

E36300 Series Programmable DC Power Supplies



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Notices

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Waste Electrical and Electronic Equipment (WEEE)

This product complies with the WEEE Directive) marketing requirement. The affixed product label (see below) indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as “Monitoring and Control instrumentation” product. Do not dispose in domestic household waste.

To return unwanted products, contact your local Keysight office, or see

about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.



Declarations of Conformity

Declarations of Conformity for this product and for other Keysight products may be downloaded from the Web. Go to <http://regulations.corporate.keysight.com/DoC/search.htm> and click on “Declarations of Conformity.” You can then search by product number to find the latest Declaration of Conformity.

Safety Information

CAUTION

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

WARNING

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

Safety and Regulatory Information

Safety Considerations

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

WARNING BEFORE APPLYING POWER

- Verify that the product is set to match the available line voltage and that the correct fuse is installed. Use the label on the rear of the instrument to configure the power. See "Options and Fuse Information" in the User's Guide for additional details.
- Ensure the mains supply voltage fluctuation do not exceed $\pm 10\%$ of the nominal supply voltage.

GROUND THE INSTRUMENT

This product is a Safety Class I instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the AC power supply mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external autotransformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the AC power lines (supply mains).

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE OR WET ENVIRONMENTS

Do not operate the device around flammable gases or fumes, vapor, or wet environments.

DO NOT OPERATE DAMAGED OR DEFECTIVE INSTRUMENTS

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Keysight Technologies Sales and Service Office for service and repair to ensure that safety features are maintained. To contact Keysight for sales and technical support, refer to the support links on the following Keysight website: www.keysight.com/find/assist (worldwide contact information for repair and service).

USE THE POWER CORD PROVIDED

Use the device with the power cord provided with the shipment.

USE THE DEVICE AS SPECIFIED

If the device is used in a manner not specified by manufacturer, the device protection may be impaired.

DO NOT BLOCK VENTILATION HOLES

Do not block any of the ventilation holes of the device.

OBSERVE ALL DEVICE MARKINGS BEFORE CONNECTING TO DEVICE

Observe all markings on the device before connecting any wiring to the device.

WARNING TURN DEVICE OFF BEFORE CONNECTING TO OUTPUT TERMINALS
Turn off the device power before connecting to the output terminals.

ENSURE COVER IS SECURED IN PLACE
Do not operate the device with the cover removed or loosened.

TURN DEVICE OFF AND REMOVE ALL CONNECTIONS BEFORE INSTALLING THE GPIB INTERFACE
Turn off the power and remove all connections, including the power cord, from the instrument prior installation of the GPIB interface.

CAUTION CLEAN WITH SLIGHTLY DAMPENED CLOTH
Clean the outside of the instrument with a soft, lint-free, slightly dampened cloth. Do not use detergent, volatile liquids, or chemical solvents.

NOTE Connect USB cable with ferrite core to the rear panel USB port of the instrument.

Safety Symbols

| Symbol | Description |
|---|---|
|  | Caution, risk of danger (refer to the manual for specific Warning or Caution information) |
|  | Protective earth (ground) terminal. |
|  | Frame or chassis (ground) terminal. |
|  | Standby supply. The instrument is not completely disconnected from AC mains when switch is off. |
|  | Alternating current (AC). |
|  | Plus, positive polarity. |
|  | Minus, negative polarity. |

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

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond CAUTION sign until the indicated conditions are fully understood and met.

NOTE The NOTE sign denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.

Regulatory Markings

| Symbol | Description |
|---|---|
|  | The RCM mark is a registered trademark of the Australian Communications and Media Authority. |
|  | 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. 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. ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product. |
|  | This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product. |
|  | This symbol is a South Korean Class A EMC Declaration. This is a Class A instrument suitable for professional use and in electromagnetic environment outside of the home. |
|  | The CSA mark is a registered trademark of the Canadian Standards Association. |

South Korean Class A EMC declaration:

Information to the user:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

- This EMC statement applies to the equipment only for use in business environment.

| 사용자 안내문 |
|---|
| 이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다. |

- 사용자 안내문은 “업무용 방송통신기자재”에만 적용한다.

Safety and EMC Requirements

This power supply is designed to comply with the following safety and EMC (Electromagnetic Compatibility) requirements:

- Low Voltage Directive 2014/35/EU
- EMC Directive 2014/30/EU

Environmental Conditions

The E36300 Series is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

| Environmental condition | Requirement |
|-------------------------|---|
| Temperature | Operating condition: 0 °C to 40 °C |
| | Storage condition: -20 °C to 70 °C |
| Humidity | Operating condition: Up to 80% RH at 40 °C (non-condensing) |
| | Storage condition: Up to 90% RH at 65 °C (non-condensing) |
| Altitude | Up to 2000 m |
| Pollution degree | 2 |

1 Service and Maintenance

Specifications and Characteristics

General Information

Troubleshooting

Self-Test Procedures

To Replace the Power-Line Fuse

User Replaceable Parts

Disassembly

This chapter provides the specifications and service information on cleaning, troubleshooting, repair, and replaceable parts of the E36300 Series. This chapter also explains how to assemble and disassemble the E36300 Series.

Specifications and Characteristics

NOTE

For the characteristics and specifications of the E36300 Series programmable DC power supplies, refer to the datasheet at <http://literature.cdn.keysight.com/litweb/pdf/5992-2124EN.pdf>.

General Information

Types of service available

If your instrument fails during the warranty period, Keysight Technologies will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices. You also have the option to purchase a service contract that extends the coverage after the standard warranty expires.

Obtaining repair service (worldwide)

To obtain service for your instrument, contact your nearest Keysight Technologies Service Center. They will arrange to have your unit repaired or replaced, and can provide warranty or repair-cost information where applicable. Ask the Keysight Technologies Service Center for shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for return shipments.

Repackaging for shipment

Ensure the following to ship the unit to Keysight for service or repair:

- 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.
- Secure the container with strong tape or metal bands.
- If the original shipping container is unavailable, use a container that will ensure at least 10 cm (4 in.) of compressible packaging material around the entire instrument. Use static-free packaging materials.

Keysight suggests that you always insure your shipments.

Cleaning and handling

Cleaning

To prevent electrical shock, disconnect the instrument from AC mains power and disconnect all test leads before cleaning. Clean the outside of the instrument using a soft, lint-free, cloth slightly dampened with water.

- Do not use detergent or solvents.
- Do not attempt to clean internally.

If required, contact a Keysight Technologies Sales and Service office to arrange for proper cleaning to ensure that safety features and performance are maintained.

Electrostatic Discharge (ESD) precautions

Almost all 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 during service operations:

- 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.

Troubleshooting

Before troubleshooting or repairing the instrument, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument was accurately calibrated within the last year (see [Calibration Adjustment Procedures > Calibration Interval](#) for details).

Perform the following verifications if the unit is inoperative:

- Verify that the ac power cord is connected to the power supply.
- Verify that the front-panel power switch is depressed.
- Verify that the correct power-line fuse is installed. See [To Replace the Power Line Fuse](#) for details.
- Verify the power-line voltage setting.

Self-Test Procedures

A power-on self-test occurs automatically when you turn on the power supply. This limited test assures you that the power supply is operational.

Press **Utilities > Test / Setup > Self Test** to perform the complete self-test of the power supply. It takes approximate 2 seconds for the self-test to complete.

You can also perform a complete self-test from the remote interface, see Programming Guide for details.

- If the self-test is successful, "Self test passed" is displayed on the front panel.
- If the self-test fails, "!Err" is displayed on the front panel. Record the error code and message and contact Keysight support if necessary.
- If the self-test is successful, this indicates a high chance that the power supply is operational.

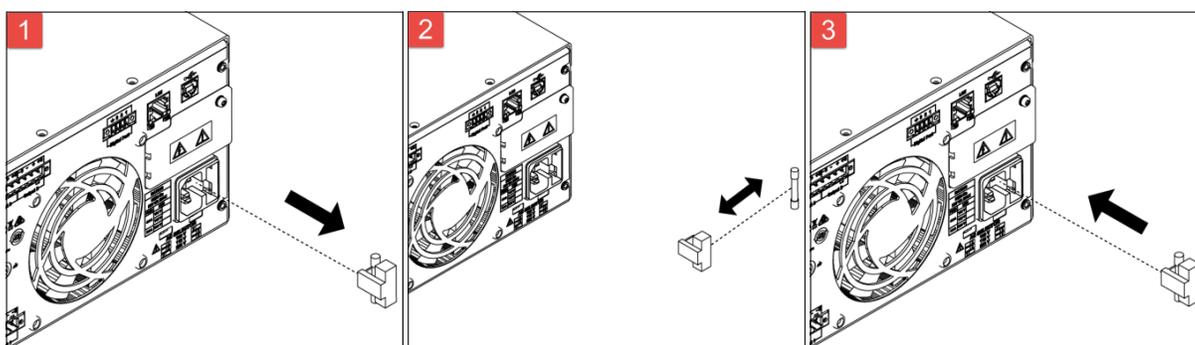
Replacing the Power-Line Fuse

The power-line fuse is located within the power supply's fuse-holder assembly on the rear panel.

