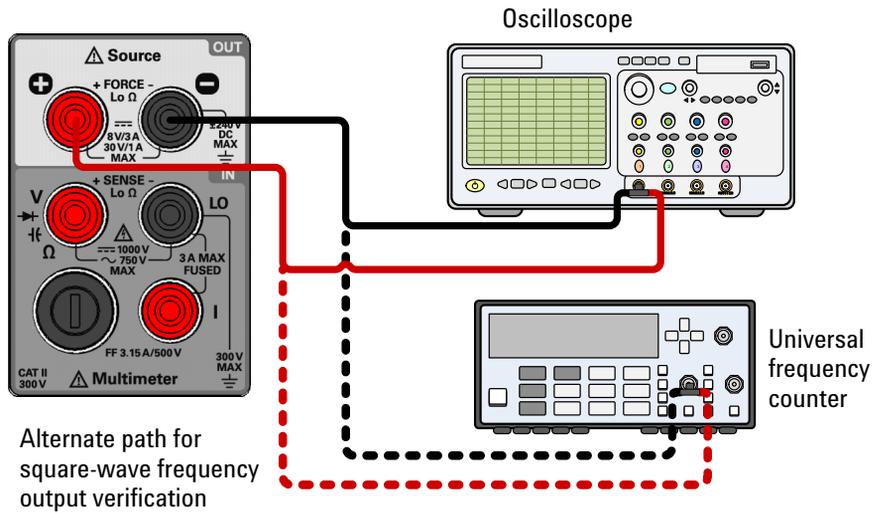


Figure 5-12 Test setup for square-wave output verification

Verification and Performance 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 8](#), “Characteristics and Specifications,” starting on page 239.

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

Self-test. A series of internal verification tests which give 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 are not performed with every calibration. Perform these tests to verify additional specifications or functions of the instrument.

Self-test

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 illuminated before “doinG” and “SELF.t” is shown on the primary and upper secondary display respectively.



If the self-test fails, the Error annunciator illuminates.

Read the errors using the utility menu (see “[Reading error messages](#)” on page 114), or use the `SYSTem:ERRor?` query from the remote interface (see the *U3606A Programmer’s Reference*). A list of the possible self-test errors is given on [page 264](#).

If repair is required, contact the Agilent Service Center.

You can initiate a more complete self-test from the utility menu (see “[Performing a self-test](#)” on page 120), or by sending the `*TST?` command to the instrument from a remote interface.

NOTE

- The instrument returns to normal operation if all the self-tests pass, or the Error annunciator illuminates if a failure occurs.
- The `*TST?` command returns a “+0” if all the self-tests pass, or a “+1” if a failure occurred.

This command may take up to 30 seconds to complete. You may need to set an appropriate remote interface SCPI query timeout value.

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.

NOTE

Ensure that you have read the “[Test Considerations](#)” on page 144 before running the performance verification tests.

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 to the **V** (red) and **L0** input terminals (see [Figure 5-1](#) on page 145). Leave the current input open.
- 2 Select each function and range in the order shown in the table below. (Remember to remove the shorting plug for zero offset capacitance verification.) Make a measurement and observe the result. Compare the measurement results to the appropriate test limits shown in [Table 5-2](#).

NOTE

Note that resistance measurements use the Null math function (Null reading taken with test leads connected together) to eliminate test lead resistance. See “[Null](#)” on page 57 for more information on the Null math function.

Table 5-2 Zero offset verification test

Input	Function	Range	Error from nominal 1 year		
Short	DC voltage	100 mV	±0.008 mV		
		1 V	±0.00005 V		
		10 V	±0.0005 V		
		100 V	±0.005 V		
		1000 V	±0.05 V		
	Resistance	100 Ω	±0.008 Ω		
		1 kΩ	±0.00005 kΩ		
		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		
		Open	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 5-2](#) on page 146).
- 2 Press $\approx V$ to select the DC voltage function. The DC annunciator will be illuminated.
- 3 Select each range in the order shown below. Provide the indicated input voltage. Compare the measurement results to the appropriate test limits shown in [Table 5-3](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 5-3 DC voltage gain verification test

Input voltage	Range	Error from nominal 1 year
100 mV	100 mV	± 0.033 mV
1 V	1 V	± 0.0003 V
10 V	10 V	± 0.003 V
100 V	100 V	± 0.03 V
1000 V	1000 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 5-3](#) on page 146).
- 2 Press $\approx I$ to select the DC current function. The DC annunciator will be illuminated.
- 3 Select each range in the order shown below. Provide the indicated input current. Compare the measurement results to the appropriate test limits shown in [Table 5-4](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 5-4 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	± 0.00207 A
3 A	3 A	± 0.00771 A

AC voltage verification test

- 1 Connect the calibrator to the front panel **V** (red) and **LO** (black) input terminals (see [Figure 5-2](#) on page 146).
- 2 Press $\approx V$ to select the AC voltage function. The AC annunciator will be illuminated.
- 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 shown in [Table 5-5](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

5 Verification and Performance Tests

Performance Verification Tests

Table 5-5 AC voltage gain verification test

Input voltage	Input frequency	Range	Error from nominal 1 year
10 mV	1 Hz	100 mV	±0.12 mV
100 mV	1 Hz	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 **L0** (black) input terminals (see [Figure 5-3](#) on page 146).
- 2 Press \approx **I** to select the AC current function. The AC annunciator will be illuminated.
- 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 shown in [Table 5-6](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 5-6 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

Resistance gain verification test

- 1 Connect the calibrator to the front panel Ω (red) and **L0** (black) input terminals (see [Figure 5-2](#) on page 146).
- 2 Press $\Omega \bullet \text{H}$ 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 shown in [Table 5-7](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 5-7 Resistance gain verification test

Input resistance	Range	Error from nominal 1 year
100 Ω	100 Ω	±0.058 Ω ^[1]
1 k Ω	1 k Ω	±0.00055 k Ω ^[1]
10 k Ω	10 k Ω	±0.0055 k Ω ^[1]
100 k Ω	100 k Ω	±0.055 k Ω
1 M Ω	1 M Ω	±0.00065 M Ω

5 Verification and Performance Tests

Performance Verification Tests

Table 5-7 Resistance gain verification test (continued)

Input resistance	Range	Error from nominal 1 year
10 M Ω	10 M Ω	± 0.0255 M Ω
10 M Ω	100 M Ω	± 0.205 M Ω

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

Frequency gain verification test

- 1 Connect the calibrator to the front panel **V** (red) and **LO** (black) input terminals (see [Figure 5-4](#) on page 147).
- 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 shown in [Table 5-8](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 5-8 Frequency gain verification test

Input frequency	Input voltage	Range	Error from nominal 1 year
1 kHz	1 V	100 kHz	± 0.0032 kHz

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 U3606A over the remote interface for this test to avoid round off errors. See the *U3606A 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 5-5](#) on page 147).
- 2 Turn on the instrument. Press **Voltage** to select the constant voltage mode. Ensure that the S1 (30 V/1 A) range is selected (the S1 annunciator is illuminated). Press **Shift > Range** again if it is not.
- 3 Output each value in the order shown below. Record the output voltage reading on the digital multimeter. Compare the measurement results to the appropriate test limits shown in [Table 5-9](#).

Table 5-9 Constant voltage programming and readback accuracy verification test

Output voltage	Range	Error from nominal 1 year
0 V	30 V	±0.005 V
30 V	30 V	±0.02 V

5 Verification and Performance Tests

Performance Verification Tests

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 5-6](#) on page 148).
- 2 Turn on the instrument. Press **Voltage** to select the constant voltage mode. Ensure that the S1 (30 V/1 A) range is selected (the S1 annunciator is illuminated). Press **Shift > Range** again if it is not.
- 3 Set the output voltage to the full rated value (30 V for S1 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 digital multimeter (see [Figure 5-6](#) on page 148).
- 5 Operate the electronic load in constant resistance mode, and set its resistance to 30 Ω . Ensure that the U3606A 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 U3606A is operating within the specified limit and protection values.
- 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 shown in [Table 5-10](#).

Table 5-10 Constant voltage load effect verification test

Output voltage	Range	Error from nominal 1 year
30 V with 30 Ω load	30 V	± 0.009 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 5-6](#) on page 148).
- 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 S1 (30 V/1 A) range is selected (the S1 annunciator is illuminated). Press **Shift > Range** again if it is not.
- 4 Set the output voltage to the full rated value (30 V for S1 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 (see [Figure 5-6](#) on page 148).
- 6 Operate the electronic load in constant resistance mode, and set its resistance to 30 Ω . Ensure that the U3606A 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 U3606A is operating within the specified limit and protection values.
- 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 5-11](#).

Table 5-11 Constant voltage source effect verification test

Input AC line	Low line voltage limit	High line voltage limit	Error from nominal 1 year
100	90 V _{ac}	110 V _{ac}	±0.003 V

5 Verification and Performance Tests

Performance Verification Tests

Table 5-11 Constant voltage source effect verification test

Input AC line	Low line voltage limit	High line voltage limit	Error from nominal 1 year
115	104 V _{ac}	127 V _{ac}	±0.003 V
230	207 V _{ac}	253 V _{ac}	±0.003 V

CV noise effect

This test measures the RMS or peak-to-peak output voltage in the frequency range from 20 Hz to 1 MHz.

- 1 Turn off the instrument and connect a differential amplifier and a 30 Ω fix resistive load between the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-7](#) on page 148).
- 2 Connect a 50 Ω feed-thru termination to the differential amplifier output and an oscilloscope to the 50 Ω feed-thru termination (see [Figure 5-7](#) on page 148).
- 3 Turn on the instrument. Press **Voltage** to select the constant voltage mode. Ensure that the S1 (30 V/1 A) range is selected (the S1 annunciator is illuminated). Press **Shift** > **Range** again if it is not.
- 4 Set the output voltage to the full rated value (30 V for S1 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 1 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 $0.03 V_{pp}$.
- 9 Disconnect the oscilloscope and connect an RMS voltmeter in its place (see Figure 5-7 on page 148). 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. The result should not exceed $0.002 V_{rms}$.

Load transient response time

This test measures the time for the output voltage to recover to within 50 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 5-8 on page 149).
- 2 Turn on the instrument. Press **Voltage** to select the constant voltage mode. Ensure that the S1 (30 V/1 A) range is selected (the S1 annunciator is illuminated). Press **Shift > Range** again if it is not.

5 Verification and Performance Tests

Performance Verification Tests

- 3 Set the output voltage to the full rated value (30 V for S1 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 (see [Figure 5-8](#) on page 149).
- 5 Operate 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 Hz rate with 50% duty cycle.
- 6 Set the oscilloscope for DC coupling, internal synchronization, and lock on either the positive or negative load transient.
- 7 Adjust the oscilloscope to display transients as shown in [Figure 5-13](#). Note that the pulse width ($t_2 - t_1$) of the transients at 50 mV from the base line should be no more than 450 ms for the output.

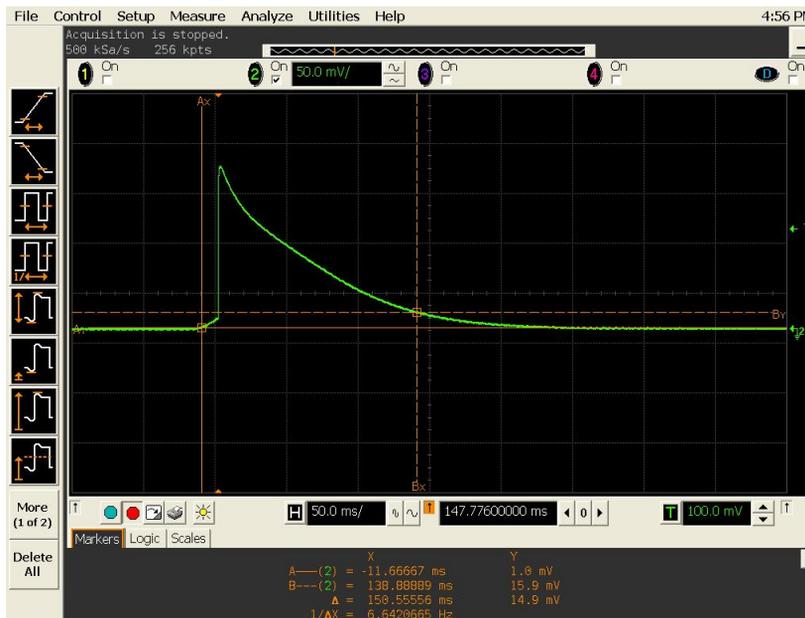


Figure 5-13 Load transient response time

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 5-9](#) on page 149).
- 2 Turn on the instrument. Press **Current** to select the constant current mode. Ensure that the S2 (8 V/3 A) range is selected (the S2 annunciator is illuminated). Press **Shift** > **Range** again if it is not.
- 3 Output each 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 5-12](#).

