Operating and
Service Guide

E36100B Series Programmable DC Power Supplies



KEYSIGHT TECHNOLOGIES

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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 https://regulations.about.keysight.com/DoC/default.htm. You can then search by product number to find the latest Declaration of Conformity.

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 bottom of the instrument to configure the power. See Options and Fuse Information for additional details.

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).

BE CAUTIOUS WHEN DEALING WITH OUTPUTS ABOVE 60 VDC

Always be cautious when dealing with output voltage above 60 VDC. Such voltage poses electrical shock hazard.

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.

WARNING OBSERVE ALL DEVICE MARKINGS BEFORE CONNECTING TO DEVICE

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

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.

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.

Safety Symbols

Symbol	Meaning
	Caution, risk of danger (refer to the manual for specific Warning or Caution information).
	Protective earth (ground) terminal.
	Frame or chassis (ground) terminal.
	In position of bi-stable push control.
	Out position of bi-stable push control.
	Alternating current (AC).
	Direct current (DC).
	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.

사 용 자 안 내 문
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)

– IEC61010-1:2010/EN61010-1:2010

– IEC61326-1:2012/EN61326-1:2013

Environmental Conditions

The E36100B 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
Installation category (AC input)	Category II

1 Getting Started

Introduction

Options and Fuse Information

Programming Ranges

Extending the Voltage Range and Current Range

Front-panel Operation

Remote Control

Rack Mounting the Instrument

This chapter describes the general operating information for the E36100B Series programmable DC power supplies.

Introduction

The Keysight E36100B Series is a series of DC bench and system power supplies with the following features and characteristics:

- Single output up to 100 V or 5 A
- Small size: two rack-units (2U), 1/4-rack form factor
- Remote sense capability
- Intuitive front panel
- High visibility organic light emitting diode (OLED) display
- High performance functionality: accuracy, transient response, and rise/fall time
- LAN (LXI Core) and USB interfaces for remote programming with SCPIS

Front panel



Item	Description
A	Tough carrying handle
B	Information-packed, high-contrast OLED display; easily viewable even from sharp angles
C	Rotary knob for quick and easy configuration
D	Fast voltage/current setting and front-panel electronic calibration
E	Menu key opens intuitive user interface
F	Front-panel lock prevents accidental changes during tests
G	Output enable/disable switch to protect your DUT quickly
H	Dual-position power switch
I	Sense terminals
J	Output terminals
K	Earth ground reference point

Rear panel



The rear panel includes the power input, standard LAN and USB ports, and a security slot. Always use the power cord that arrived with the instrument or one with equivalent ratings.

Display

The power supply's front panel features a high-visibility OLED display.