Table below describes the fuse that you should use with each of the power supply's option.

| Option | Fuse part number | Description | Fuse type | Manufacturer | Application |
|--|------------------|------------------------------|---------------|--------------|------------------------------|
| E36311A-OE9 E36311A-OEM E36312A-OE9 E36312A-OEM | 2110-1672 | Fuse 4 A, 125 V Time-delay | Medium-Acting | Littelfuse | 100 V and 115 V line voltage |
| E36311A-OE3 E36312A-OE3 | 2110-1640 | Fuse 2 A, 250 V Time-delay | Slow-Blo | | 230 V line voltage |
| E36313A-OE9 E36313A-OEM | 2110-1673 | Fuse 7 A, 125 V Time-delay | Medium-Acting | | 100 V and 115 V line voltage |
| E36313A-OE3 | 2110-0954 | Fuse 3.5 A, 250 V Time-delay | Slow-Blo | | 230 V line voltage |

To configure the correct fuse, follow the three steps shown below:



1 Pull the fuse holder out of the power supply.

2 Remove and insert the proper fuse into the fuse holder.

3 Re-insert the fuse holder into the power supply.

User Replaceable Parts

You can find the instrument support part list at Keysight's Test & Measurement Parts Catalog

<http://www.keysight.com/find/parts>.

Disassembly

Tools required

| Items | Torque value |
|-----------------|--------------|
| PZ1 driver | 9.0 in.lbs |
| T10 Torx driver | 9.0 in.lbs |
| T8 Torx driver | 9.0 in.lbs |
| 1/4" nut socket | 9.0 in.lbs |
| 1/2" nut socket | 3.5 in.lbs |

Removing/Installing the GPIB module (E36312A and E36313A only)

WARNING

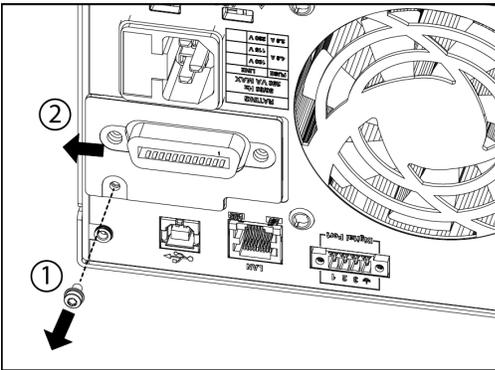
TURN OFF POWER AND REMOVE ALL CONNECTIONS BEFORE PROCEED

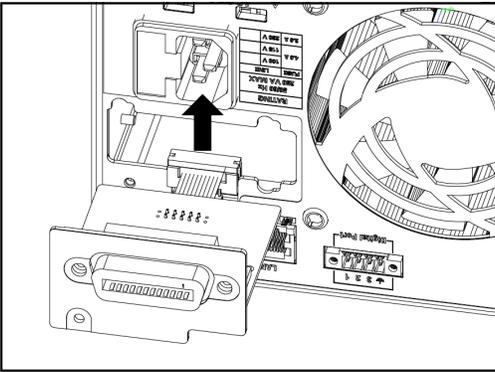
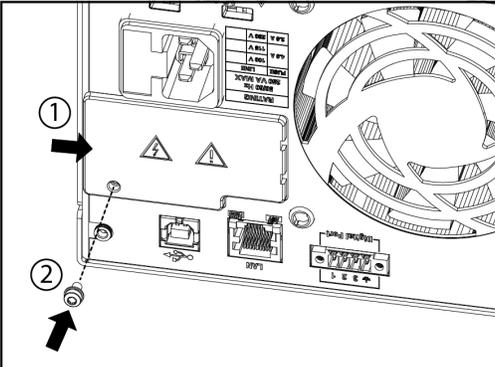
Turn off the power and remove all connections, including the power cord, from the instrument prior installation/removal of the GPIB interface.

RETAIN GPIB COVER PLATE

After installing the GPIB option, retain the cover plate for use in the event that you ever remove the GPIB option. The instrument should never be connected to power or inputs on the output terminals without either the GPIB module or the cover plate securely covering the rear-panel opening.

Make sure you turn the power supply upside down before proceeding.

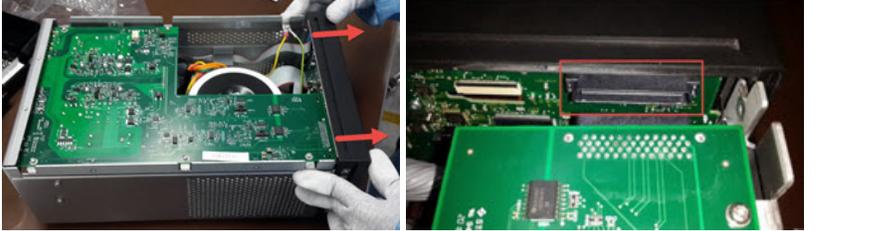
| Steps | Instructions | Visual |
|-------|---|--|
| 1. | <p>Remove the screw from the GPIB module plate using a T10 driver. Retain the screw for use later in this procedure.</p> <p>Then, remove the GPIB module by sliding it to the left.</p> |  |

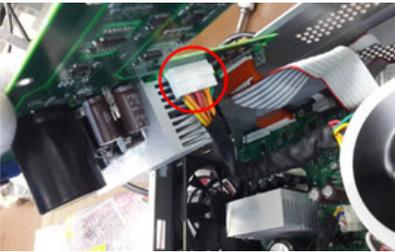
| Steps | Instructions | Visual |
|-------|---|--|
| 2. | Pull the cable from the connector. |  |
| 3. | Slide the cover plate to the right so that it is flushed against the instrument's sheet metal. Use the screw that was removed earlier to secure the cover plate in place. |  |
| 4. | To install the GPIB module, perform the above steps in reverse order. | |

Removing/Installing the front panel binding post

- WARNING** Only qualified, service-trained personnel should remove and install the front panel binding post.
- NOTE** The GPIB module must be removed before you proceed to remove the front panel binding post.

| Steps | Instructions | Visual |
|-------|--|--|
| 1. | Remove the side trims from the front panel. |  |
| 2. | Remove four Pozi screws from the front panel using a PZ1 driver. |  |

| Steps | Instructions | Visual |
|-------|--|--|
| 3. | Remove six screws from the top panel using a T10 driver. |  |
| 4. | Remove the top panel: Slide the top panel towards the rear and lift it up. |  |
| 5. | Remove the screw that holds two ground lugs to the chassis. For reassembly, take note on the grounds lugs and washers arrangement. |  |
| 6. | Remove five screws from the 25 V main PCA board. |  |
| 7. | Gently pull out the front panel assembly from the chassis and remove all the board-to-board connectors. |  |

| Steps | Instructions | Visual |
|-------|---|---|
| 8. | Lift the 25 V main PCA board. Disconnect the transformer and fan cable from the PCA board. |  |
| 9. | Disconnect another transformer cable from the PCA board. |  |
| 10. | Disconnect two IDC cables from the 25 V main PCA board (located on top) and 6 V PCA board (located at the bottom). For reassembly, take note on the cable routing. |  |
| 11. | Disconnect one ribbon cable from the 6 V PCA board. For reassembly, take note on the cable routing. |  |
| 12. | Remove front panel assembly from the chassis. |  |
| 13. | Remove the two knobs from the front panel. |  |
| 14. | Remove six screws from the front panel PCA board using a T8 driver. |  |

| Steps | Instructions | Visual |
|-------|---|--|
| 15. | <p>For E36311A, remove six hex-lock nuts from the front panel PCA board using a 1/4" nut socket.</p> <p>For E36312A and E36313A, remove seven hex-lock nuts from the front panel PCA board.</p> |  |
| 16. | <p>Disconnect FPC cable from the front panel PCA board and lift up the board from front frame.</p> |  |
| 17. | <p>For E36311A, remove the six plastic hex-lock nuts from the front panel frame using a 1/2" nut socket.</p> <p>For E36312A and E36313A, remove the seven plastic hex-lock nuts from the front panel frame.</p> |  |
| 18. | <p>To install the binding post, perform the above steps in reverse order.</p> | |

2 Verification and Adjustments

Performance Verification

Test Record Forms

Calibration Adjustment Procedures

This chapter contains the performance verification procedures which verify that the E36300 Series is operating within its published specifications. This chapter also provides information on adjustments performed after a performance verification fails.