Table 5-12 Constant current programming and readback accuracy verification test

Output current	Range	Error from nominal 1 year
0 A	3 A	± 0.003 A
3 A	3 A	± 0.0075 A

CC load effect (load regulation)

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

- 1 Turn off the instrument and connect a 0.01 Ω current shunt monitoring resistor between the front panel **+** (red) and **-** (black) output terminals and a digital multimeter across the current shunt monitoring resistor (see [Figure 5-10](#) on page 150).
- 2 Turn on the instrument. Press **Current** to select the constant current mode. Ensure that the S2 (8 V/3 A) range is selected (the S2 annunciator is illuminated). Press **Shift** > **Range** again if it is not.
- 3 Set the output current to the full rated value (3 A for S2 range) and voltage to full scale.
- 4 Connect an additional electronic load across the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-10](#) on page 150).

5 Verification and Performance Tests

Performance Verification Tests

- 5 Operate the electronic load in constant resistance mode, and set its resistance to 2.5Ω . Ensure that the U3606A 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 U3606A is operating within the specified limit and protection values.
- 6 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.
- 7 Within a few seconds after [step 6](#), operate the electronic load in short mode. 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 5-13](#).

Table 5-13 Constant current load effect verification test

Output current	Range	Error from nominal 1 year
3 A with 2.5Ω load	3 A	± 0.0012 A

CC source effect (line regulation)

This test measures the change in output current 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 0.01Ω 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 5-10](#) on page 150).
- 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 S2 (8 V/3 A) range is selected (the S2 annunciator is illuminated). Press **Shift** > **Range** again if it is not.
- 4 Set the output current to the full rated value (3 A for S2 range) and voltage to full scale. Enable the output.
- 5 Connect an additional electronic load across the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-10](#) on page 150).

- 6 Operate the electronic load in constant resistance mode, and set its resistance to 2.5 Ω . Ensure that the U3606A 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 U3606A is operating within the specified limit and protection values.
- 7 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.
- 8 Within a few seconds after [step 7](#), adjust the AC voltage source to the high line voltage limit. Record the output current reading on the digital multimeter.
- 9 Compare the difference between the measurement results to the appropriate test limits shown in [Table 5-14](#).

Table 5-14 Constant current source effect verification test

Input AC line	Low line current limit	High line current limit	Error from nominal 1 year
100	90 V _{ac}	110 V _{ac}	± 0.0015 A
115	104 V _{ac}	127 V _{ac}	± 0.0015 A
230	207 V _{ac}	253 V _{ac}	± 0.0015 A

CC noise effect

This test measures the RMS output current in the frequency range from 20 Hz to 1 MHz.

- 1 Turn off the instrument and connect a 2.5 Ω fix resistive load between the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-11](#) on page 150).
- 2 Connect an AC/DC converter to the fix resistive load and a 50 Ω feed-thru termination to the AC/DC converter. Connect a differential amplifier to the 50 Ω feed-thru termination (see [Figure 5-11](#) on page 150).
- 3 Connect another 50 Ω feed-thru termination to the differential amplifier output and an RMS voltmeter to the 50 Ω feed-thru termination (see [Figure 5-11](#) on page 150).

5 Verification and Performance Tests

Performance Verification Tests

- 4 Turn on the instrument. Press **Current** to select the constant current mode. Ensure that the S2 (8 V/3 A) range is selected (the S2 annunciator is illuminated). Press **Shift > Range** again if it is not.
- 5 Set the output current to the full rated value (3 A for S2 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 $\times 10$.
 - iv Set the attenuation to 1.
 - v Set the low pass filter to 1 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 $1\text{ M}\Omega$.
- 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. The result should not exceed $0.001\text{ A}_{\text{rms}}$.

Additional Verification Tests

Optional capacitance gain verification test

- 1 Connect the calibrator to the front panel ∇ (red) and **L0** (black) input terminals (see [Figure 5-2](#) on page 146).
- 2 Press $\rightarrow \nabla$ to select the capacitance function.
- 3 Select each range in the order shown below. Provide the indicated input capacitance. Compare the measurement results to the appropriate test limits shown in [Table 5-15](#). (Be certain to allow for appropriate source settling when using the Fluke 5520A.)

Table 5-15 Optional capacitance gain verification test

Input capacitance	Range	Error from nominal 1 year
0.4 nF	1 nF	± 0.016 nF
1 nF	10 nF	± 0.06 nF
10 nF	100 nF	± 0.6 nF
0.1 μ F	1 μ F	± 0.006 μ F
1 μ F	10 μ F	± 0.06 μ F
10 μ F	100 μ F	± 0.6 μ F
100 μ F	1000 μ F	± 6 μ F
1000 μ F	10000 μ F	± 70 μ F
1 nF	1 nF	± 0.028 nF
10 nF	10 nF	± 0.15 nF
0.1 nF	100 nF	± 0.501 nF
1 μ F	1 μ F	± 0.015 μ F
10 μ F	10 μ F	± 0.15 μ F
100 μ F	100 μ F	± 1.5 μ F

5 Verification and Performance Tests

Additional Verification Tests

Table 5-15 Optional capacitance gain verification test

Input capacitance	Range	Error from nominal 1 year
1000 μF	1000 μF	$\pm 15 \mu\text{F}$
10000 μF	10000 μF	$\pm 250 \mu\text{F}$

NOTE

For the best accuracy, take a zero null measurement with open test leads to null out the test lead capacitance, before connecting the test leads to the calibrator.

Optional square-wave output verification test

This test verifies that the square-wave amplitude, frequency, and duty cycle functions 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 U3606A over a remote interface for this test to avoid round off errors. See the *U3606A Programmer's Reference* for more information on remote interface programming.

Square-wave amplitude output verification test

- 1 Turn off the instrument and connect an oscilloscope between the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-12](#) on page 151).
- 2 Turn on the instrument. Press **□** to select the square-wave mode. Ensure that the S1 (30 V/1 A) range is selected (the S1 annunciator is illuminated). Press **Shift** > **Range** again if it is not.
- 3 Output each value in the order shown below. Record the output voltage reading on the oscilloscope. Compare the measurement results to the appropriate test limits shown in [Table 5-16](#).
- 4 Repeat [step 2](#) and [step 3](#) for the S2 (8 V/3 A) range. Press **Shift** > **Range** to select the S2 range (the S2 annunciator is illuminated).

Table 5-16 Square-wave amplitude output verification test

Output amplitude	Output frequency	Range	Error from nominal 1 year
30 V	4800 Hz @ 99.60%	30 V	±0.2 V
8 V	4800 Hz @ 99.60%	8 V	±0.2 V

Square-wave frequency output verification test

- 1 Turn off the instrument and connect a universal frequency counter between the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-12](#) on page 151).
- 2 Turn on the instrument. Press **□** to select the square-wave mode.
- 3 Output each value in the order shown below. Record the output frequency reading on the universal frequency counter. Compare the measurement results to the appropriate test limits shown in [Table 5-17](#).

Table 5-17 Square-wave frequency output verification test

Output frequency	Output amplitude	Range	Error from nominal 1 year
4800 Hz @ 50%	30 V	30 V	±0.25 Hz
4800 Hz @ 50%	8 V	8 V	±0.25 Hz

Square-wave duty cycle output verification test

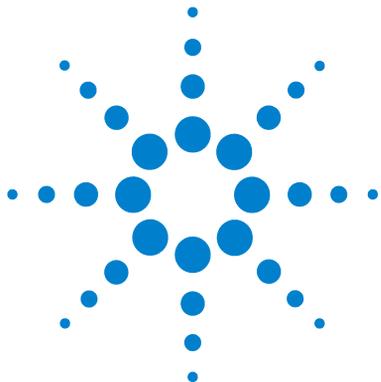
- 1 Turn off the instrument and connect an oscilloscope between the front panel **+** (red) and **-** (black) output terminals (see [Figure 5-12](#) on page 151).
- 2 Turn on the instrument. Press **□** to select the square-wave mode.
- 3 Output each value in the order shown below. Record the output duty cycle reading on the oscilloscope. Compare the measurement results to the appropriate test limits shown in [Table 5-18](#).

5 Verification and Performance Tests

Additional Verification Tests

Table 5-18 Square-wave duty cycle output verification test

Output duty cycle	Output amplitude	Range	Error from nominal 1 year
50% @ 4800 Hz	30 V	30 V	±2.55 %
50% @ 4800 Hz	8 V	8 V	±2.55 %



6 Calibration Procedures

- Calibration Overview 176
 - Closed-case electronic calibration 176
 - Agilent Technologies calibration services 176
 - Calibration interval 177
 - Adjustment is recommended 177
 - Time required for calibration 177
- Recommended Test Equipment 178
- Calibration Process 179
- Calibration Security 180
 - Unsecuring the instrument for calibration 180
 - Changing the calibration security code 183
 - Resetting the security code to the factory default 183
- Calibration Count 186
- Calibration Message 187
- Using the Front Panel for Adjustments 188
 - Selecting the adjustment mode 188
 - Entering adjustment values 188
 - Aborting a calibration in progress 189
 - General calibration procedure 190
- Adjustments procedures 193
 - Zero offset adjustment 193
 - Gain adjustments 195
 - Output adjustments 208
 - Finishing the adjustments 217

This chapter contains the procedures for the instrument adjustment (calibration). You must first unsecure the instrument before any adjustment can be done. The steps to secure and unsecure the instrument for calibration are also described in this chapter.



Calibration Overview

This section contains procedures for verifying the instrument performance, as well as procedures for making adjustments where necessary.

NOTE

Ensure that you have read the “[Test Considerations](#)” on page 144 before calibrating the instrument.

Closed-case electronic calibration

The instrument features closed-case electronic calibration. 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 does not change when power has been turned off, after a Factory Reset (*RST command), or after an Instrument Preset (SYSTEM:PRESet command).

Agilent Technologies calibration services

Agilent Technologies offers calibration services at competitive prices. When your instrument is due for calibration, contact your local Agilent Service Center for recalibration. See “[Types of Services Available](#)” on page 237 for information on contacting Agilent.

Calibration interval

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

A 1-year interval is adequate for most applications. Accuracy specifications will remain valid only if adjustment is made at regular calibration intervals. Accuracy specifications are not valid beyond the 1-year calibration interval. Agilent does not recommend extending calibration intervals beyond 2 years for any application. This criteria for re-adjustment provides the best long-term stability.

Adjustment is recommended

Specifications are only valid within the period stated from the last adjustment. Whatever calibration interval you select, Agilent recommends that a complete re-adjustment is always performed at the calibration interval. This is necessary to ensure that the instrument will remain within the specification for the next calibration interval. This criteria for re-adjustment provides the best long-term stability.

Performance data measured during performance verification tests (see [Chapter 5](#), “Verification and Performance Tests,” starting on page 139) does not mean that the instrument will remain within these limits unless the adjustments are performed.

Use the calibration count feature (see [“Calibration Count”](#) on page 186) to verify that all 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 144).

Recommended Test Equipment

The test equipment recommended for the adjustment procedures is listed below. If the exact instrument is not available, substitute with calibration standards of equivalent accuracy.

Table 6-1 Recommended test equipment for adjustment procedures

Application	Recommended equipment		Recommended accuracy requirements
Zero calibration	Shorting plug — Dual banana plug with copper wire short between the two input terminals		-
DC voltage	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification
DC current	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification
	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification
AC current	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification
Resistance	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification
Frequency	Function/Arbitrary waveform generator	Agilent 33250A	< 20% of instrument 1 year specification
Capacitance	Calibrator	Fluke 5520A	< 20% of instrument 1 year specification

Calibration Process

The test equipment recommended for the calibration process and procedure is listed in [“Recommended Test Equipment”](#) on page 178.

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

- 1 Read the [“Test Considerations”](#) on page 144.
- 2 Perform the verification tests to characterize the instrument (See [“Verification and Performance Tests Overview”](#) on page 152).
- 3 Unsecure the instrument for calibration. (See [“Unsecuring the instrument for calibration”](#) on page 180.)
- 4 Perform the adjustment procedures ([“Adjustments procedures”](#) on page 193).
- 5 Secure the instrument against calibration. Change the calibration code if necessary. (See [“Changing the calibration security code”](#) on page 183.)
- 6 Note the new security code (if it has been changed) and calibration count in the instrument maintenance records.

NOTE

Ensure that you quit the adjustment mode before powering off the instrument.

Calibration Security

This feature allows you to enter a security code to prevent 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 180).

The security code is set to “ATU3606A” 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).

NOTE

You can unsecure the instrument from the front panel, but you cannot enter a new security code or 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 the `CALibration:SECurity:CODE` command in the *U3606A Programmer's Reference* for more details.

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 ATU3606A.

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 183.