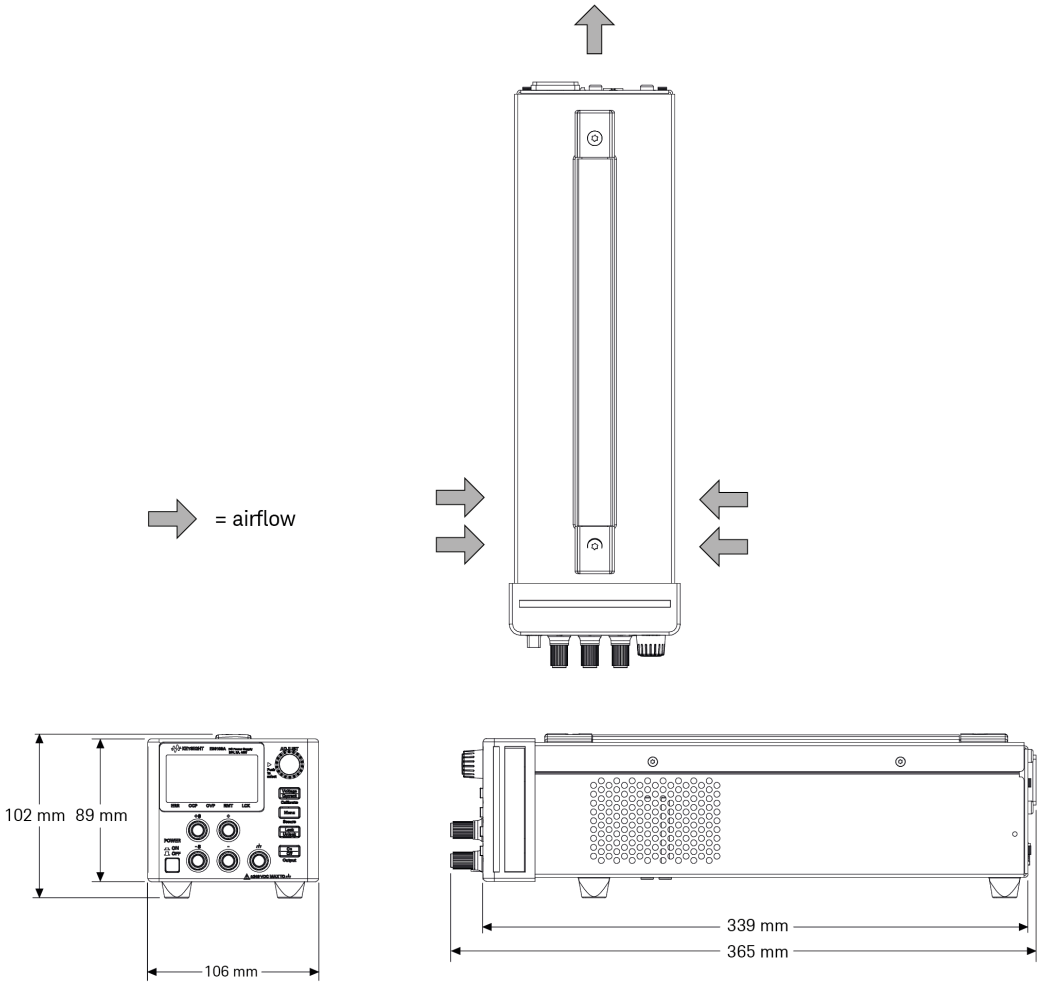


The upper left corner of the display shows either CV or CC to indicate that the instrument is in constant voltage or constant current mode. Below that is either 2W or 4W, to indicate whether 2-wire (normal) or 4-wire (remote sensing) measurement is in use. The right side of the display shows the output voltage and current (when the output is enabled), and the voltage and current settings are shown near the bottom of the screen.

The very bottom of the screen can show arrows, each of which represents a different annunciator.

Label	Meaning
ERR	An error has occurred.
OCP	An overcurrent protection event has occurred.
OVP	An overvoltage protection event has occurred.
RMT	The instrument is being programmed remotely.
LCK	The front panel is locked.

Dimension diagram



Setup the instrument

Place the instrument's feet on a flat, smooth horizontal surface. Connect output and sense leads to the front panel, being careful not to short the leads together. Attach the power cable to the rear panel, then plug it into main power. Connect LAN or USB cables as desired, and you may also secure the instrument with a security lock cable.

Before disconnecting cables and cords from the instrument, turn the instrument off using the front-panel power switch and disconnect from the supply source by unplugging the detachable power cord.

Options and Fuse Information

WARNING Ensure you order the proper instrument option for the mains power that will be used for the instrument.

Options 0EM, 0E3, and 0E9 determine which power-line voltage is selected at the factory. The default is configured for 230 VAC ± 10%, 47-63 Hz input voltage (option 0E3).

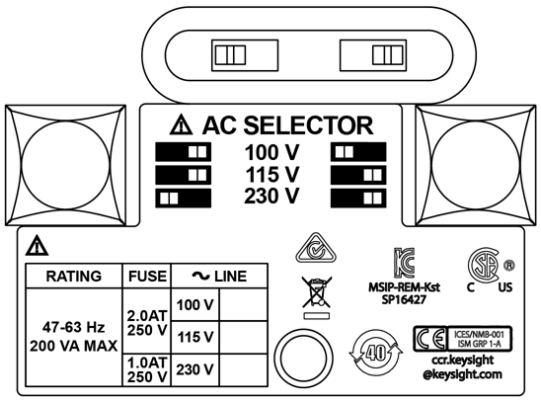
Option	Description
0EM	115 VAC ± 10%, 47-63 Hz input voltage
0E3	230 VAC ± 10%, 47-63 Hz input voltage
0E9	100 VAC ± 10%, 47-63 Hz input voltage

Input power for E36102B, E36103B, E36104B, E36105B, and E36106B is 200 VA maximum.