Performance Verification

Performance verification ensures that the instrument performs within the specifications stated in the data sheet (<http://literature.cdn.keysight.com/litweb/pdf/5992-2124EN.pdf>)

Recommended test equipment

The test equipments recommended for the performance verification and adjustment procedures are listed below. If the exact instrument is not available, use the accuracy requirements shown to select substitute calibration standards.

| Type | Specification | Recommended model |
|---|--|--|
| Digital multimeter | Readout: 6 1/2 digits Basic DC Accuracy: 0.0035% | Keysight 34401A or equivalent |
| Current monitor | 15 A (0.1 Ω), TC = 4 ppm/°C | Guidline 9230A-15R |
| Electronic load | 150 V, 5 A minimum, with transient capability and a slew rate of 833 kA/s or better. | Keysight N3300A mainframe, with N330xA modules |
| Fixed load | Wirewound resistor 300 W, 1.6 Ω or equivalent – E36311A/E36312A Output 1: 1.2 Ω – E36313A Output 1: 0.6 Ω | Ohmite MPN: E300K1R6E |
| | Wirewound resistor 225 W, 25 Ω or equivalent – E36311A/E36312A Output 2 and 3: 25 Ω – E36313A Output 2 and 3: 12.5 Ω | Ohmite MPN: E225K25RE |
| LAN / USB controller | N/A | PC with Keysight Connection Expert loaded |
| Oscilloscope | Sensitivity: 1 mV; Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip | Keysight Infiniium/6054A or equivalent |
| RMS voltmeter | True RMS; Bandwidth: 20 MHz Sensitivity: 100 μ V | Rhode and Schwartz model URE3 or equivalent |
| Differential amplifier | Bandwidth: 20 MHz | LeCroy 1855A or equivalent |
| Terminations | 1 – 50 Ω BNC termination 2 – 50 Ω , \geq 1/8 W resistor | N/A |
| Variable voltage transformer or AC source | Adjustable to highest rated input voltage range. Power: 500 VA | Keysight 6813B or equivalent |
| Calibration resistors for low range current | – E36312A/E36313A Output 1: 300 Ω power resistor, \geq 1 W – E36312A/E36313A Output 2 and 3: 2.5 k Ω power resistor, \geq 1 W | N/A |

Test considerations

- Ensure that the calibration ambient temperature is stable and between 20 °C and 30 °C.
- Ensure ambient relative humidity is less than 80%.
- Allow a 1-hour warm-up period before verification or calibration.
- Keep cables as short as possible, consistent with the impedance requirements.
- For E36311A, performance verification and calibration procedure must be performed through front panel output.
- For E36312A and E36313A, performance verification and calibration procedure must be performed through rear panel output.

CAUTION The tests should be performed by qualified personnel. During performance verification tests, hazardous voltages may be present at the outputs of the power supply.

Measurement techniques

Voltmeter

To ensure that the values read by the voltmeter during both the verification procedure and the calibration procedure are not affected by the instantaneous measurement of the AC peaks of the output current ripple, make several DC measurements and average them.

Current-monitoring resistor

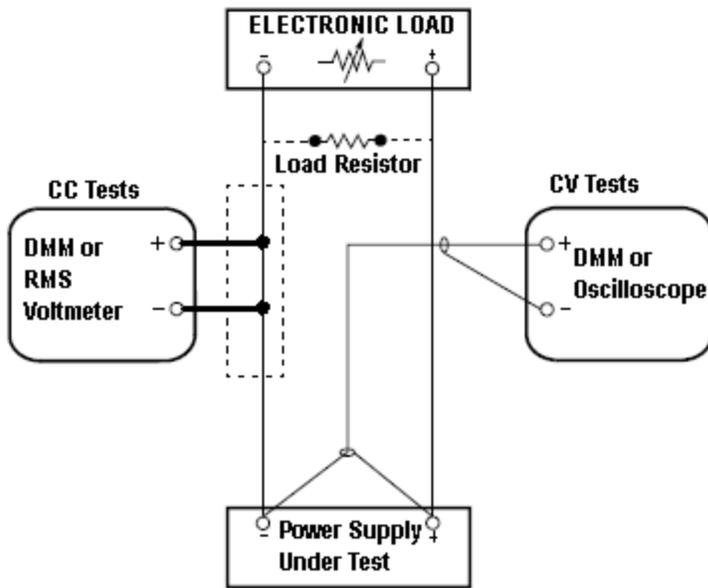
The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

Electronic load

Many of the test procedures require the use of a variable load capable of dissipating the required power. If a variable resistor is used, switches should be used to connect, disconnect, or short the load resistor. For most tests, an electronic load can be used. The electronic load is considerably easier to use than load resistors, but it may not be fast enough to test transient recovery time and may be too noisy for the noise (PARD) tests.

Fixed load resistors may be used in place of a variable load, with minor changes to the test procedures. Also, if computer controlled test setups are used, the relatively slow (compared to computers and system voltmeters) settling times and slew rates of the power system may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the power system.

Setup for most tests



This setup is used for most tests and it requires the DMM, electronic load, and power supply being verified. Some wire is also required for connection between instruments. A LAN or USB cable is needed for readback data. The DMM measures the power supply output, and the electronic load draws current from the power supply. The accuracy of the current monitoring resistor must be 0.01% or better, which should include any self-heating effects.

Constant Voltage (CV) verification

Voltage programming and readback accuracy

These tests verify that the voltage programming and the LAN or USB readback functions are within specifications. Note that the readback values over the remote interface should be identical to those displayed on the front panel, but with maximum resolution.

1. Turn off the power supply using the AC line switch.
2. Connect a DMM between the (+) and (-) terminals of the output.
3. If you are using a computer to control the power supply, connect a LAN, GPIB or USB cable from the power supply to the PC.
4. Turn on the power supply using the AC line switch.

Voltage programming accuracy

| Step | Front Panel | SCPI |
|------|--|--|
| 5. | Set the instrument settings as described in the test record form under the Voltage Programming and Readback . See Test Record Forms for details. | VOLT 6, (@<channel>; CURR 5, (@<channel> This is an example for the E36311A, 6 V, 5 A output. |
| 6. | Enable the output by pressing ON key for the selected output. | OUTP ON, (@<channel>) |
| 7. | The output status should be CV and the output current should be close to zero. | |
| 8. | Record the voltage measured by the DMM and verify whether it is within the limits calculated. | |

Voltage readback accuracy

| Step | Front Panel | SCPI |
|------|--|---|
| 9. | | MEAS:VOLT?, (@<channel> This is an example for the E36311A, 6 V, 5 A output. |
| 10. | Record the voltage returned by the SCPI command query via Keysight Connection Expert, and verify whether it is within the limits calculated. | |

CV load and line regulation

These tests verify that the voltage variation due to load or line variation are within specifications.

CV load regulation

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

1. Turn off the power supply using the AC line switch.
2. Connect the power supply output with a DMM and an electronic load.
3. If you are using a PC to control the power supply, connect a LAN or USB cable from the power supply to the PC.
4. Turn on the power supply using the AC line switch.
5. Set the power supply settings as described in the test record form under “CV Load Regulation”. See the **Test Record Forms** under “CV Load Regulation” for details. Enable the output.
6. Operate the electronic load in constant current mode and set its current to the value in the test record form under “CV Load Regulation”. See the **Test Record Forms** under Test Description of “CV Load Regulation” for details. Check that the front panel CV annunciator of the power supply remains lit. If it turns to **CC** or **UNREG**, adjust the load so that the output current drops slightly until the CV annunciator lights up. Record the output voltage reading on the DMM as V_{load} .
7. Operate the electronic load in open mode (input off). Record the output voltage reading on the DMM immediately as V_{noload} .
8. Take the difference between the DMM readings in steps 6 and 7 that is the CV load regulation ($V_{load} - V_{noload}$). The difference of the readings during the immediate change should be within the specification limits.