Unsecuring from the front panel Only four characters (the fourth through 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 “ATU3606A”. When unsecuring from the front panel, the code length is four characters and the first three characters (ATU) are ignored.

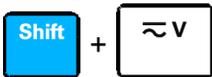
In our example, the code now becomes: *3606*

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 our 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*



To unsecure the instrument from the front panel

- 1 Press **Shift** + **~V** together during normal operation.
- 2 The instrument will enter the calibration security code edit mode. “SECUR” is displayed in the upper secondary display while the security code is displayed in the primary display.



- 3 Press **◀** or **▶** to move the cursor to the right or to the left.

6 Calibration Procedures

Calibration Security

- 4 Press Δ or ∇ to increment or decrement the digit.
- 5 Press $\frac{\text{OUT}}{\text{SBY}}$ when you are done.
- 6 If the correct security code is entered, “PASS” is displayed in the primary display for 3 seconds, after which the instrument will enter the adjustment mode.



- 7 If the incorrect security code is entered, “FAiL” is displayed in the primary display for 3 seconds, after which the calibration security code edit mode will appear again.



To unsecure the instrument from the remote interface

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

→ CAL:SEC:CODE OFF,
ATU3606A

This command unsecures the instrument for calibration. The default security code is ATU3606A. The security code can only be changed when the instrument is unsecured.

→ CAL:SEC:CODE ON, ATU3606A

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.

- | | |
|--|--|
| → <code>CAL:SEC:State OFF, ATU3606A</code> | <i>This command unsecures the instrument for calibration. The default security code is ATU3606A. The security code can only be changed when the instrument is unsecured.</i> |
| → <code>CAL:SEC:CODE ABC1234</code> | <i>This command changes the security code to "ABC1234".</i> |
| → <code>CAL:SEC:State ON, ABC1234</code> | <i>This command secures the instrument from accidental or unauthorized adjustments.</i> |

See the `CALibration` subsystem in the *U3606A Programmer's Reference* for more information on the `CALibration:SECurity:CODE <new_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 (ATU3606A).

NOTE

If you do not have a record (or have lost the record) of the security code, first try the factory default code — "3606", from the front panel or "ATU3606A", 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 227.
- 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 6-1. On the U3606A PC board, the pads are marked as “SECUR”.



Figure 6-1 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 codes 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 “ATU3606A”. (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 183. 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.

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 that your instrument was calibrated before it left the factory. When you receive your instrument, be sure to read the count to determine its initial value.

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).



Reading the calibration count

- 1 Unsecure the instrument for calibration. See [“Unsecuring the instrument for calibration”](#) on page 180 for more information on how to unsecure the instrument.
- 2 Press **MinMax** to view the calibration count. The calibration count is displayed in the upper secondary display.



- 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 "CAL: 27 Nov 2009"` *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).*

← `"CAL: 27 Nov 2009"`

See the *U3606A Programmer's Reference* for more information on the `CALibration` subsystem.

Using the Front Panel for Adjustments

This section describes the process used to perform adjustments from the front panel. Refer to the *U3606A Programmer's Reference* for remote interface commands.

Selecting the adjustment mode

Before performing any adjustments, you must first unsecure the instrument for calibration. See “[Unsecuring the instrument for calibration](#)” on page 180 for more information. Once unsecured, “CALib” is displayed on the lower secondary display to indicate that you are in adjustment mode.

Entering adjustment values

In the adjustment procedures, to enter an input calibration value from the front panel, use these keys to position the cursor on a digit:

Key	Description
	Press ◀ to move the cursor to the left.
	Press ▶ to move the cursor to the right.

When the cursor is positioned on a digit (the digit currently being edited will flash), use these keys to edit the value:

Key	Description
	Press Δ to increment the digit.
	Press ∇ to decrement the digit.

Press $\frac{OUT}{SBY}$ when you are done. The adjustment will begin.

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 265](#).

General calibration procedure

The steps below shows how the calibration adjustments are performed. For detailed steps involved in each measurement or source function in the U3606A Multimeter|DC Power Supply, see the “[Adjustments procedures](#)” on page 193.

- 1 Unsecure the instrument (see “[Unsecuring the instrument for calibration](#)” on page 180).
- 2 After verifying that the security code you entered is correct (“PASS” is briefly displayed in the primary display), the instrument goes into the adjustment mode – “CALib” is displayed on the lower secondary display and the reference input value of the next adjustment item is displayed on the upper secondary display.

For example, if the reference input of the next adjustment item is shorting the input terminals, the upper secondary display will display “Short”.



Refer to “[Adjustments procedures](#)” on page 193 for the list and sequence of all the adjustment items.

NOTE

If you do not intend to perform the complete set of adjustment items, you may press Δ or ∇ to select the item you wish to calibrate.

- 3 Set up the indicated reference input and apply this input to the correct terminals of the U3606A. For example:
 - If the required reference input is “Short”, use a shorting plug to short the two relevant terminals.
 - If the required reference input is “Open”, just leave the terminals open.
 - If the required reference input is a voltage, current, resistance, capacitance, or temperature value, set up the Fluke 5520A calibrator (or another device with an equivalent standard of accuracy) to provide the necessary input.
- 4 With the required reference input applied to the correct terminals, press $\frac{OUT}{SBY}$ to start the adjustment.

During calibration, the primary display will indicate the uncalibrated reading, and the calibration indicator, “CALib”, will flash on the lower secondary display.



If the reading is within the acceptable range, “PASS” is displayed momentarily. The instrument will then proceed to the next adjustment item.



6 Calibration Procedures

Using the Front Panel for Adjustments

If the reading is out of the acceptable range, “FAiL” and the error code is displayed momentarily. The instrument will then return to the failed adjustment item. If this is the case, you are required to inspect whether the correct reference input has been applied. Refer to [Table 9-7](#) on page 265 for the meaning of the error codes.



- 5 Repeat [step 3](#) and [step 4](#) until all adjustments for that particular function have been completed.
- 6 Select another function to be calibrated. Repeat [step 3](#) to [step 5](#).
For a key that hosts more than one function, for example ≈ 1 , press ≈ 1 again to switch to the next function.
- 7 After calibrating all the functions, press **Shift** > **Exit** or **Shift** + $\approx V$ to exit adjustment mode.
- 8 Power-off the instrument and then power-on it again. The instrument is now calibrated and ready for normal operation.

NOTE

See “[Adjustments procedures](#)” on page 193 and its respective submodule headings for a list of adjustment items and input adjustment values for each measurement and source function in the U3606A.

Adjustments procedures

You will need a test input cable and connectors set, and a shorting plug to adjust the instrument (see “[Input Connections](#)” on page 145).

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 265](#). 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.

- 1 Follow the steps outlined below. Review the “[Test Considerations](#)” on page 144 before beginning this test.
- 2 After unsecuring the instrument, the instrument goes into the adjustment mode (“CALib” is shown on the lower secondary display) with the upper secondary display showing “Short”. Connect the shorting plug between the **V** (red) and **LO** (black) front panel input terminals. Leave the current input **I** (red) open.

6 Calibration Procedures

Adjustments procedures

NOTE

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

ShiftHold

- 3 Press **Shift > Hold**. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
- 4 The primary 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 primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 5 Remove the shorting plug from the input terminals.

ShiftMinMax

- 6 Press **Shift > MinMax**. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
- 7 The primary 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 primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Perform the “[Zero offset verification test](#)” on page 154 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.

Most measuring functions and ranges have gain adjustment procedures. The 100 M Ω 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 6-2 Valid gain adjustment input values

Function	Range	Valid amplitude input values	Page
DC voltage	<ul style="list-style-type: none"> • 100 mV • 1 V • -1 V • 10 V • 100 V • 1000 V 	0.9 to 1.1 × full scale	page 197
AC voltage	<ul style="list-style-type: none"> • 10 mV • 100 mV • 1 V • 10 V • 100 V • 750 V 	0.9 to 1.1 × full scale	page 199
Frequency	Autorange/1 kHz	Input $\geq 100 \text{ mV}_{\text{rms}}$, 900 Hz to 1100 Hz	page 200
Resistance (2-wire)	<ul style="list-style-type: none"> • 100 Ω • 1 kΩ • 10 kΩ • 100 kΩ • 1 MΩ • 10 MΩ 	0.9 to 1.1 × full scale	page 201
DC current	<ul style="list-style-type: none"> • 10 mA • 100 mA • 1000 mA 	0.9 to 1.1 × full scale	page 203

Table 6-2 Valid gain adjustment input values (continued)

Function	Range	Valid amplitude input values	Page
AC current	<ul style="list-style-type: none"> • 1 mA • 10 mA • 100 mA • 1000 mA 	0.9 to 1.1 × full scale	page 204
Capacitance	<ul style="list-style-type: none"> • 0.4 nF • 1 nF • 10 nF • 100 nF • 1 μF • 10 μF • 100 μF • 100 μF • 10000 μF 	0.9 to 1.1 × full scale	page 205

DC voltage gain adjustment procedure

Review the “[Test Considerations](#)” on page 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

- 1 Press $\approx V$ to enter the DC voltage gain calibration. The DC annunciator will be illuminated.
- 2 The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3 Configure each adjustment item shown in [Table 6-3](#).

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 Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-3](#).

NOTE

Always complete tests in the same order as shown in [Table 6-3](#).

6 Calibration Procedures

Adjustments procedures

- 6 Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).
- 7 Press $\frac{\text{OUT}}{\text{SBY}}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-3](#).
- 9 Verify the DC voltage gain adjustments using the “[DC voltage gain verification test](#)” on page 156.

Table 6-3 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 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

- 1 Press $\approx V$ twice to enter the AC voltage gain calibration. The AC annunciator will be illuminated.
- 2 The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3 Configure each adjustment item shown in [Table 6-4](#).
- 4 Use Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-4](#).

NOTE

Always complete tests in the same order as shown in [Table 6-4](#).

- 6 Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).
- 7 Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-4](#).
- 9 Verify the AC voltage gain adjustments using the “[AC voltage verification test](#)” on page 157.

Table 6-4 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 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

- 1 Press **Hz ms %** to enter the frequency gain calibration.
- 2 The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3 Configure each adjustment item shown in [Table 6-5](#).
- 4 Use Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-5](#).

NOTE

Always complete tests in the same order as shown in [Table 6-5](#).

- 6 Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).

- 7 Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-5](#).
- 9 Verify the frequency gain adjustments using the “[Frequency gain verification test](#)” on page 160.

Table 6-5 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 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

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

- 1 Press $\Omega \cdot \text{||}$ to enter the resistance gain calibration.
- 2 The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3 Configure each adjustment item shown in [Table 6-6](#).

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.

6 Calibration Procedures

Adjustments procedures

- 4 Use Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-6](#).

NOTE

Always complete tests in the same order as shown in [Table 6-6](#).

- 6 Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).
- 7 Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-6](#).
- 9 Verify the resistance gain adjustments using the “[Resistance gain verification test](#)” on page 159.

Table 6-6 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 M Ω	10 M Ω
1.00000 M Ω	1 M Ω
100.000 k Ω	100 k Ω
10.0000 k Ω	10 k Ω

Table 6-6 Resistance gain adjustment

Adjustment item	Input resistance
1000.00 Ω	1000 Ω
100.000 Ω	100 Ω

DC current gain adjustment procedure

Review the “[Test Considerations](#)” on page 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

- 1 Press \approx I to enter the DC current gain calibration. The DC annunciator will be illuminated.
- 2 The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3 Configure each adjustment item shown in [Table 6-7](#).

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 Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-7](#).

NOTE

Always complete tests in the same order as shown in [Table 6-7](#).

- 6 Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).
- 7 Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.

6 Calibration Procedures

Adjustments procedures

- An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-7](#).
 - 9 Verify the DC current gain adjustments using the “[DC current gain verification test](#)” on page 157.

Table 6-7 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 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

- 1 Press \approx I twice to enter the AC current gain calibration. The AC annunciator will be illuminated.
- 2 The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3 Configure each adjustment item shown in [Table 6-8](#).
- 4 Use Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-8](#).

NOTE

Always complete tests in the same order as shown in [Table 6-8](#).

- 6** Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).
- 7** Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8** Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-8](#).
- 9** Verify the AC current gain adjustments using the “[AC current verification test](#)” on page 158.

Table 6-8 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 144 and “[Gain adjustment considerations](#)” on page 195 sections before beginning this procedure.

- 1** Press $\rightarrow \text{-(C)}$ to enter the capacitance gain calibration.
- 2** The primary display will show the uncalibrated value and the upper secondary display will show the reference value of the adjustment item.
- 3** Configure each adjustment item shown in [Table 6-9](#).

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 Δ or ∇ to select the adjustment item.
- 5 Apply the input signal shown in the “Input” column of [Table 6-9](#).

NOTE

Always complete tests in the same order as shown in [Table 6-9](#).