Ensure the correct AC input voltage and fuse settings

Use the proper switch settings

To change the input AC voltage selector on the power supply, use the two AC selector switches on the underside of the power supply as shown.



For example, to select 230 V, slide the left switch to the left and the right switch to the right, as illustrated in the diagram below the switches.

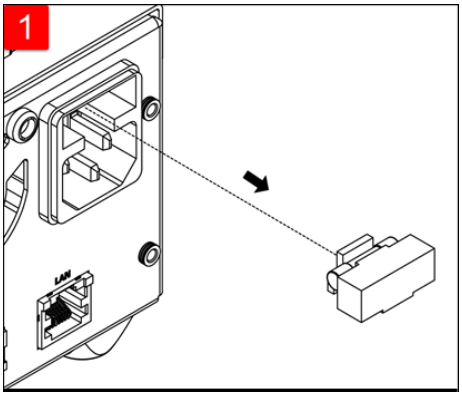
To select 115 V, slide both switches to the right, and to select 100 V, slide the two switches towards each other.

Use the correct fuse

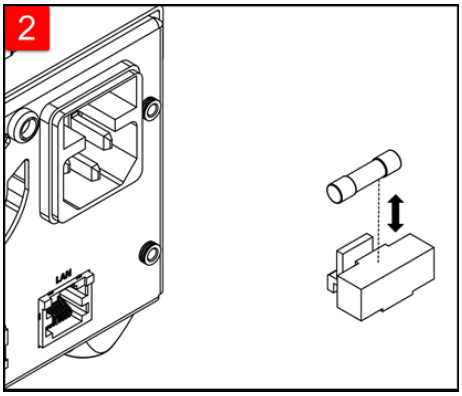
You must use a time delay 2-A fuse for 100- and 115-VAC inputs, and a time delay 1-A fuse for 230-VAC inputs:

Part Number	Description	Manufacturer	Application
2110-1639	Fuse 1 A, 250 V Time-delay	Littelfuse	230-V line voltage
2110-1640	Fuse 2 A, 250 V Time-delay		100- and 115-V line voltage

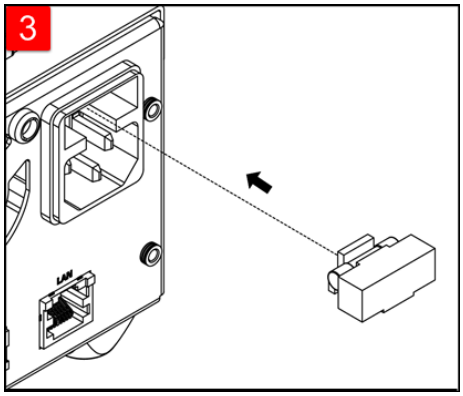
To configure the correct fuse, follow the three steps shown below:



Pull the fuse holder out of the power supply.



Remove and insert the proper fuse into the fuse holder.



Re-insert the fuse holder into the power supply.

Programming Ranges

The following table shows the maximum voltage, current, and power that can be programmed for each model. The DEFault voltage is always 0 V.

Model	Max voltage (V)	Max current (A)	Max power (W)
E36102B	6	5.0	30
E36103B	20	2.0	40
E36104B	35	1.0	35
E36105B	60	0.6	36
E36106B	100	0.4	40

Note that the actual programmable values are 3% above these nominal values, but instrument specifications are only guaranteed up to the values shown in this table.

Table of programming and readback resolutions

Model	Voltage programming	Voltage readback	Current programming	Current readback	Small current readback
E36102B	0.001 V	0.001 V	0.001 A	0.001 A	0.001 mA
E36103B	0.001 V	0.001 V	0.001 A	0.001 A	0.001 mA
E36104B	0.001 V	0.001 V	0.001 A	0.001 A	0.001 mA
E36105B	0.001 V	0.01 V	0.001 A	0.0001 A	0.001 mA
E36106B	0.001 V	0.01 V	0.001 A	0.0001 A	0.001 mA

Extending the Voltage Range and Current Range

The power supply may be able to provide voltages and currents greater than its rated maximum outputs if the power- line voltage is at or above its nominal value.