CV line regulation

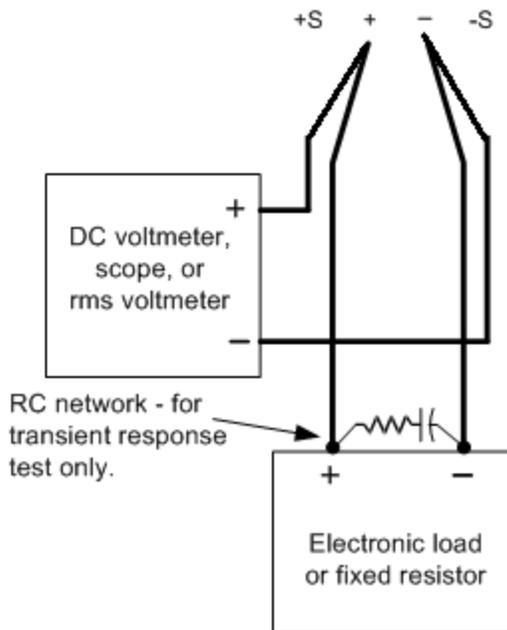
This test measures the change in output voltage that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

1. Turn off the power supply using the AC line switch.
2. Connect the power supply output with a DMM and an electronic load.
3. Connect a variable AC Source or Variac to the AC input, set to an appropriate line voltage for the power supply configuration.
4. If you are using a PC to control the power supply, connect a LAN, GPIB or USB cable from the power supply to the PC.
5. Turn on the power supply using the AC line switch.
6. Set the power supply settings as described in the test record form under “CV Line Regulation”. See the **Test Record Forms** under “CV Line Regulation” for details. Enable the output.
7. Operate the electronic load in constant current mode and set its current to the value in the test record form under “CV Line Regulation”. See the **Test Record Forms** under Test Description of “CV Line Regulation” for details. Check that the front panel CV annunciator of the power supply remains lit. If it turns to **CC** or **UNREG**, adjust the load so that the output current drops slightly until the CV annunciator lights up.
8. Adjust the AC power source to low line voltage limit (90 VAC for nominal 100 VAC, 104 VAC for nominal 115 VAC, 194 VAC for nominal 215 VAC, or 207 VAC for nominal 230 VAC). Record the output reading on the DMM as V_{lowline} .
9. Adjust the AC power source to high line voltage (110 VAC for nominal 100 VAC, 127 VAC for nominal 115 VAC, 237 VAC for nominal 215 VAC or 253 VAC for nominal 230 VAC). Record the voltage reading on the DMM immediately as V_{highline} .
10. Take the difference between the DMM readings in steps 8 and 9 that is the CV line regulation ($V_{\text{lowline}} - V_{\text{highline}}$). The difference of the readings during the immediate change should be within the limit calculated from the specification.

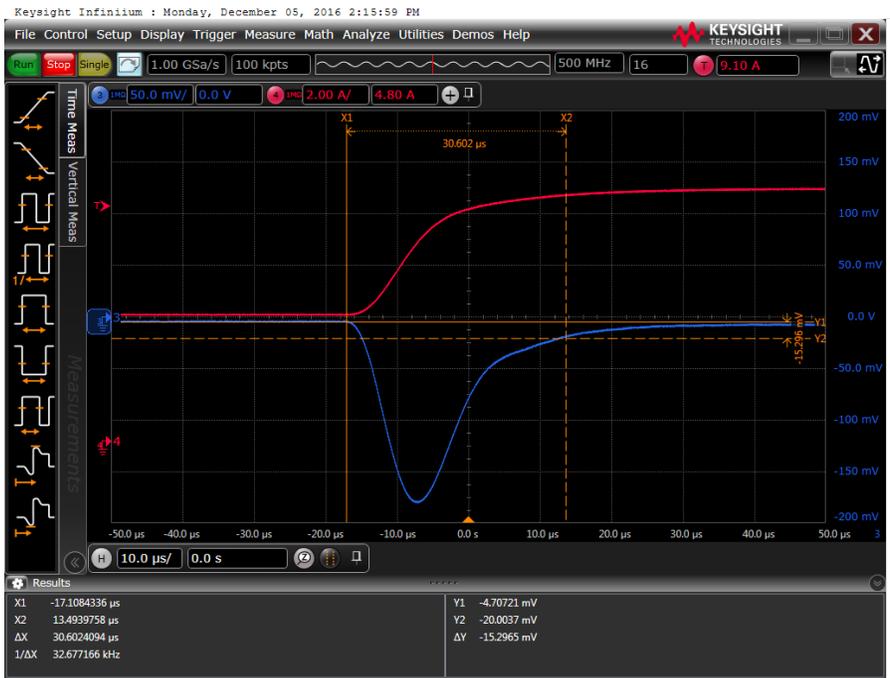
Transient response verification

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load current.

1. Turn off the power supply using the AC line switch.
2. Connect an oscilloscope and electronic load between the (+) and (-) terminals of the output to be tested as shown below.



3. If you are using a PC to control the power supply, connect a LAN, GPIB or USB cable from the power supply to the PC.
4. Turn on the power supply using the AC line switch.
5. Set the instrument settings as described in the test record form under "Transient Response". See the **Test Record Forms** under "Transient Response" for details. Enable the output.
6. Operate the electronic load in constant current mode and set its current to the value in the test record form under "Transient Response". See the **Test Record Forms** under Test Description of "Transient Response" for details. Set the transient level to $\frac{1}{2}$ the maximum current. Set the transient duty cycle to 50% and transient frequency to 1 kHz. Check that the front panel CV annunciator of the power supply remains lit. If it turns to **CC** or **UNREG**, adjust the maximum current load so that the output current drops slightly until the CV annunciator lights up.
7. Adjust the oscilloscope to display transients as shown below. Note that the pulse width (t_2-t_1) of the transient at the voltage settling band, for example 15 mV for the E36313A Output 1 from the base line is no more than 50 μ s.



NOTE

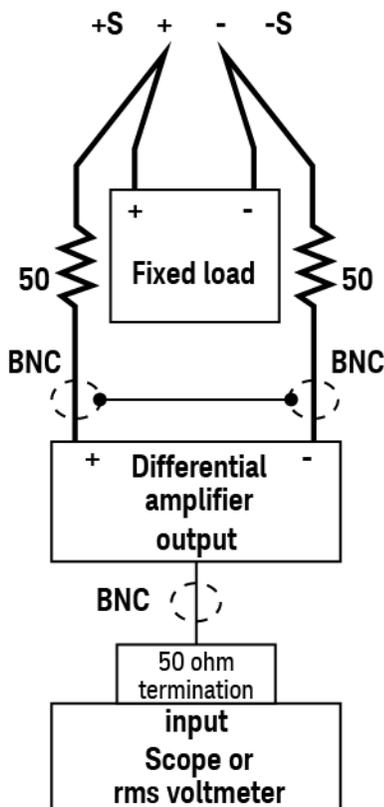
The oscilloscope cursors X1 and X2 represent t1 and t2.
 The oscilloscope red trace and blue trace represent output current and output voltage trace.

- Transient response specification is met when the voltage recovers within 50 μ s.

Output noise verification

Periodic and random output deviations superimpose a residual AC voltage on the DC output. This residual voltage is specified as the rms or peak-to-peak noise in and is specified in the product data sheet.

1. Turn off the power supply using the AC line switch.
2. Connect a fixed load, differential amplifier, and an oscilloscope (AC coupled) to the output as shown below.



3. Use an appropriate load resistor (see fixed load value **Recommended test equipment** list) to keep the power system at the instrument setting specified in the test record form under “CV Ripple and Noise”. See the **Test Record Forms** under “CV Ripple and Noise” for details.
4. As shown in the figure, use two BNC cables to connect the differential amplifier to the (+) and (-) output terminals. Each cable should be terminated by a 50 Ω resistor. The shields of the two BNC cables should be connected together. Connect the differential amplifier output to the oscilloscope with a 50 Ω termination at the oscilloscope input.
5. Set the differential amplifier to multiply by ten, divide by one, and 1 M Ω input resistance. Set the differential amplifier's positive and negative inputs to AC coupling. Set the oscilloscope's time base to 5 ms/div, and the vertical scale to 10 mV/div. Turn the bandwidth limit on (usually 20 or 30 MHz), and set the sampling mode to peak detect.