- 6 Enter the actual applied input (see “[Entering adjustment values](#)” on page 188).
- 7 Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 8 Repeat [step 3](#) through [step 7](#) for each gain adjustment point shown in [Table 6-9](#).
- 9 Verify the capacitance gain adjustments using the “[Optional capacitance gain verification test](#)” on page 171.

Table 6-9 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

Table 6-9 Capacitance gain adjustment (continued)

Adjustment item	Input capacitance
10.00 nF	10 nF
100.0 nF	100 nF
1.000 μ F	1 μ F
10.00 μ F	10 μ F
100.0 μ F	100 μ F
1000 μ F	1000 μ F
10000 μ F	10000 μ F

Output adjustments

The instrument calculates and stores output corrections for each output level. The U3606A 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 U3606A 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.

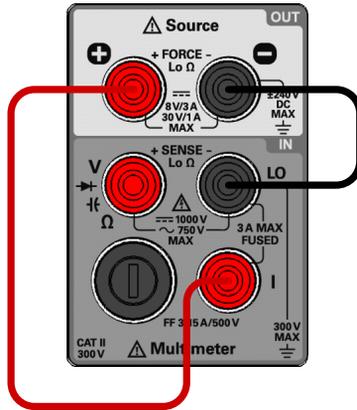
Table 6-10 Valid output adjustment levels

Function	Range	Valid output levels	Page
Constant current	S2 (8 V/3 A)	<ul style="list-style-type: none"> • OUt-L • OUt-H 	Front terminal on page 209
	S1 (30 V/1 A)	<ul style="list-style-type: none"> • OUt-L • OUt-H • LOAd 	Rear terminal on page 213
Constant voltage	S2 (8 V/3 A)	<ul style="list-style-type: none"> • OUt-L • OUt-H 	Front terminal on page 211
	S1 (30 V/1 A)	<ul style="list-style-type: none"> • OUt-L • OUt-H • LOAd 	Rear terminal on page 215

CC output adjustment procedure — front output terminals

Review the “Test Considerations” on page 144 and “Input Connections” on page 145 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. Ensure that the S2 (8 V/3 A) range is selected (the S2 annunciator is illuminated). Press **Current** again if it is not.
- 3 The primary display will show the uncalibrated value and the upper secondary display will show the reference level of the adjustment item.
- 4 Configure each adjustment item shown in [Table 6-11](#).
- 5 Use **Δ** or **▽** to select the adjustment item.

NOTE

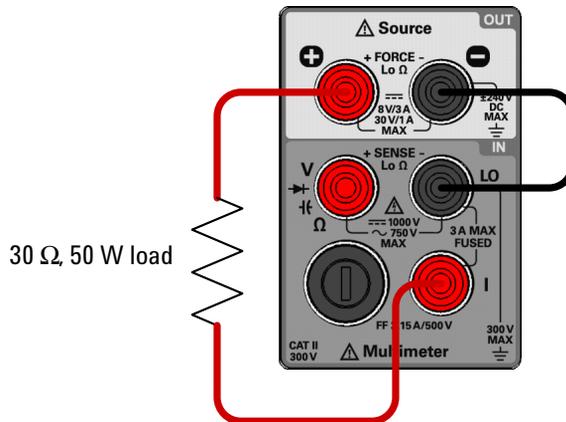
Always complete tests in the same order as shown in [Table 6-11](#).

- 6 Press **OUT**/**SBY** to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.

6 Calibration Procedures

Adjustments procedures

- An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- Repeat [step 3](#) through [step 6](#) for each output adjustment item shown in [Table 6-11](#).
 - Repeat [step 3](#) through [step 7](#) for the S1 (30 V/1 A) range. Press **Current** to select the S1 range (the S1 annunciator is illuminated).
For adjustment item “LOAd”, connect a 30 Ω , 50 W load across the front panel **+** (red) output terminal and the **I** (red) terminal. Leave the **-** (black) terminal and **L0** (black) terminal connected.



- Verify the constant current adjustments using the “[CC programming and readback accuracy](#)” on page 167.

Table 6-11 Constant current output adjustment

Range	Adjustment item	Output current
S2 (8 V/3 A)	Out-L	0 A
	Out-H	3 A

Table 6-11 Constant current output adjustment (continued)

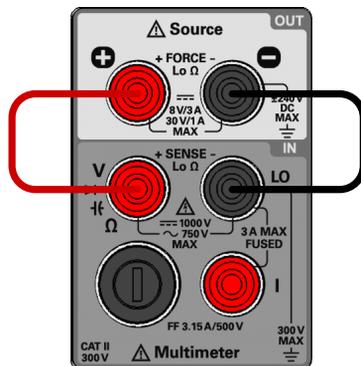
Range	Adjustment item	Output current
S1 (30 V/1 A)	OUt-L	0 A
	OUt-H	1 A
	LOAd ^[1]	1 A with additional 30 Ω , 50 W load

[1] See [step 8](#) for information on how to connect the LOAd adjustment item.

CV output adjustment procedure — front output terminals

Review the “[Test Considerations](#)” on page 144 and “[Input Connections](#)” on page 145 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.



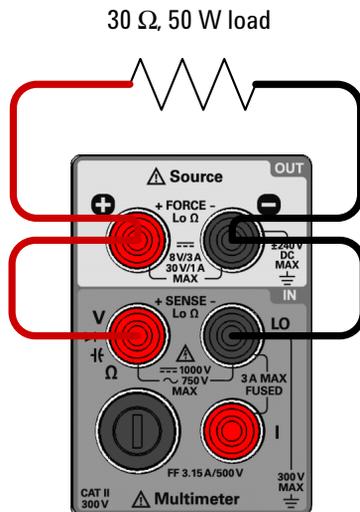
- 2 Turn on the instrument. Press **Voltage** to enter the constant voltage output calibration. Ensure that the S2 (8 V/3 A) range is selected (the S1 annunciator is illuminated). Press **Voltage** again if it is not.
- 3 The primary display will show the uncalibrated value and the upper secondary display will show the reference level of the adjustment item.
- 4 Configure each adjustment item shown in [Table 6-12](#).
- 5 Use Δ or ∇ to select the adjustment item.

NOTE

Always complete tests in the same order as shown in Table 6-12.

- 6 Press $\frac{OUT}{SBY}$ to start the adjustment. The display “CALib” in the lower secondary display starts flashing to indicate that the calibration is in progress.
 - Successful completion of the adjustment is indicated by a short beep and the primary display briefly showing “PASS”.
 - An adjustment failure is indicated by a long beep, the primary display showing “FAiL” and a calibration error number appearing in the upper secondary display. Correct the problem and repeat this procedure.
- 7 Repeat step 3 through step 6 for each output adjustment item shown in Table 6-12.
- 8 Repeat step 3 through step 7 for the S1 (30 V/1 A) range. Press **Voltage** to select the S1 range (the S1 annunciator is illuminated).

For adjustment item “LOAd”, connect an additional 30 Ω , 50 W load across the front panel \oplus (red) and \ominus (black) output terminals. Leave the connections from the output terminals (\ominus and \oplus) to the input terminals (V and LO) intact.



- 9 Verify the constant voltage adjustments using the “[CV programming and readback accuracy](#)” on page 161.

Table 6-12 Constant voltage output adjustment

Range	Adjustment item	Output voltage
S2 (8 V/3 A)	OUt-L	0 V
	OUt-H	8 V
S1 (30 V/1 A)	OUt-L	0 V
	OUt-H	30 V
	LOAd ^[1]	30 V with additional 30 Ω, 50 W load

[1] See [step 8](#) for information on how to connect the LOAd adjustment item.

CC output adjustment procedure — rear output terminals

Review the “[Test Considerations](#)” on page 144 and “[Input Connections](#)” on page 145 sections before beginning this procedure.

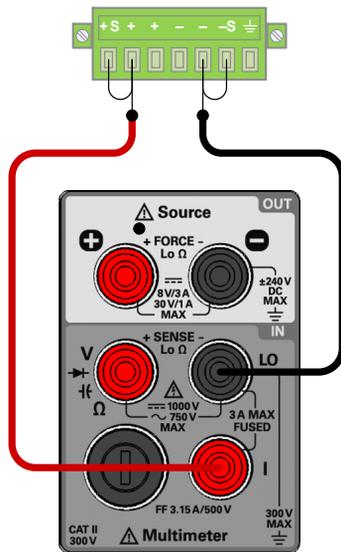
- 1 Turn off the instrument and connect the rear panel + and – output terminals to the **I** (red) and **LO** (black) input terminals.

NOTE

Ensure that the rear panel sense terminals (+S and –S) are shorted to the rear panel output (+ and –) terminals. See “[Remote sensing connections](#)” on page 100 for more information on how to connect the load leads.

6 Calibration Procedures

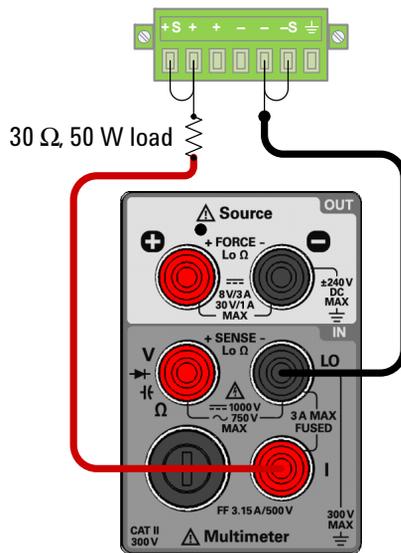
Adjustments procedures



- 2 Press **Shift** > **EXT** to enable remote sensing. When the U3606A is operating in remote sensing mode, the EXT annunciator on the front panel is illuminated.
- 3 Perform [step 2](#) through [step 7](#) of the “[CC output adjustment procedure – front output terminals](#)” on page 209. Refer to [Table 6-11](#) on page 210 for the constant current output adjustment items.
- 4 Repeat [step 3](#) through [step 7](#) of the “[CC output adjustment procedure – front output terminals](#)” on page 209 for the S1 (30 V/1 A) range. Press **Voltage** to select the S1 range (the S1 annunciator is illuminated).
For adjustment item “LOAD”, connect a 30 Ω, 50 W load across the front panel + rear output terminal and the **I** (red) terminal. 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) as the rear panel output (+ and –) terminals. See “[Remote sensing connections](#)” on page 100 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 167.

CV output adjustment procedure — rear output terminals

Review the “[Test Considerations](#)” on page 144 and “[Input Connections](#)” on page 145 sections before beginning this procedure.

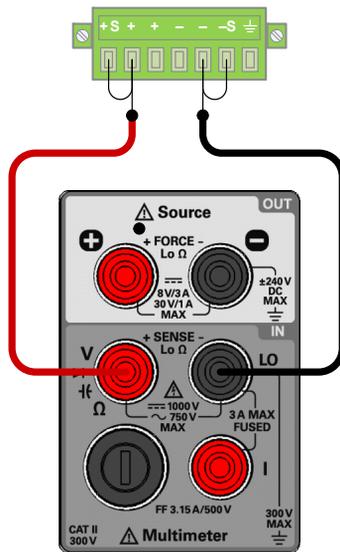
- 1 Turn off the instrument and connect the rear panel + and – output terminals to the **V** (red) and **LO** (black) input terminals.

NOTE

Ensure that the rear panel sense terminals (+S and –S) are shorted to the rear panel output (+ and –) terminals. See “[Remote sensing connections](#)” on page 100 for more information on how to connect the load leads.

6 Calibration Procedures

Adjustments procedures

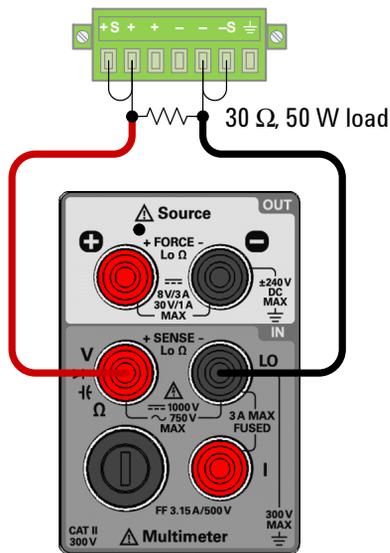


- 2 Press **Shift** > **EXT** to enable remote sensing. When the U3606A is operating in remote sensing mode, the EXT annunciator on the front panel is illuminated.
- 3 Perform [step 2](#) through [step 7](#) of the “[CV output adjustment procedure – front output terminals](#)” on page 211. Refer to [Table 6-12](#) on page 213 for the constant voltage output adjustment items.
- 4 Repeat [step 3](#) through [step 7](#) of the “[CV output adjustment procedure – front output terminals](#)” on page 211 for the S1 (30 V/1 A) range. Press **Voltage** to select the S1 range (the S1 annunciator is illuminated).

For adjustment item “LOAD”, connect an additional 30 Ω , 50 W load across the rear panel + and – output terminals. 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) as the rear panel output (+ and –) terminals. See “[Remote sensing connections](#)” on page 100 for more information on how to connect the load leads.



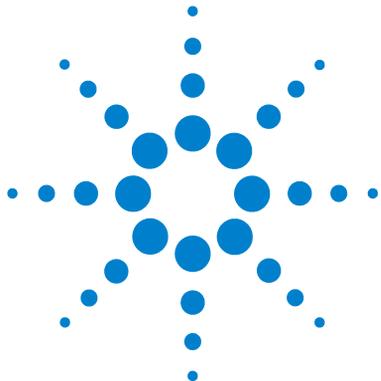
- 5 Verify the constant voltage adjustments using the “[CV programming and readback accuracy](#)” on page 161.

Finishing the adjustments

- 1 Remove all shorting plugs and connections from the instrument.
- 2 Reset the calibration message (“[Calibration Message](#)” on page 187).
- 3 Record the new calibration count (“[Calibration Count](#)” on page 186).
- 4 Press **Shift** > **Exit** or **Shift** + **⌘V** to exit the adjustment mode.
- 5 The instrument will be secured and returns to normal operation.

6 Calibration Procedures
Adjustments procedures

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7 Disassembly and Repair

Operating Checklist	220
Cleaning	221
Fuse Replacement	221
To replace the power line fuse	221
To replace the current input fuse	224
Electrostatic Discharge (ESD) Precautions	226
Mechanical Disassembly	227
General disassembly	227
Replaceable Parts	235
To Order Replaceable Parts	236
Types of Services Available	237
Repackaging for Shipment	238

This chapter will help you troubleshoot a failing instrument. It also describes how to obtain repair service 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

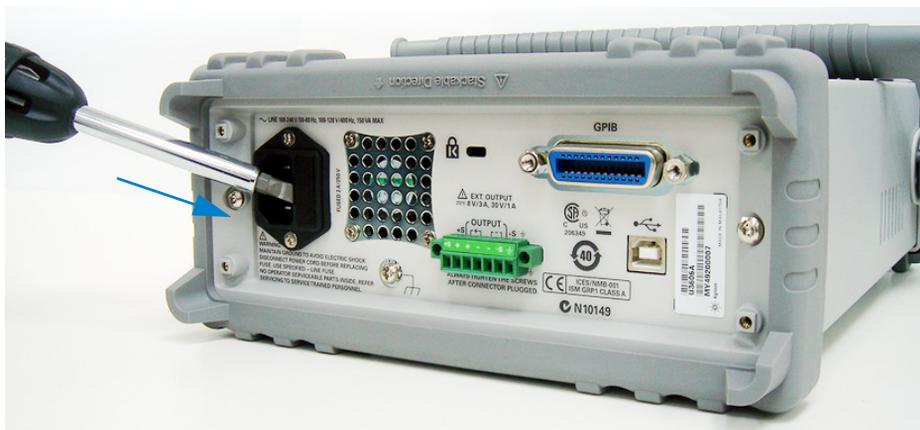
The power line fuse is located within the U3606A fuse-holder assembly on the rear panel. The U3606A is shipped from the factory with a power-line fuse installed. The supplied fuse is a time-lag, low-breaking, 2 A/250 V,

7 Disassembly and Repair

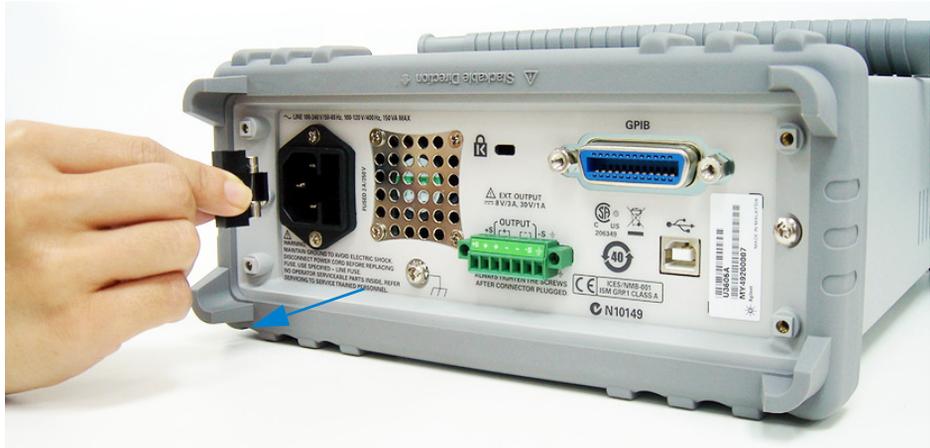
Cleaning

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 rear 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.

7 Disassembly and Repair

Cleaning

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)
- #2 Pozi-drive screw driver
- Flat blade screw driver

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.



7 Disassembly and Repair

Mechanical Disassembly

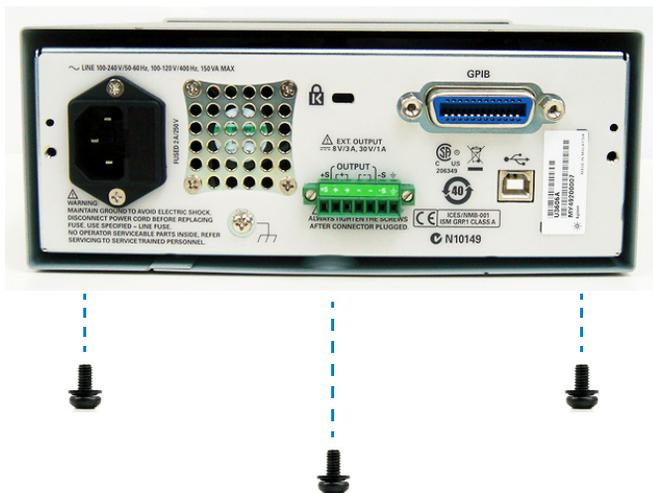
- 3 Remove the instrument bumpers.** Pull from a corner and stretch the bumpers off the instrument.



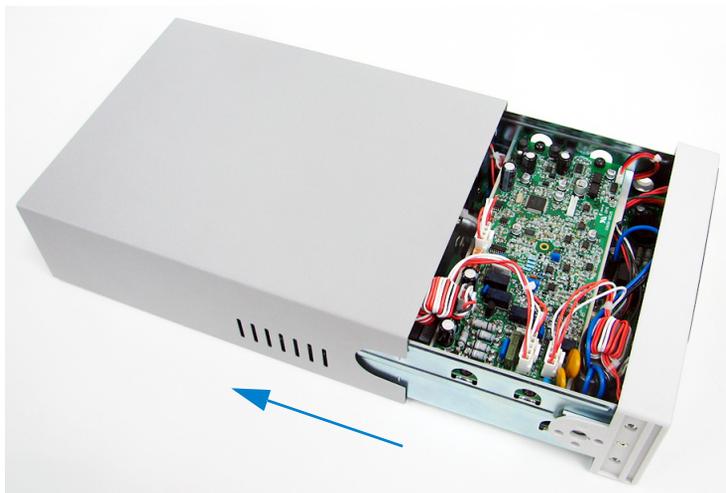
- 4 Remove the rear bezel.** Loosen the two captive screws in the rear bezel and remove the rear bezel.



5 Remove the cover. Remove the screws in the bottom of the cover.



6 Slide the cover off the instrument.



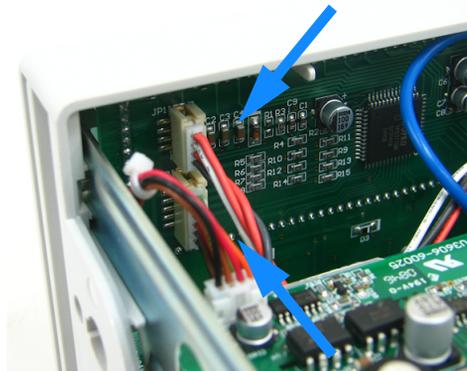
Front panel removal

7 Remove the push rod and disconnect the display cable.

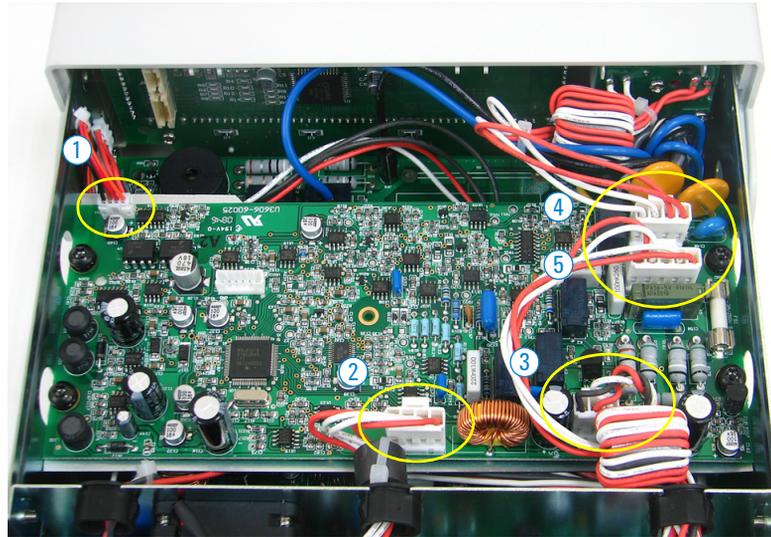
- a** Turn the instrument over and gently move the power switch push rod towards the front of the instrument to disengage it from the switch. Be careful not to twist or bend the push rod.



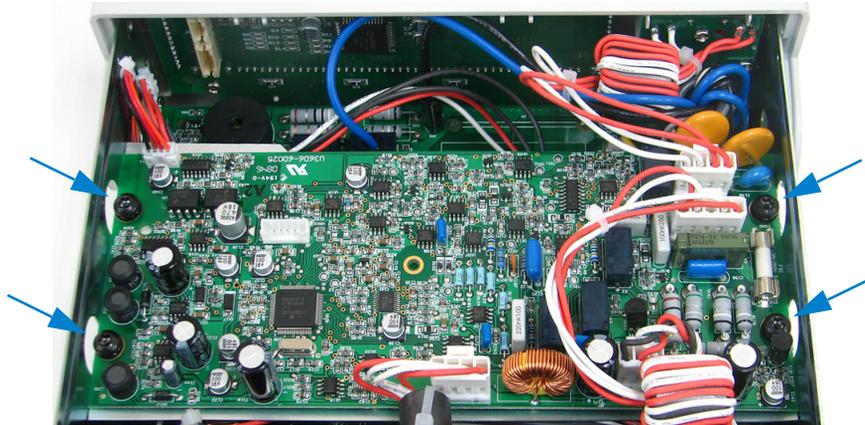
- b** Disconnect the two ribbon cable connectors from the front panel.



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



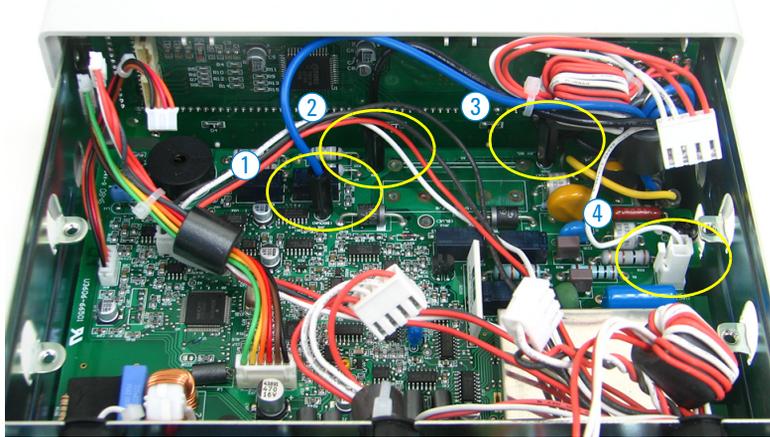
- 8 Remove the top layer circuit board. Loosen the four captive screws in the top layer circuit board and remove the top layer circuit board. Remove the protective metal sheet as well.



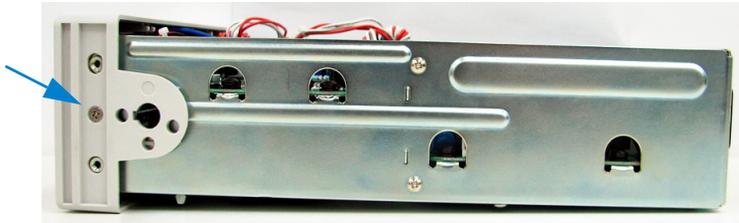
7 Disassembly and Repair

Mechanical Disassembly

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



- 10 Remove the two screws holding the front panel.