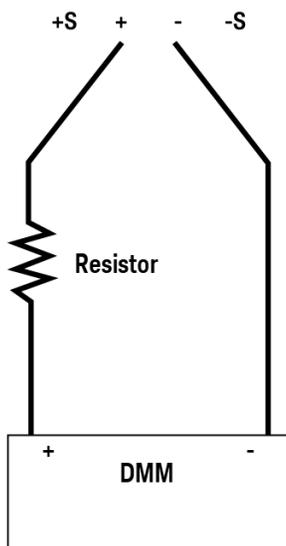
6. Program the power supply to the settings indicated in the in the test record form for the appropriate model under “CV Ripple and Noise” see the **Test Record Forms** under Test Description of “CV Ripple and Noise” for details and enable the output. Let the oscilloscope run for a few seconds to generate enough measurement points. On the Keysight Infiniium oscilloscope, the maximum peak-to-peak voltage measurement is indicated at the bottom of the screen on the right side. Divide this value by 10 to get the CV peak-to-peak noise measurement. The result should not exceed the peak-to-peak upper limits for instrument's “CV Ripple and Noise, peak-to-peak.” See the **Test Record Forms** under “CV Ripple and Noise” for details.
7. Disconnect the oscilloscope and connect an rms voltmeter in its place. Do not disconnect the 50 Ω termination. Divide the reading of the rms voltmeter by 10. The result should not exceed the rms limits in the test record form for the appropriate model under “CV Ripple and Noise, rms”. See the **Test Record Forms** under “CV Ripple and Noise” for details.

Low range current verification (For E36312A and E36313A only)

Low range current programming and readback accuracy

These tests verify that the current programming and the LAN, GPIB or USB readback measurement functions are within specifications. Note that the readback values over the remote interface should be identical to those displayed on the front panel, but with maximum resolution.

1. Turn off the power supply using the AC line switch.
2. Connect a DMM between the (+) and (-) terminals of the output.
3. Connect appropriate resistor in series with the (+) terminals of the power supply and (+) terminals of the DMM as shown below.



4. If you are using a PC to control the power supply, connect a LAN, GPIB or USB cable from the power supply to the PC.
5. Turn on the power supply using the AC line switch.

Low range current readback accuracy

| Step | Front Panel | SCPI |
|------|---|--|
| 6. | Set the instrument settings as described in the test record form under Low Range Current Readback, Maximum Low Range Current ($I_{low\ max}$) . See Test Record Forms for details. | VOLT 6, (@<channel>; CURR 0.020, (@<channel>) This is an example for the E36313A, 6 V, 20 mA output. |
| 7. | Enable the output by pressing the Output ON key | OUTP ON, (@<channel>) |
| 8. | Record the current measured by the DMM and current returned by the SCPI MEAS:CURR?, (@channel) command query via Keysight Connection Expert and verify whether it is within the limits calculated. | MEAS:CURR?, (@<channel>) This is an example for the E36313A, 6 V, 20 mA output. |

Constant Current (CC) verification

Current programming and readback accuracy

These tests verify that the current programming and the LAN, GPIB or USB readback measurement functions are within specifications. Note that the readback values over the remote interface should be identical to those displayed on the front panel, but with maximum resolution.

1. Turn off the power supply using the AC line switch.
2. Connect the current shunt directly across the output terminals. Connect the DMM directly across the current shunt.
3. If you are using a PC to control the power supply, connect a LAN, GPIB or USB cable from the power supply to the PC.
4. Turn on the power supply using the AC line switch.

Current programming accuracy

| Step | Front Panel | SCPI |
|------|--|---|
| 5. | Set the instrument settings as described in the test record form under Current Programming and Readback . See Test Record Forms for details. | VOLT 6, (@<channel>; CURR 5, (@<channel>) This is an example for the E36311A, 6 V, 5 A output. |
| 6. | Enable the output by pressing the Output ON key | OUTP ON, (@<channel>) |
| 7. | The output status should be CC and the output voltage should be close to zero. | |
| 8. | Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps. | |
| 9. | Record the current measured by the DMM and verify whether it is within the limits calculated. | |

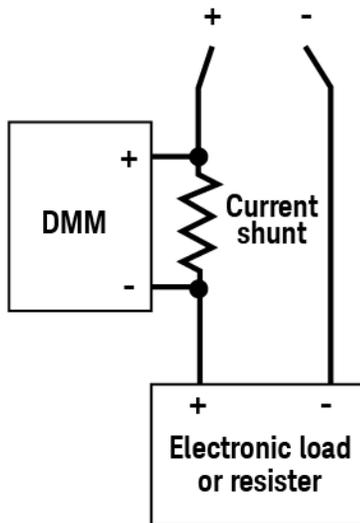
Current readback accuracy

| Step | Front Panel | SCPI |
|------|--|--|
| 10. | | MEAS:CURR?, (@<channel>) This is an example for the E36311A, 6 V, 5 A output. |
| 11. | Record the current returned by the SCPI command query via Keysight Connection Expert, and verify whether it is within the limits calculated. | |

CC load regulation

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

1. Turn off the power supply using the AC line switch.
2. Connect the power supply output with a DMM, an electronic load and a current shunt as shown below.



3. Turn on the power supply using the AC line switch.
4. Program the output voltage and output current as described in the test record form under CC load regulation.
5. Enable the output by sending the command OUTP ON or by pressing the Output ON key.
6. Operate the electronic load in constant voltage mode and set its voltage to the power supply output value as described in the test record form under "CC Load Regulation". See the **Test Record Forms** under Test Description of "CC Load Regulation" for details. Check that the front panel CC annunciator of the power supply remains lit. If it turns to **CV** or **UNREG**, adjust the load so that the output current drops slightly until the CC annunciator lights up. Record the current reading (I_{load}), by dividing the voltage reading on the DMM by the resistance of the current monitoring resistor.
7. Operate the electronic load in short (input short) mode. Record the current reading, (I_{short}), by dividing the voltage reading on the DMM by the resistance of the current monitoring resistor.
8. Take the difference between the current readings in steps 6 and 7 is the load regulation current ($I_{load} - I_{short}$). The difference of the readings during the immediate change should be within the specification limits.

CC line regulation

1. Turn off the power supply using the AC line switch.
2. Connect the power supply output with a DMM, an electronic load and a current shunt. See **Recommended test equipment** for details.
3. Connect the AC power cord of the power supply to the AC power source.
4. Turn on the power supply using the AC line switch.
5. Program the output voltage and output current as described in the test record form under CC line regulation.
6. Operate the electronic load in constant voltage mode and set its voltage to the power supply output value as described the test record form under “CC Line Regulation”. See the **Test Record Forms** under Test Description of “CC Line Regulation” for details. Check that the front panel CC annunciator of the power supply remains lit. If it turns to **CV** or **UNREG**, adjust the load so that the output current drops slightly until the CC annunciator lights up.
7. Adjust the AC power source to low line voltage limit (90 VAC for nominal 100 VAC, 104 VAC for nominal 115 VAC, 194 VAC for nominal 215 VAC, or 207 VAC for nominal 230 VAC). Record the output current reading (I_{lowline}) by dividing the voltage reading on the DMM by the resistance of the current monitoring resistor.
8. Adjust the AC power source to high line voltage (110 VAC for nominal 100 VAC, 127 VAC for nominal 115 VAC, 237 VAC for nominal 215 VAC or 253 VAC for nominal 230 VAC). Record the current reading (I_{highline}) again immediately by dividing the voltage reading on the DMM by the resistance of the current monitoring resistor.
9. Take the difference between the DMM readings in steps 7 and 8 is the CC line regulation ($I_{\text{lowline}} - I_{\text{highline}}$). The difference of the readings during the immediate change should be within the specification limits.