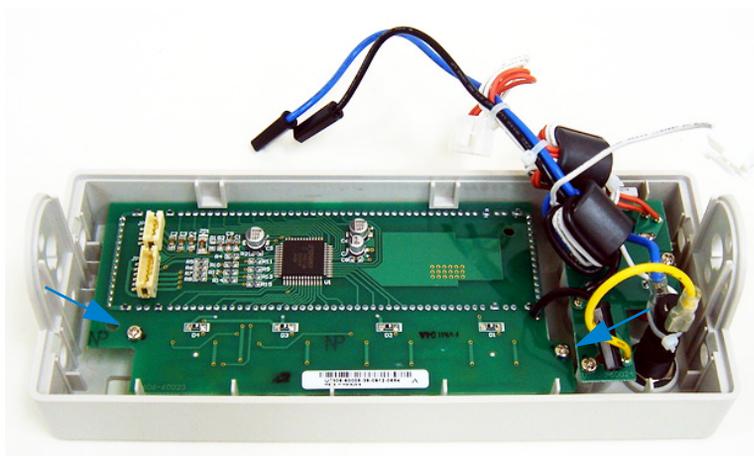


- 11 You can now pry the side of the front panel from the chassis and remove it.



Front panel disassembly

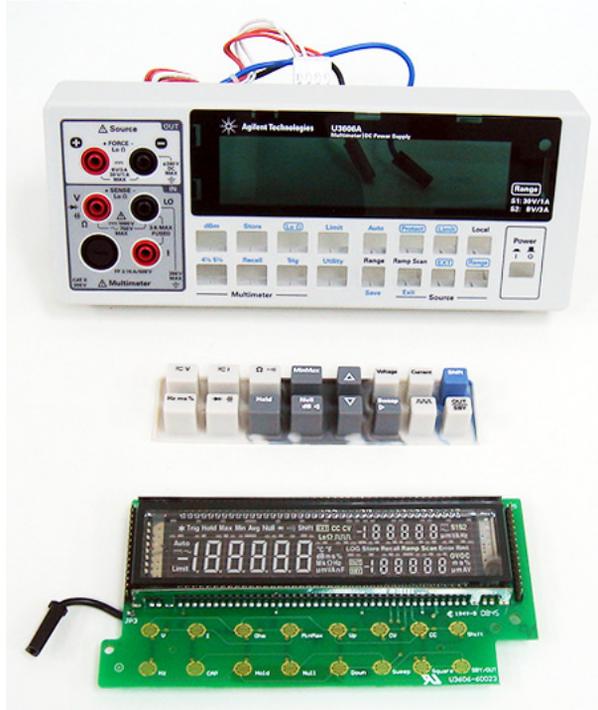
- 12 Loosen the two captive screws and remove the keypad and display assembly.



7 Disassembly and Repair

Mechanical Disassembly

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 backwards.

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 7-1 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
A02-62-25600-2U	Front panel fuse holder
A02-62-25657-1U	Fuse 3.15 A/500 V F/B 6.3 × 32 mm
U3401-40001	Rubber bumper kit (front and rear)
U3606-00200	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

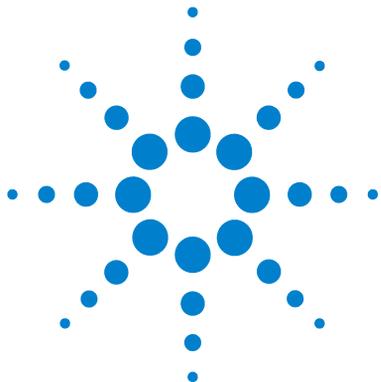
If the unit is to be shipped to Agilent for service or repair, be sure to:

- 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.
- 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.



8 Characteristics and Specifications

Product Characteristics	240
Digital Multimeter Specifications	242
Specification assumptions	242
DC specifications	242
AC specifications	245
Frequency specifications	246
Duty cycle and pulse width specifications	247
Operating specifications	248
Supplementary characteristics	249
DC Power Supply Specifications	253
Safety considerations	253
Specifications assumptions	253
Performance specifications	254
Supplementary characteristics	255

This chapter specifies the characteristics, environmental conditions, and specifications of the U3606A.



Product Characteristics

POWER SUPPLY

- Universal 100 V_{ac} to 240 V_{ac} ±10%
- AC line frequency of 45 Hz to 66 Hz; 360 Hz to 440 Hz for 100/120 V operation

POWER CONSUMPTION

150 VA maximum

CURRENT INPUT FUSE

3.15 A, 500 V FF fuse. (on front panel)

DISPLAY

Highly visible vacuum-fluorescent display (VFD)

OPERATING ENVIRONMENT

- Operating temperature from 0 °C to +55 °C
- Relative humidity up to 80% at 30 °C RH (non-condensing)
- Altitude up to 2000 meters
- Pollution degree 2
- For indoor use only

STORAGE COMPLIANCE

–40 °C to 70 °C

SAFETY COMPLIANCE

Certified with:

- IEC 61010-1:2001/EN61010-1:2001 (2nd Edition)
- Canada: CAN/CSA-C22.2 No. 61010-1-04
- USA: ANSI/UL 61010-1:2004

EMC COMPLIANCE

Certified with:

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

SHOCK AND VIBRATION

Tested to IEC/EN 60068-2

REMOTE INTERFACE

- GPIB IEEE-488 compatible
- Full Speed USB 2.0 (Standard-A to Type-B)
- USBTMC 488.2 Class device compatible
- USB-CDC

MEASUREMENT CATEGORY

- CAT II, 300 V
- CAT I, 1000 V_{dc}, 750 V_{ac} rms
- 2500 V_{pk} transient over voltages

DIMENSIONS (W × H × D)

- 255 × 105 × 329 mm (with rubber bumpers)
- 215 × 87 × 312 mm (without rubber bumpers)

WEIGHT

- 3.774 kg (with rubber bumpers)
- 3.535 kg (without rubber bumpers)

WARRANTY

- Please refer to http://www.agilent.com/go/warranty_terms
 - 3 years for the product
 - 3 months for the standard accessories unless otherwise specified
- Please note that for the product, the warranty does not cover:
 - Damage from contamination
 - Normal wear and tear of mechanical components
 - Manuals or fuses

CALIBRATION CYCLE

One year

WARM UP TIME

60 minutes

Digital Multimeter Specifications

Specification assumptions

- Specifications stated are for 60-minutes warm-up and 5½ digit resolution.
- One-year calibration cycle, with calibration temperature of 18 °C to 20 °C.
- Operating temperature at 18 °C to 28 °C (64.4 °F to 82.4 °F).
- Accuracy is expressed as: $\pm(\% \text{ of reading} + \% \text{ of range})$
- Temperature coefficient: Add $[0.1 \times (\text{the applicable accuracy}) / \text{°C}]$ for 0 °C to 18 °C and 28 °C to 55 °C.
- Relative humidity (RH) up to 80% at 30 °C, proportional to 50% for 30 °C to 55 °C.

DC specifications

Table 8-1 DC accuracy specifications \pm (% of reading + % of range)

Function	Range ^[1]	Test current or burden voltage	24 Hours ^[2] 23 °C \pm 1 °C	90 Days 23 °C \pm 5 °C	1 Year 23 °C \pm 5 °C	Temperature coefficient 0 °C to 18 °C 28 °C to 55 °C
DC voltage	19.9999 mV	-	0.012 + 0.04	0.015 + 0.04	0.025 + 0.04	0.0015 + 0.0005
	100.000 mV	-	0.012 + 0.008	0.015 + 0.008	0.025 + 0.008	0.0015 + 0.0005
	1.00000 V	-	0.012 + 0.005	0.015 + 0.005	0.025 + 0.005	0.0010 + 0.0005
	10.0000 V	-	0.012 + 0.005	0.015 + 0.005	0.025 + 0.005	0.0020 + 0.0005
	100.000 V	-	0.012 + 0.005	0.015 + 0.005	0.025 + 0.005	0.0015 + 0.0005
	1000.00 V	-	0.012 + 0.005	0.015 + 0.005	0.025 + 0.005	0.0015 + 0.0005

Table 8-1 DC accuracy specifications ± (% of reading + % of range) (continued)

Function	Range ^[1]	Test current or burden voltage	24 Hours ^[2] 23 °C ± 1 °C	90 Days 23 °C ± 5 °C	1 Year 23 °C ± 5 °C	Temperature coefficient 0 °C to 18 °C 28 °C to 55 °C
DC current ^[3]	10.0000 mA	< 0.2 V	0.05 + 0.015	0.05 + 0.015	0.05 + 0.015	0.0060 + 0.0005
	100.000 mA	< 0.2 V	0.05 + 0.005	0.05 + 0.005	0.05 + 0.005	0.0060 + 0.0005
	1.00000 A	< 0.3 V	0.05 + 0.007	0.05 + 0.007	0.15 + 0.007	0.0100 + 0.0005
	3.0000 A	< 0.7 V	0.05 + 0.007	0.05 + 0.007	0.15 + 0.007	0.0150 + 0.0010
Resistance ^[4]	100.000 Ω	0.83 mA	0.04 + 0.008	0.04 + 0.008	0.05 + 0.008	0.0050 + 0.0005
	1000.00 Ω	0.83 mA	0.04 + 0.005	0.04 + 0.005	0.05 + 0.005	0.0050 + 0.0005
	10.0000 kΩ	100 μA	0.04 + 0.005	0.04 + 0.005	0.05 + 0.005	0.0050 + 0.0005
	100.000 kΩ	10 μA	0.04 + 0.005	0.04 + 0.005	0.05 + 0.005	0.0050 + 0.0005
	1.00000 MΩ	900 nA	0.05 + 0.005	0.05 + 0.005	0.06 + 0.005	0.0050 + 0.0005
	10.0000 MΩ	205 nA	0.20 + 0.005	0.20 + 0.005	0.25 + 0.005	0.0150 + 0.0005
	100.000 MΩ	205 nA 10 MΩ	1.60 + 0.005	1.60 + 0.005	2.00 + 0.005	0.1500 + 0.0005
Low-resistance ^[5]	100 mΩ	1.0000 A	-	-	0.25 + 0.05	-
	1000 mΩ	0.1000 A	-	-	0.25 + 0.03	-
	10 Ω	0.1000 A	-	-	0.25 + 0.03	-
Continuity	1.0000 kΩ	0.83 mA	0.04 + 0.005	0.04 + 0.005	0.05 + 0.005	0.0050+0.0005
Diode ^[6]	1.0000 V	0.83 mA	0.04 + 0.005	0.04 + 0.005	0.05 + 0.005	0.0050 + 0.0005

8 Characteristics and Specifications

Digital Multimeter Specifications

Table 8-1 DC accuracy specifications \pm (% of reading + % of range) (continued)

Function	Range ^[1]	Test current or burden voltage	24 Hours ^[2] 23 °C \pm 1 °C	90 Days 23 °C \pm 5 °C	1 Year 23 °C \pm 5 °C	Temperature coefficient 0 °C to 18 °C 28 °C to 55 °C
Capacitance ^[7]	1.000 nF	0.75 μ A current source	-	-	2.0 + 0.8	0.02 + 0.001
	10.00 nF	0.75 μ A	-	-	1.0 + 0.5	0.02 + 0.001
	100.00 nF	8.3 μ A	-	-	1.0 + 0.5	0.02 + 0.001
	1.000 μ F	83 μ A	-	-	1.0 + 0.5	0.02 + 0.001
	10.00 μ F	83 μ A	-	-	1.0 + 0.5	0.02 + 0.001
	100.0 μ F	83 μ A	-	-	1.0 + 0.5	0.02 + 0.001
	1000 μ F	0.83 mA	-	-	1.0 + 0.5	0.02 + 0.001
	10000 μ F	0.83 mA	-	-	2.0 + 0.5	0.02 + 0.001

[1] 20% over range on all ranges, except for 20 mV_{dc}, 1000 V_{dc}, and 3 A_{dc} range.

[2] Relative to calibration standards.

[3] Any current measurement greater than 500 mA will have a temporary thermo-effect. If you wish to measure a lower current or offset current immediately after a high current measurement, ensure that the U3606A has cooled down.

[4] Specifications stated are for 2-wire resistance measurements using the Null math operation. Without Null, add a 0.2 Ω error. To eliminate the noise interference, which might be induced due to the test leads, a shielded test cable is recommended for measuring resistance above 100 k Ω .

[5] Specifications stated are for 4-wire low-resistance measurements. The test current is sent from the FORCE terminals and the resistance is measured by the SENSE terminals.

[6] Specifications stated are for the voltage measured at the input terminals only. The test current (1 mA) is typical. Variation in the current source will create some variation in the voltage dropped across a diode junction.

[7] Specifications stated are for open test lead measurements and film capacitor or better using the Null math operation.

NOTE

For the total measurement accuracy, add the temperature probe error. The contact strength will significantly influence to the measuring result. Ensure proper contact at the test point you want to measure.