Test Record Forms

Test record form - Keysight E36311A

Test record form - Keysight E36312A

Test record form - Keysight E36313A

Test record form - Keysight E36311A

| E36311A | Report Number _____ | Date _____ | | |
|---|---------------------|----------------------|--------|----------------------|
| Description | Outputs | Lower limit | Result | Upper limit |
| Constant Voltage Tests | | | | |
| Voltage Programming | | | | |
| Zero Voltage Output (V_0) | Output 1 | -0.005 V | _____ | 0.005 V |
| | Output 2 | -0.02 V | _____ | 0.02 V |
| | Output 3 | -0.02 V | _____ | 0.02 V |
| Maximum Voltage Output (V_{max}) | Output 1 | 5.989 V | _____ | 6.011 V |
| | Output 2 | 24.9675 V | _____ | 25.0325 V |
| | Output 3 | 24.9675 V | _____ | 25.0325 V |
| Voltage Readback | | | | |
| Zero Voltage measured over interface | Output 1 | $V_0 - 0.005$ V | _____ | $V_0 + 0.005$ V |
| | Output 2 | $V_0 - 0.01$ V | _____ | $V_0 + 0.01$ V |
| | Output 3 | $V_0 - 0.01$ V | _____ | $V_0 + 0.01$ V |
| Maximum Voltage measured over interface | Output 1 | $V_{max} - 0.011$ V | _____ | $V_{max} + 0.011$ V |
| | Output 2 | $V_{max} - 0.0225$ V | _____ | $V_{max} + 0.0225$ V |
| | Output 3 | $V_{max} - 0.0225$ V | _____ | $V_{max} + 0.0225$ V |
| CV Load Regulation ($V_{load} - V_{noload}$) | Output 1 | -2.6 mV | _____ | 2.6 mV |
| | Output 2 | -4.5 mV | _____ | 4.5 mV |
| | Output 3 | -4.5 mV | _____ | 4.5 mV |
| CV Line Regulation ($V_{lowline} - V_{highline}$) | Output 1 | -1.6 mV | _____ | 1.6 mV |
| | Output 2 | -3.5 mV | _____ | 3.5 mV |
| | Output 3 | -3.5 mV | _____ | 3.5 mV |
| CV Ripple and Noise | | | | |
| peak-to-peak | Output 1 | – | _____ | 2 mV |
| | Output 2 | – | _____ | 2 mV |
| | Output 3 | – | _____ | 2 mV |
| rms | Output 1 | – | _____ | 350 μ V |
| | Output 2 | – | _____ | 350 μ V |
| | Output 3 | – | _____ | 350 μ V |
| Transient Response | Output 1 | – | _____ | 50 μ s |
| | Output 2 | – | _____ | 50 μ s |
| | Output 3 | – | _____ | 50 μ s |
| Constant Current Tests | | | | |

| E36311A | Report Number _____ | Date _____ | | |
|---|---------------------|---------------------|--------------------|---------------------|
| Description | Outputs | Lower limit | Result | Upper limit |
| Current Programming | | | | |
| Zero Current Output (I_0) | Output 1 | -0.01 A | _____ | 0.01 A |
| | Output 2 | -0.004 A | _____ | 0.004 A |
| | Output 3 | -0.004 A | _____ | 0.004 A |
| Maximum Current Output (I_{max}) | Output 1 | 4.985 A | _____ | 5.015 A |
| | Output 2 | 0.995 A | _____ | 1.005 A |
| | Output 3 | 0.995 A | _____ | 1.005 A |
| Current Readback | | | | |
| Zero Current measured over interface | Output 1 | $I_0 - 0.01$ A | _____ | $I_0 + 0.01$ A |
| | Output 2 | $I_0 - 0.004$ A | _____ | $I_0 + 0.004$ A |
| | Output 3 | $I_0 - 0.004$ A | _____ | $I_0 + 0.004$ A |
| Maximum Current measured over interface | Output 1 | $I_{max} - 0.015$ A | _____ | $I_{max} + 0.015$ A |
| | Output 2 | $I_{max} - 0.005$ A | _____ | $I_{max} + 0.005$ A |
| | Output 3 | $I_{max} - 0.005$ A | _____ | $I_{max} + 0.005$ A |
| CC Load Regulation ($I_{load} - I_{short}$) | Output 1 | -750 μ A | _____ | 750 μ A |
| | Output 2 | -350 μ A | _____ | 350 μ A |
| | Output 3 | -350 μ A | _____ | 350 μ A |
| CC Line Regulation ($I_{lowline} - I_{highline}$) | Output 1 | -750 μ A | _____ | 750 μ A |
| | Output 2 | -350 μ A | _____ | 350 μ A |
| | Output 3 | -350 μ A | _____ | 350 μ A |
| Test Description | Instrument settings | | | |
| | Output 1 | Output 2 | Output 3 | |
| Voltage Programming & Readback, Zero Voltage (V_0) | 0 V, 5 A | 0 V, 1 A | 0 V, 1 A | |
| Voltage Programming & Readback, Maximum Voltage (V_{max}) | 6 V, 5 A | 25 V, 1 A | 25 V, 1 A | |
| CV Load Regulation, Line Regulation, Ripple and Noise | 6 V, 5 A | 25 V, 1 A | 25 V, 1 A | |
| Transient Response | 6 V, 2.5 A to 5 A | 25 V, 0.5 A to 1 A | 25 V, 0.5 A to 1 A | |
| Current Programming & Readback, Zero Current (I_0) | 0 A, 6 V | 0 A, 25 V | 0 A, 25 V | |
| Current Programming & Readback, Maximum Current (I_{max}) | 5 A, 6 V | 1 A, 25 V | 1 A, 25 V | |
| CC Load Regulation, Line Regulation, Ripple and Noise | 5 A, 6 V | 1 A, 25 V | 1 A, 25 V | |

Test record form - Keysight E36312A

| E36312A | Report Number _____ | Date _____ | | |
|---|---------------------|----------------------|--------|----------------------|
| Description | Outputs | Lower limit | Result | Upper limit |
| Constant Voltage Tests | | | | |
| Voltage Programming | | | | |
| Zero Voltage Output (V_0) | Output 1 | -0.002 V | _____ | 0.002 V |
| | Output 2 | -0.005 V | _____ | 0.005 V |
| | Output 3 | -0.005 V | _____ | 0.005 V |
| Maximum Voltage Output (V_{max}) | Output 1 | 5.9962 V | _____ | 6.0038 V |
| | Output 2 | 24.9875 V | _____ | 25.0125 V |
| | Output 3 | 24.9875 V | _____ | 25.0125 V |
| Voltage Readback | | | | |
| Zero Voltage measured over interface | Output 1 | $V_0 - 0.002$ V | _____ | $V_0 + 0.002$ V |
| | Output 2 | $V_0 - 0.005$ V | _____ | $V_0 + 0.005$ V |
| | Output 3 | $V_0 - 0.005$ V | _____ | $V_0 + 0.005$ V |
| Maximum Voltage measured over interface | Output 1 | $V_{max} - 0.0044$ V | _____ | $V_{max} + 0.0044$ V |
| | Output 2 | $V_{max} - 0.015$ V | _____ | $V_{max} + 0.015$ V |
| | Output 3 | $V_{max} - 0.015$ V | _____ | $V_{max} + 0.015$ V |
| CV Load Regulation ($V_{load} - V_{noload}$) | Output 1 | -2.6 mV | _____ | 2.6 mV |
| | Output 2 | -4.5 mV | _____ | 4.5 mV |
| | Output 3 | -4.5 mV | _____ | 4.5 mV |
| CV Line Regulation ($V_{lowline} - V_{highline}$) | Output 1 | -1.6 mV | _____ | 1.6 mV |
| | Output 2 | -3.5 mV | _____ | 3.5 mV |
| | Output 3 | -3.5 mV | _____ | 3.5 mV |
| CV Ripple and Noise | | | | |
| peak-to-peak | Output 1 | - | _____ | 2 mV |
| | Output 2 | - | _____ | 2 mV |
| | Output 3 | - | _____ | 2 mV |
| rms | Output 1 | - | _____ | 350 μ V |
| | Output 2 | - | _____ | 350 μ V |
| | Output 3 | - | _____ | 350 μ V |
| Transient Response | Output 1 | - | _____ | 50 μ s |
| | Output 2 | - | _____ | 50 μ s |
| | Output 3 | - | _____ | 50 μ s |
| Constant Current Tests | | | | |