AC specifications

Table 8-2 AC accuracy specifications \pm (% of reading + % of range)

Function	Range ^[1]	Frequency range	24 Hour ^[2] 23 °C \pm 1 °C	90 Days 23 °C \pm 5 °C	1 Year 23 °C \pm 5 °C	Temperature coefficient 0 °C to 18 °C 28 °C to 55 °C
True rms AC voltage ^[3]	100.000 mV to 750.00 V ^[4]	20 Hz to 45 Hz	0.60 + 0.1	0.60 + 0.1	1.00 + 0.1 ^[5]	0.02 + 0.02
		45 Hz to 10 kHz	0.16 + 0.1	0.16 + 0.1	0.20 + 0.1	0.02 + 0.02
		10 kHz to 30 kHz	0.80 + 0.1	0.80 + 0.1	1.00 + 0.1 ^[6]	0.02 + 0.02
		30 kHz to 100 kHz ^[7]	3.00 + 0.2	3.00 + 0.2	3.00 + 0.2 ^{[8][9]}	0.05 + 0.02
True rms AC current	10.0000 mA to 3.0000 A ^[10]	20 Hz to 45 Hz	0.80 + 0.1	0.80 + 0.1	1.50 + 0.1	0.02 + 0.02
		45 Hz to 1 kHz	0.40 + 0.1	0.40 + 0.1	0.50 + 0.1	0.02 + 0.02
		1 kHz to 10 kHz ^[11]	2.00 + 0.2	2.00 + 0.2	2.00 + 0.2	0.02 + 0.02

[1] 20% over range on all ranges, except for 750 V_{ac} range.

[2] Relative to calibration standards.

[3] Specifications stated are for input signals greater than 5% of range.

[4] Available ranges: 100.000 mV, 1.00000 V, 10.0000 V, 100.000 V, 750.00 V

[5] For 750 V range accuracy is specified for input less than 200 V_{rms}.

[6] For 100 mV range, the 10 kHz to 30 kHz accuracy is 1.5 + 0.3

[7] Additional error 0.003% of full scale per kHz to be added when signal input changes less than 10% of range.

[8] For 100 mV range, the 30 kHz to 100 kHz accuracy is 5 + 0.3

[9] For 750 V range accuracy is specified for input less than 300 V_{rms}.

[10] Available ranges: 10.0000 mA, 100.000 mA, 1.00000 A, 3.0000 A

[11] For 1 A and 3 A ranges, the accuracy is specified for frequencies less than 5 kHz.

NOTE

The specification of the AC+DC measurement will be the sum of the AC and DC accuracy. The frequency range will be from 50 Hz for 5½ digit resolution and 225 Hz for 4½ digit resolution.

Frequency specifications

Table 8-3 Frequency accuracy specifications ± (% of reading + % of range)

Function	Range	Frequency range	1 Year 23 °C ± 5 °C	Temperature coefficient 0 °C to 18 °C 28 °C to 55 °C
Frequency ^[1]	Voltage path: 100 mV to 750 V	< 2 Hz	0.18 + 0.003	0.005
		< 20 Hz	0.04 + 0.003	0.005
		20 Hz to 100 kHz	0.02 + 0.003	0.005
		100 kHz to 300 kHz	0.02 + 0.003	0.005
	Current path: 10 mA to 3 A	< 2 Hz	0.18 + 0.003	0.005
		< 20 Hz	0.04 + 0.003	0.005
20 Hz to 10 kHz		0.02 + 0.003	0.005	

[1] For 100 mV and 1 V ranges, the measurable frequency is up to 1 MHz at 0.5 V signal . Minimum input frequency is 1 Hz.

NOTE

All frequency counters are susceptible to errors when measuring low-voltage, low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.

Table 8-4 Frequency sensitivity for voltage measurement

Input range ^[1]	Minimum sensitivity (rms sine wave)		
	20 Hz to 100 kHz	100 kHz to 300 kHz	300 kHz to 1 MHz
100 mV	50 mV	50 mV	0.5 V
1.0 V	100 mV	120 mV	0.5 V
10 V	1 V	1.2 V	

Table 8-4 Frequency sensitivity for voltage measurement (continued)

Input range ^[1]	Minimum sensitivity (rms sine wave)		
	20 Hz to 100 kHz	100 kHz to 300 kHz	300 kHz to 1 MHz
100 V	10 V	12 V	
750 V	100 V		

[1] Maximum input for specified accuracy = $10 \times$ range or 750 V_{rms} or 1000 V_{dc}

Table 8-5 Frequency sensitivity for current measurement

Input range	Minimum sensitivity (rms sine wave)
	20 Hz to 10 kHz
10 mA	1 mA
100 mA	10 mA
1.000 A	100 mA
3 A	300 mA

Duty cycle and pulse width specifications

Table 8-6 Duty cycle and pulse width resolution and accuracy

Function	Range	Resolution	Accuracy of full scale
Duty cycle	100.000% ^[1]	0.001%	0.3% + 0.2% per kHz
	199.999 ms ^[2]	0.001 ms	Duty cycle/Frequency
Pulse width	1999.99 ms ^[2]	0.01 ms	Duty cycle/Frequency

[1] The range is calculated from $\{10 \mu\text{s} \times \text{frequency} \times 100\%$ to $\{[1 - (10 \mu\text{s} \times \text{frequency})] \times 100\%$. For example, a 1 kHz signal can be measured from 1% to 99%.

[2] The positive or negative pulse width must be greater than 10 μs . The range of the pulse width is determined by the frequency of the signal.

Operating specifications

Table 8-7 Reading speed (typical)

Function	Rate	Reading speed ^[1] (readings/second)	Reading speed over USB ^[2] (readings/second)	Reading speed over GPIB ^[3] (readings/second)
DC voltage (10 V)	Slow (5½ digit)	15	17	17
	Fast (4½ digit)	70	31	32
DC current (1 A)	Slow (5½ digit)	15	17	17
	Fast (4½ digit)	70	37	36
AC voltage (10 V at 1 kHz)	Slow (5½ digit)	15	17	17
	Fast (4½ digit)	70	31	32
AC current (1A at 1 kHz)	Slow (5½ digit)	15	16	17
	Fast (4½ digit)	70	37	37
Resistance (100 kΩ)	Slow (5½ digit)	15	17	17
	Fast (4½ digit)	70	27	31
Capacitance (10 μF)	Slow/Fast (3½ digit)	5	4.4	4.6
Frequency (voltage path at 10 V, 1 kHz)	Slow (5½ digit)	9	2.7	2.7
	Fast (4½ digit)	9	2.7	2.7
Frequency (current path at 1 A, 1 kHz)	Slow (5½ digit)	9	2.7	2.7
	Fast (4½ digit)	9	2.7	2.7

[1] Reading rate of the A/D converter.

[2] Number of measurements per second that can be read through USB using SCPI "READ?" command.

[3] Number of measurements per second that can be read through GPIB using SCPI "READ?" command.

Supplementary characteristics

WARNING

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

DC voltage

Measurement method:	Sigma Delta A-to-D converter
Maximum input voltage:	1000 V _{dc} on all ranges
Input impedance:	10 MΩ ± 2% range (typical) in parallel with capacitance < 120 pF
Input protection	1000 V _{rms} on all ranges, < 0.3 A short circuit
Response time:	Approximately 0.15 s when the displayed reading reaches 99.9% DC value of the tested input signal at the same range

DC current

Measurement method:	Sigma Delta A-to-D converter
Maximum input current:	10 mA to 3.0 A DC ^[1]
Burden voltage and shunt resistance:	<ul style="list-style-type: none"> • < 0.2 V, 10 Ω for 10 mA range • < 0.2 V, 1 Ω for 100 mA range • < 0.3 V, 0.1 Ω for 1 A range • < 0.7 V, 0.01 Ω for 3 A range
Input protection	Protected with a 3.15 A/500 V, FF fuse
Response time:	Approximately 0.15 s when the displayed reading reaches 99.9% DC value of the tested input signal at the same range.

AC voltage

Measurement method:	AC coupled true rms
Maximum input voltage:	750 V _{rms} /1200 V _{peak} /3 × 10 ⁷ V-Hz of product
Input impedance:	1 MΩ ± 2% range (typical) in parallel with capacitance < 120 pF
Input protection:	750 V _{rms} on all ranges

8 Characteristics and Specifications

Digital Multimeter Specifications

Crest factor:	For < 5:1 errors included. Limited by the peak input and 100 kHz bandwidth. Maximum 3.0 at full scale.
Peak input:	300% of range. Limited by maximum input.
Response time:	Approximately 2.5 s when the displayed reading reaches 99.9% AC rms value of the tested input signal at the same range.
Overload ranging:	Will select higher range if peak input overload is detected during auto range. Overload is reported in manual ranging.

AC current

Measurement method:	AC coupled true rms
Maximum input current:	10 mA to 3.0 A DC or AC rms ^[1]
Burden voltage and shunt resistance:	<ul style="list-style-type: none">• < 0.2 V, 10 Ω for 10 mA range• < 0.2 V, 1 Ω for 100 mA range• < 0.3 V, 0.1 Ω for 1 A range• < 0.7 V, 0.01 Ω for 3 A range
Input protection	Protected with a 3.15 A/500 V, FF fuse
Crest factor:	For < 5:1 errors included. Limited by the peak input and 100 kHz bandwidth. Maximum 3.0 at full scale.
Peak input:	300% of range. Limited by maximum input.
Response time:	Approximately 2.5 s when the displayed reading reaches 99.9% AC rms value of the tested input signal at the same range.

[1] Any current measurement greater than 500 mA will have a temporary thermo-effect. If you wish to measure a smaller current or offset current measurement immediately after a high current measurement, ensure that the U3606A is cooled down.

Resistance	
Measurement method:	Two-wire, open-circuit voltage limited to < 5 V
Open circuit voltage:	< +5.0 V _{dc}
Input protection:	1000 V _{rms} on all ranges, < 0.3 A short circuit
Response time:	Approximately 0.15 seconds for 1 MΩ and ranges below 1 MΩ.
Low-resistance	
Measurement method:	Four-wire, the test current is sent from the FORCE terminals and the resistance is measured by the SENSE terminals.
Input protection:	<ul style="list-style-type: none"> • FORCE terminals: 1000 V_{dc} on all ranges, protected with a 3.15 A/250 V FF fuse • SENSE terminals: 1000 V_{rms} on all ranges, < 0.3 A short circuit
Continuity	
Measurement method	0.83 mA ± 0.2% constant current source
Open circuit voltage:	< +5.0 V _{dc}
Audible tone:	Continuous beep when reading is less than threshold resistance of 10 Ω at 1.0 kΩ range
Input protection:	1000 V _{rms} on all ranges, < 0.3 A short circuit
Diode	
Measurement method	0.83 mA ± 0.2% constant current source
Open circuit voltage:	< +5.0 V _{dc}
Audible tone:	<ul style="list-style-type: none"> • Continuous beep when level is below +50 mV DC • Single tone for normal forward-biased diode or semiconductor junction where 0.3 V ≤ reading ≤ 0.8 V
Input protection:	1000 V _{rms} on all ranges, < 0.3 A short circuit
Capacitance	
Measurement method	Computed from constant current source charge time, typical 0.2 V to 1.4 V _{ac} signal level
Maximum voltage at full scale	<ul style="list-style-type: none"> • For 1 nF to 10 μF range: < 1.5 V • For 100 μF to 10000 μF: 0.33 V
Input protection:	1000 V _{rms} on all ranges, < 0.3 A short circuit

8 Characteristics and Specifications

Digital Multimeter Specifications

Response time:	Approximately 1 s for 100 μ F and ranges below 100 μ F
Charge and discharge voltage:	5 V _{pp} (approximately from +3 V to -2 V)
Frequency	
Measurement method:	Reciprocal counting technique
Signal level:	0.2 V to 1.4 V
Input protection:	<ul style="list-style-type: none">• Voltage path: 1000 V_{rms} on all ranges, < 0.3 A short circuit• Current path: Protected with a 3.15 A/500 V, FF fuse
Maximum display counts (excluding frequency)	
5½ digit:	120,000
4½ digit:	12,000
Measurement noise Rejection	
CMRR (common mode rejection ratio) for 1 k Ω unbalanced in LO lead	<ul style="list-style-type: none">• DC: 140 dB• AC: 70 dB
NMRR (Normal Mode Rejection Ratio)	<ul style="list-style-type: none">60 Hz \pm 0.1%• 5½ digits: 65 dB• 4½ digits: 0 dB50 Hz \pm 0.1%• 5½ digits: 55 dB• 4½ digits: 0 dB

DC Power Supply Specifications

Safety considerations

The U3606A Multimeter|DC Power Supply is a safety class I instrument, which means it has a protective earth terminal. The terminal must be connected to an earth ground through a power source with a 3-wire ground receptacle.