| E36312A | | Report Number _____ | Date _____ | |
|---|---------------------|---------------------------|--------------------|---------------------------|
| Description | Outputs | Lower limit | Result | Upper limit |
| Current Programming | | | | |
| Zero Current Output (I_0) | Output 1 | -0.003 A | _____ | 0.003 A |
| | Output 2 | -0.002 A | _____ | 0.002 A |
| | Output 3 | -0.002 A | _____ | 0.002 A |
| Maximum Current Output (I_{max}) | Output 1 | 4.995 A | _____ | 5.005 A |
| | Output 2 | 0.9976 A | _____ | 1.0024 A |
| | Output 3 | 0.9976 A | _____ | 1.0024 A |
| Current Readback | | | | |
| Zero Current measured over interface | Output 1 | $I_0 - 0.003 A$ | _____ | $I_0 + 0.003 A$ |
| | Output 2 | $I_0 - 0.003 A$ | _____ | $I_0 + 0.003 A$ |
| | Output 3 | $I_0 - 0.003 A$ | _____ | $I_0 + 0.003 A$ |
| Maximum Current measured over interface | Output 1 | $I_{max} - 0.005 A$ | _____ | $I_{max} + 0.005 A$ |
| | Output 2 | $I_{max} - 0.0034 A$ | _____ | $I_{max} + 0.0034 A$ |
| | Output 3 | $I_{max} - 0.0034 A$ | _____ | $I_{max} + 0.0034 A$ |
| CC Load Regulation ($I_{load} - I_{short}$) | Output 1 | -750 μA | _____ | 750 μA |
| | Output 2 | -350 μA | _____ | 350 μA |
| | Output 3 | -350 μA | _____ | 350 μA |
| CC Line Regulation ($I_{lowline} - I_{highline}$) | Output 1 | -750 μA | _____ | 750 μA |
| | Output 2 | -350 μA | _____ | 350 μA |
| | Output 3 | -350 μA | _____ | 350 μA |
| Low Range Current Measurement | | | | |
| Maximum Low Range Current measured over interface | Output 1 | $I_{low max} - 130 \mu A$ | _____ | $I_{low max} + 130 \mu A$ |
| | Output 2 | $I_{low max} - 105 \mu A$ | _____ | $I_{low max} + 105 \mu A$ |
| | Output 3 | $I_{low max} - 105 \mu A$ | _____ | $I_{low max} + 105 \mu A$ |
| Test Description | Instrument settings | | | |
| | Output 1 | Output 2 | Output 3 | |
| Voltage Programming & Readback, Zero Voltage (V_0) | 0 V, 5 A | 0 V, 1 A | 0 V, 1 A | |
| Voltage Programming & Readback, Maximum Voltage (V_{max}) | 6 V, 5 A | 25 V, 1 A | 25 V, 1 A | |
| CV Load Regulation, Line Regulation, Ripple and Noise | 6 V, 5 A | 25 V, 1 A | 25 V, 1 A | |
| Transient Response | 6 V, 2.5 A to 5 A | 25 V, 0.5 A to 1 A | 25 V, 0.5 A to 1 A | |
| Current Programming & Readback, Zero Current (I_0) | 0 A, 6 V | 0 A, 25 V | 0 A, 25 V | |
| Current Programming & Readback, Maximum Current (I_{max}) | 5 A, 6 V | 1 A, 25 V | 1 A, 25 V | |
| CC Load Regulation, Line Regulation, Ripple and Noise | 5 A, 6 V | 1 A, 25 V | 1 A, 25 V | |
| Low Range Current Readback, Maximum Low Range Current ($I_{low max}$) | 0.02 A, 6 V | 0.01 A, 25 V | 0.01 A, 25 V | |

Test record form - Keysight E36313A

| E36313A | Report Number _____ | Date _____ | | |
|---|---------------------|----------------------|--------|----------------------|
| Description | Outputs | Lower limit | Result | Upper limit |
| Constant Voltage Tests | | | | |
| Voltage Programming | | | | |
| Zero Voltage Output (V_0) | Output 1 | -0.003 V | _____ | 0.003 V |
| | Output 2 | -0.005 V | _____ | 0.005 V |
| | Output 3 | -0.005 V | _____ | 0.005 V |
| Maximum Voltage Output (V_{max}) | Output 1 | 5.9952 V | _____ | 6.0048 V |
| | Output 2 | 24.9875 V | _____ | 25.0125 V |
| | Output 3 | 24.9875 V | _____ | 25.0125 V |
| Voltage Readback | | | | |
| Zero Voltage measured over interface | Output 1 | $V_0 - 0.003 V$ | _____ | $V_0 + 0.003 V$ |
| | Output 2 | $V_0 - 0.005 V$ | _____ | $V_0 + 0.005 V$ |
| | Output 3 | $V_0 - 0.005 V$ | _____ | $V_0 + 0.005 V$ |
| Maximum Voltage measured over interface | Output 1 | $V_{max} - 0.0054 V$ | _____ | $V_{max} + 0.0054 V$ |
| | Output 2 | $V_{max} - 0.0125 V$ | _____ | $V_{max} + 0.0125 V$ |
| | Output 3 | $V_{max} - 0.0125 V$ | _____ | $V_{max} + 0.0125 V$ |
| CV Load Regulation ($V_{load} - V_{noload}$) | Output 1 | -4.6 mV | _____ | 4.6 mV |
| | Output 2 | -6.5 mV | _____ | 6.5 mV |
| | Output 3 | -6.5 mV | _____ | 6.5 mV |
| CV Line Regulation ($V_{lowline} - V_{highline}$) | Output 1 | -1.6 mV | _____ | 1.6 mV |
| | Output 2 | -3.5 mV | _____ | 3.5 mV |
| | Output 3 | -3.5 mV | _____ | 3.5 mV |
| CV Ripple and Noise | | | | |
| peak-to-peak | Output 1 | - | _____ | 2 mV |
| | Output 2 | - | _____ | 5 mV |
| | Output 3 | - | _____ | 5 mV |
| rms | Output 1 | - | _____ | 350 μ V |
| | Output 2 | - | _____ | 1 mV |
| | Output 3 | - | _____ | 1 mV |
| Transient Response | Output 1 | - | _____ | 50 μ s |
| | Output 2 | - | _____ | 50 μ s |
| | Output 3 | - | _____ | 50 μ s |
| Constant Current Tests | | | | |

| E36313A | | Report Number _____ | Date _____ | |
|--|---------------------|------------------------------|------------------|------------------------------|
| Description | Outputs | Lower limit | Result | Upper limit |
| Current Programming | | | | |
| Zero Current Output (I_0) | Output 1 | -0.004 A | _____ | 0.004 A |
| | Output 2 | -0.003 A | _____ | 0.003 A |
| | Output 3 | -0.003 A | _____ | 0.003 A |
| Maximum Current Output (I_{max}) | Output 1 | 9.991 A | _____ | 10.009 A |
| | Output 2 | 1.9962 A | _____ | 2.0038 A |
| | Output 3 | 1.9962 A | _____ | 2.0038 A |
| Current Readback | | | | |
| Zero Current measured over interface | Output 1 | $I_0 - 0.005$ A | _____ | $I_0 + 0.005$ A |
| | Output 2 | $I_0 - 0.003$ A | _____ | $I_0 + 0.003$ A |
| | Output 3 | $I_0 - 0.003$ A | _____ | $I_0 + 0.003$ A |
| Maximum Current measured over interface | Output 1 | $I_{max} - 0.01$ A | _____ | $I_{max} + 0.01$ A |
| | Output 2 | $I_{max} - 0.0038$ A | _____ | $I_{max} + 0.0038$ A |
| | Output 3 | $I_{max} - 0.0038$ A | _____ | $I_{max} + 0.0038$ A |
| CC Load Regulation ($I_{load} - I_{short}$) | Output 1 | -1500 μ A | _____ | 1500 μ A |
| | Output 2 | -700 μ A | _____ | 700 μ A |
| | Output 3 | -700 μ A | _____ | 700 μ A |
| CC Line Regulation ($I_{lowline} - I_{highline}$) | Output 1 | -1500 μ A | _____ | 1500 μ A |
| | Output 2 | -700 μ A | _____ | 700 μ A |
| | Output 3 | -700 μ A | _____ | 700 μ A |
| Low Range Current Measurement | | | | |
| Maximum Low Range Current measured over interface | Output 1 | $I_{low\ max} - 130$ μ A | _____ | $I_{low\ max} + 130$ μ A |
| | Output 2 | $I_{low\ max} - 105$ μ A | _____ | $I_{low\ max} + 105$ μ A |
| | Output 3 | $I_{low\ max} - 105$ μ A | _____ | $I_{low\ max} + 105$ μ A |
| Test Description | Instrument settings | | | |
| | Output 1 | Output 2 | Output 3 | |
| Voltage Programming & Readback, Zero Voltage (V_0) | 0 V, 10 A | 0 V, 2 A | 0 V, 2 A | |
| Voltage Programming & Readback, Maximum Voltage (V_{max}) | 6 V, 10 A | 25 V, 2 A | 25 V, 2 A | |
| CV Load Regulation, Line Regulation, Ripple and Noise | 6 V, 10 A | 25 V, 2 A | 25 V, 2 A | |
| Transient Response | 6 V, 5 A to 10 A | 25 V, 1 A to 2 A | 25 V, 1 A to 2 A | |
| Current Programming & Readback, Zero Current (I_0) | 0 A, 6 V | 0 A, 25 V | 0 A, 25 V | |
| Current Programming & Readback, Maximum Current (I_{max}) | 10 A, 6 V | 2 A, 25 V | 2 A, 25 V | |
| CC Load Regulation, Line Regulation, Ripple and Noise | 10 A, 6 V | 2 A, 25 V | 2 A, 25 V | |
| Low Range Current Readback, Maximum Low Range Current ($I_{low\ max}$) | 0.02 A, 6 V | 0.01 A, 25 V | 0.01 A, 25 V | |

Calibration Adjustment Procedures

This chapter includes calibration adjustment procedures for Keysight E36300 series power supply. Instructions are applicable for performing the procedures from either the front panel or a controller over the LAN, USB, or GPIB.