The DC power supply performance specifications are listed in the following pages. Specifications are warranted in the temperature range of 0 °C to 55 °C with a fix resistive load. Supplemental characteristics – which are not warranted, but are descriptions of performance – are determined either by design or testing.

Specifications assumptions

- Specifications stated are after 60-minutes of warm-up with no load.
- Operating temperature at 18 °C to 28 °C (64.4 °F to 82.4 °F)
- Accuracy is expressed as: $\pm(\% \text{ of output} + \text{offset})$ at 23 °C \pm 5 °C
- Temperature coefficient: Add $[0.1 \times (\text{the specified accuracy}) / \text{°C}]$ for 0 °C to 18 °C and 28 °C to 55 °C
- Relative humidity (RH) up to 80% at 30 °C, proportional to 50% for 30 °C to 55 °C

Performance specifications

Table 8-8 DC power supply performance specifications

Parameter		Specifications
Output ratings	Range S1	<ul style="list-style-type: none"> • 0 V to 30 V • 0 A to 1 A
	Range S2	<ul style="list-style-type: none"> • 0 V to 8 V • 0 A to 3 A
Programming accuracy 1 year (@ 23 °C ± 5 °C), ±(% of output + offset)	Voltage	0.05% + 5 mV
	Current	0.15% + 3mA
Readback accuracy 1 year over GPIB and USB or front panel with respect to actual output (@ 23 °C ± 5 °C), ±(% of output + offset)	Voltage	0.05% + 5 mV
	Current	0.15% + 3mA
Ripple and noise With outputs ungrounded, or with either output terminal grounded, 20 Hz to 1 MHz	Normal mode voltage	< 2 mV _{rms} ; < 30 mV _{pp}
	Normal mode current	< 1 mA _{rms}
Front terminal load regulation ±(% of output + offset)	Voltage	< 3 mV ^[1]
	Current	< 0.03% + 0.3 mA
Rear terminal load regulation ±(% of output + offset)	Voltage	< 0.01% + 3 mV
	Current	< 0.03% + 0.3 mA
Line regulation	Voltage	±3 mV
	Current	±1.5 mA
Programming resolution	Voltage	1 mV
	Current	0.1 mA
Readback resolution	Voltage	1 mV
	Current	0.1 mA

Table 8-8 DC power supply performance specifications (continued)

Parameter	Specifications	
Front panel resolution	Voltage	1 mV
	Current	0.1 mA
Transient response time	Less than 450 ms for output to recover to within 50 mV following a change in output current from full load to half load or vice versa.	
Command processing time	Average time for output voltage to begin to change after receipt of digital data when instrument is connected directly to the USB or GPIB is less than 100 ms.	
Overvoltage protection (for CC mode):	<ul style="list-style-type: none"> • Accuracy: 0.5% + 0.5 V • Activation time^[2]: < 2ms 	
Overcurrent protection (for CV mode):	<ul style="list-style-type: none"> • Accuracy: 0.5% + 0.05 A • Activation time^[2]: < 2 ms 	

[1] Contacts and leads resistance may contribute an additional error of 6 mV/A (typical).

[2] Average time for the detection of OVP or OCP condition.

Supplementary characteristics

Maximum output programming range:	Range S1 <ul style="list-style-type: none"> • CV/CC: 0 V to 31.500 V/0 A to 1.05 A • OV/OC: 31.500 V/1.05 A • OVP/OCP: 33.000 V/1.1 A Range S2 <ul style="list-style-type: none"> • CV/CC: 0 V to 8.4 V/0 A to 3.15 A • OV/OC: 8.4 V/3.15 A • OVP/OCP: 8.8 V/3.3 A
Temperature coefficient: ± (% of output + offset) maximum change in output/readback per °C for 0 °C to 18 °C/28°C to 55 °C	<ul style="list-style-type: none"> • Voltage: 0.005% + 0.5 mV • Current: 0.02% +1 mA

8 Characteristics and Specifications

DC Power Supply Specifications

Remote sensing capability:	Output can maintain specifications for <ul style="list-style-type: none"> • Range S1 (30 V/1 A): Up to a 0.75-volt drop per load lead. • Range S2 (8 V/3 A): Up to a 0.5-volt drop per load lead.
Voltage programming speed: (excludes command processing time)	Full load <ul style="list-style-type: none"> • Up: 300 ms • Down: 400 ms No load <ul style="list-style-type: none"> • Up: 300 ms • Down: 400 ms

Square-wave output specifications

Table 8-9 Square-wave output specifications

Parameter		Specifications
Amplitude accuracy ± (offset)	Range S1	0.2 V
	Range S2	0.2 V
Amplitude resolution	Range S1	1 mV
	Range S2	1 mV
Frequency accuracy ± (% of frequency setting + offset)	Range (27 steps ^[1])	0.005% + 1 count
Frequency resolution		0.01 Hz
Duty cycle accuracy ± (% of duty cycle setting)	Range (256 steps : 0.39% to 99.60%)	0.4% ^{[2][3]}
Duty cycle resolution		0.39% ^[3]
Pulse width accuracy ^{[3][4]} ± (offset)	Range (256 steps: 1/frequency)	Duty cycle/frequency
Pulse width resolution		Range/256

[1] Available frequencies: 0.5, 2, 5, 6, 10, 15, 25, 30, 40, 50, 60, 75, 80, 100, 120, 150, 200, 240, 300, 400, 480, 600, 800, 1200, 1600, 2400, 4800 (Hz)

[2] For frequency signals greater than 100 Hz, an additional 0.1% per 100 Hz is added. The accuracy of the duty cycle should be calculated as:

$$Accuracy = \left(0.4\% + \left[\left(\frac{frequency}{100} - 1 \right) \times 0.1\% \right] \right)$$

Specification of duty cycle = ± (Accuracy × Duty cycle setting)

Calculation example: Frequency setting = 4800 Hz, Duty cycle setting = 50%

$$Specification\ of\ duty\ cycle = \pm \left(\left(0.4\% + \left[\left(\frac{4800}{100} - 1 \right) \times 0.1\% \right] \right) \times 50\% \right) = \pm \left(\frac{5.1}{100} \times 50\% \right) = \pm 2.55\%$$

The duty cycle accuracy (for frequency setting 4800 Hz) is calculated as 50% ± 2.55%.

[3] Specification applies when the positive or negative pulse width is greater than 50 μs.

[4] For frequency signals greater than 100 Hz, an additional 0.1% per 100 Hz is added. The accuracy of the pulse width should be calculated as:

$$Accuracy = \left(0.4\% + \left[\left(\frac{frequency}{100} - 1 \right) \times 0.1\% \right] \right)$$

Specification of pulse width = ± (Accuracy × Pulse width setting)

Calculation example: Frequency setting = 4800 Hz, Duty cycle setting = 50%

$$Specification\ of\ pulse\ width = \pm \left(\left(0.4\% + \left[\left(\frac{4800}{100} - 1 \right) \times 0.1\% \right] \right) \times \frac{1}{4800} \right) = \pm \left(\frac{5.1}{100} \times \frac{1}{4800} \right) = \pm 10.625\ \mu s$$

The pulse width accuracy (for frequency setting 4800 Hz and duty cycle setting 50%) is calculated as 0.2083 ms ± 10.625 μs.

NOTE

- The rise and fall time is less than 25 μs.
- The additional load regulation is 0.15 V/A.

8 Characteristics and Specifications

DC Power Supply Specifications

Sweep specifications

Table 8-10 Scan output specifications

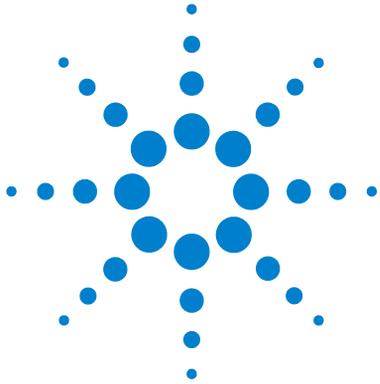
Scan	Constant voltage		Constant current	
	S1	S2	S1	S2
Range	S1	S2	S1	S2
Amplitude ^[1]	0 V to 31.500 V	0 V to 8.4000 V	0 A to 1.0500 A	0 A to 3.1500 A
Step	1 step to 100 steps		1 step to 100 steps	
Dwelling time	1 s to 99 s		1 s to 99 s	

[1] Amplitude start position is fixed at 0 (V or A) by default.

Table 8-11 Ramp output specifications

Ramp	Constant voltage		Constant current	
	S1	S2	S1	S2
Range	S1	S2	S1	S2
Amplitude ^[1]	0 V to 31.500 V	0 V to 8.4000 V	0 A to 1.0500 A	0 A to 3.1500 A
Step	1 step to 10000 steps		1 step to 10000 steps	
Dwelling time	300 ms (typical) per step		300 ms (typical) per step	

[1] Amplitude start position is fixed at 0 (V or A) by default.



9 List of Error Messages

Error Messages	260
Command errors	261
Execution errors	262
Internal errors	263
Query errors	263
Device specific errors	263
Self-test errors	264
Calibration errors	265

The U3606A error messages are summarized in this chapter.



Error Messages

Error messages are created once an erroneous condition is detected.

Errors are retrieved in first-in-first-out (FIFO) order using the `SYSTEM:ERROR?` query or read from the front panel (see [“Reading error messages”](#) on page 114).

The first error returned is the first error that was stored. Reading this error will clear this error allowing the next stored error to be read (if there are other errors stored). Once you have read all of the interface-specific errors, the errors in the global error queue will be retrieved.

If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with error number: `-350, "Queue overflow"`. No additional errors are stored until you remove the previously stored errors from the queue.

If no errors have occurred when you read the error queue, the instrument responds with the message: `+0, "No error"` or `"nonE"` if read from the front panel.

The interface-specific and global error queues are cleared by the clear status (`*CLS`) command and when the instrument power is cycled. The error queue will not be cleared by a Factory Reset (`*RST` command) or an Instrument Preset (`SYSTEM:PRESet` command).

Command errors

The following table shows the list of command errors. These errors set the Standard Event Status register bit 5.

Table 9-1 List of command errors

Error code	Error message
+0	No error
-100	Command error
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-108	Parameter not allowed
-109	Missing parameter
-112	Program mnemonic too long
-113	Undefined header
-120	Numeric data error
-121	Invalid character in number
-123	Exponent too large
-128	Numeric data not allowed
-130	Suffix error
-131	Invalid suffix
-134	Suffix too long
-138	Suffix not allowed
-141	Invalid character data
-144	Character data too long
-148	Character data not allowed

9 List of Error Messages

Error Messages

Table 9-1 List of command errors (continued)

Error code	Error message
-150	String data error
-151	Invalid string data
-158	String data not allowed

Execution errors

The following table shows the list of execution errors. These errors set the Standard Event Status register bit 4.

Table 9-2 List of execution errors

Error code	Error message
-200	Execution error
-211	Trigger ignored
-213	Init ignored
-214	Trigger deadlock
-220	Parameter error
-221	Settings conflict
-222	Data out of range
-223	Too much data
-230	Data corrupt or stale

Internal errors

The following table shows the list of internal errors.

Table 9-3 List of internal errors

Error code	Error message
-350	Queue overflow

Query errors

The following table shows the list of query errors. These errors set the Standard Event Status register bit 2.

Table 9-4 List of query errors

Error code	Error message
-410	Queue INTERRUPTED
-420	Query UNTERMINATED

Device specific errors

The following table shows the list of device specific errors. These errors set the Standard Event Status register bit 3.

Table 9-5 List of device specific errors

Error code	Error message
510	Voltage output over protection
511	Current output over protection
512	Voltage output over limit setting

Table 9-5 List of device specific errors (continued)

Error code	Error message
513	Current output over limit setting
521	Input buffer overflow
532	Cannot achieve requested resolution
540	Cannot use overload as math reference

Self-test errors

The following errors indicate failures that may occur during a self-test.

Table 9-6 List of self-test errors

Error code	Error message
630	EEPROM read failure
631	Program ROM Checksum failed
632	Program RAM failed
633	Display board failed
634	ADC failed
635	Interface board failed
636	Source board failed
637	I/O Processor Failed Self-Test
638	Source Processor Failed Self-Test
639	DC Path error
640	AC Path attenuated error
641	AC Path attenuated 10 error
642	AC Path attenuated 100 or amplified 10 error
643	Frequency measurement path failed

Table 9-6 List of self-test errors (continued)

Error code	Error message
644	Constant Current 0.2V/1kohm error
645	Constant Current 0.2V/10kohm or amplified 11 error
646	Constant Current 0.8V/100kohm or amplified 11 error
647	Constant Current 0.8V/1.1Mohm or amplified 11 error

Calibration errors

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

Table 9-7 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	No cal for this function or range
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

9 List of Error Messages

Error Messages

Table 9-7 List of calibration errors (continued)

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

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