NOTE

Perform the verification tests before calibrating your instrument. If the instrument passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.

Closed-case electronic calibration

The instrument uses closed-case electronic calibration; no internal mechanical adjustments are required. The instrument calculates correction factors based on reference signals that you apply and stores the correction factors in non-volatile memory. This data is not changed by cycling power, *RST, or SYSTem:PRESet.

Calibration interval

The recommended calibration interval for Keysight E36300 series power supply is one year.

Calibration adjustment process

The following general procedure is recommended to complete a full calibration adjustment.

1. Adhere to the test considerations. See [Performance Verification > Test considerations](#) for details.
2. Perform the performance verification tests to characterize the instrument. See [Performance Verification](#) for details.
3. Unsecure the instrument for calibration. See [Calibration security](#) for details.
4. Perform the calibration procedures. See [Calibration procedure](#) for details.
5. Secure the instrument against the calibration. See [Calibration security](#) for details.
6. Take note of the security code and calibration count in the instrument's maintenance records.
7. Perform the performance verification tests to verify the calibration.

Calibration security

The instrument has a calibration passcode to prevent accidental or unauthorized calibration. When you receive your power supply, it is secured by a default passcode. The default passcode is 0. The security code cannot be changed by a power cycle or *RST.

You can enter a passcode of up to 9 digits.

You can change the passcode from both front panel and remote interface.

From the front panel:

1. Press **Utilities > Test / Setup > Calibration > Change Passcode**
2. Enter your desired passcode and press **Done**.

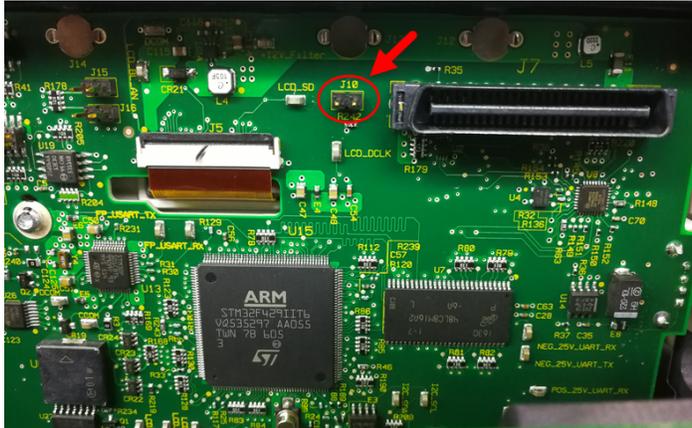
From the remote interface:

To change a new passcode to 12345:

```
CAL:SEC:CODE 12345
```

NOTE

To change a forgotten passcode to a new passcode, you can turn on the instrument after shorting CAL SECURE jumper J10 on the front panel board as shown below and send CAL:SEC:CODE <code> to change the passcode.



Calibration count

The instrument counts the number of times it has saved calibration data. Your instrument was calibrated at the factory; when you receive your instrument, read and record the initial count. You can only read the calibration count by sending the CAL:COUNT? query, and the calibration count is not change by a power cycle or *RST.

If Auto Save is enabled, the count increments when you exit the calibration state. To avoid double counting, do not manually save the count with Auto Save enabled.

Calibration message

You can use the CALibration:STRing command to store a message of up to 40 characters in calibration memory. For example, you could store the last calibration date, the calibration due date, or contact information for the person responsible for calibration. The calibration message is not affected by a power cycle or *RST.

You can only store the calibration message when the instrument is unsecured, but you can execute the CALibration:STRing? query regardless of whether the instrument is secured. A new calibration message overwrites the previous message, and messages over 40 characters are truncated.

Saving calibration data

You must always save new calibration data before cycling instrument power or leaving the calibration state with the Auto Save feature off. To save calibration data, send CAL:SAVE or save the calibration data from the front panel.

Calibration auto save

The instrument includes a calibration Auto Save feature. This feature automatically saves the calibration data to non-volatile memory and increments the calibration count when you exit the calibration state.

To enable or disable the CAL auto Save feature, send CAL:ASAV ON or CAL:ASAV OFF. To query the CAL auto Save state, send CAL:ASAV?

Calibration procedure

Enter the calibration state

To begin the calibration procedure, you must enter the calibration state.

| Step | Front Panel | SCPI |
|------|--|------------------------|
| 1 | Press Utilities > Test / Setup > Calibration . Enter the default passcode (default passcode is 0). Press Login to enter the calibration page. | CAL:SEC:STAT 0, <code> |
| 2 | To change a forgotten passcode to a new passcode, you can turn on the instrument after shorting CAL SECURE jumper J10 on the front panel board and send scpi command to change the passcode. | CAL:SEC:CODE <code> |

Calibrate voltage

Let the unit sit with output ON for one minute, then connect the DMM voltage input to the power supply.

| Step | Front Panel | SCPI |
|------|---|--|
| 1 | Press Perform Calibration and select the output for calibration. Press Cal Volt . | CAL:VOLT:LEV MIN, (@<channel>) |
| 2 | Measure the output voltage (low point) with the DMM. | |
| 3 | Enter the measured value, and press Next . | CAL:VOLT <reading>, (@<channel>) CAL:VOLT:LEV MAX, (@<channel>) |
| 4 | Measure the output voltage (high point) with the DMM. | |
| 5 | Enter the measured value, and press Next . | CAL:VOLT <reading>, (@<channel>) |
| 6 | Read DONE or FAIL on the display. | (wait 30 seconds) SYST:ERR? |
| 7 | Press Cal Save . | CAL:SAVE |

Calibrate current

Let the unit sit with output ON for one minute, then connect a current monitoring resistor across the output terminals to be calibrated and then connect a DMM across the terminals of the monitoring resistor.

| Step | Front Panel | SCPI |
|------|--|--|
| 1 | Press Perform Calibration and select the output for calibration. Press Cal Curr. | CAL:CURR:LEV MIN, (@<channel>) |
| 2 | Measure the output current (low point) with the DMM. | |
| 3 | Enter the measured value, and press Next . | CAL:CURR <reading>, (@<channel>) CAL:CURR:LEV MAX, (@<channel>) |
| 4 | Measure the output current (high point) with the DMM. | |
| 5 | Enter the measured value, and press Next . | CAL:CURR <reading>, (@<channel>) |
| 6 | Read DONE or FAIL on the display. | (wait 30 seconds) SYST:ERR? |
| 7 | Press Cal Save . | CAL:SAVE |

Calibrate low range current (For E36312A and E36313A only)

Allow the unit to sit with output ON for one minute before continuing.

| Step | Front Panel | SCPI |
|------|--|--------------------------------------|
| 1 | Press Perform Calibration and select the output for calibration. Press Cal Low Curr. | CAL:CURR:LEV:LOW MIN, (@<channel>) |
| 2 | Wait approximately 50 seconds. Connect calibration resistor with the correct value as stated in the instruction shown on the display. Measure the output low range current (low point) with the DMM. | |
| 3 | Enter the measured value, and press Next . | CAL:CURR:LOW <reading>, (@<channel>) |
| 4 | Measure the output low range current (high point) with the DMM. | CAL:CURR:LEV:LOW MAX, (@<channel>) |
| 5 | Enter the measured value, and press Next . | CAL:CURR:LOW <reading>, (@<channel>) |
| 6 | Read DONE or FAIL on the display. | (wait 30 seconds) SYST:ERR? |
| 7 | Press Cal Save . | CAL:SAVE |

Save the calibration data

To save calibration data, go to the 'CAL Save' menu to save the calibration data or enable the 'Auto Save' feature. With Auto Save, calibration data will be saved when the user exits the calibration menu.

After completing the Voltage, Current and Low Range Current calibrations, save the calibration data before exiting the calibration state, or simply exit the calibration state if Auto Save is on.

To save the CAL data: CAL:SAVE

To enable the CAL Auto Save: CAL:ASAVE ON

To exit CAL State: CAL:STAT 1 <code>



This information is subject to change without notice.

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