Operation can be extended up to 3% over the rated output without damage to the power supply, but performance cannot be guaranteed to meet specifications in this region. If the power- line voltage is maintained in the upper end of the input voltage range, the power supply will probably operate within its specifications. The power supply is more likely to stay within specifications if only one of the voltage or current outputs is exceeded.

Series connections

You can connect up to four E36100B Series power supplies up to the output isolation rating of any one supply to obtain a higher voltage than a single power supply can produce. Series-connected power supplies can be operated with one load across both power supplies or with a separate load for each power supply. The power supply has a reverse polarity diode connected across the output terminals so that if operated in series with other power supplies, damage will not occur if the load is short-circuited or if one power supply is turned on separately from its series partners.

When the series connection is used, the output voltage is the sum of the voltages of the individual power supplies. The current is the current of any one power supply. Each of the individual power supplies must be adjusted in order to obtain the total output voltage.

Parallel connections

You can connect up to four E36100B Series power supplies in parallel to obtain a total output current greater than a single power supply can produce. The total output current is the sum of the output currents of the individual power supplies. The output of each power supply can be set separately. The output voltage controls of one power supply should be set to the desired output voltage; the other power supply should be set for a slightly higher output voltage. The supply with the higher output voltage setting will deliver its constant current output, and drop its output voltage until it equals the output of the other supply, and the other supply will remain in the constant voltage operation and only deliver that fraction of its rated output current which is necessary to fulfill the total load demand.

Front Panel Operation

This section describes how to perform the following operations from the instrument's front panel.

- Configure the LAN interface
- Set voltage and current
- Specify 2- or 4-wire measurement
- Configure Overcurrent Protection (OCP) and Overvoltage Protection (OVP)
- Clear an OCP or OVP event
- Clear an overtemperature protection (OTP) event
- Lock and unlock the front panel
- Save or recall the instrument's state
- Configure the Power-on State
- Read error codes

Configure the LAN interface

You should generally be able to connect to the LAN by simply connecting the LAN cable and turning the instrument on. However, you can use the procedure below if you want to specify connections other than the default values or if you need to see what a given value is. This section provides procedures for viewing and changing LAN settings.

1. Press [Menu].
2. Turn the knob to I/O Config and press the knob.
3. Turn the knob to LAN and press the knob.
4. Turn the knob to the desired IP Address to a value of the form xxx.xxx.xxx.xxx, where each xxx represents a base 10 number from 0 to 255. Press [Voltage/Current] to move between numbers, then press the knob to finish.
5. The instrument will briefly display CHANGE SAVED to indicate success.
6. Turn the knob to the desired Subnet address using the same method with which you set the IP Address. Then press the knob to select.
7. The instrument will briefly display CHANGE SAVED to indicate success.
8. Turn the knob to the desired Gateway address. Then press the knob to select.
9. The instrument will briefly display CHANGE SAVED to indicate success.
10. Press [Menu] to exit the menu system.

Set voltage and current

NOTE If you are in a menu, you must exit the menu before setting the voltage and current.

1. Press [Voltage / Current].
2. Turn the knob to the desired voltage value, pushing the knob to move between digits.
3. Press [Voltage / Current].
4. Turn the knob to the desired current value, pushing the knob to move between digits.
5. Press [Voltage / Current].
6. If the display currently shows OFF, press [Output On / Off] to enable the output. Press this key again to turn the output off.

Constant voltage and constant current

If the output load resistance exceeds the voltage setting divided by the current setting, the instrument will operate in constant voltage mode. The current will equal the voltage divided by the load resistance.

If the output load resistance is less than the voltage setting divided by the current setting, the instrument will operate in constant current mode. The voltage will equal the current multiplied by the load resistance.

Specify 2- or 4-wire measurement

You have the option to use the remote sense terminals on the front panel to measure the voltage at the device under test (DUT). To specify whether you want to use this option:

1. Press [Menu].
2. Turn the knob to Sense Setting and press the knob.
3. Turn the knob to Internal or External and press the knob.

The internal setting sets a relay within the power supply to connect the output and sensing connector. This means that only two wires are used; and remote sensing is disabled. The external setting sets a relay within the power supply to disconnect the output and remote sensing inputs. This means that four wires are used; and remote sensing is enabled.

Configure Overcurrent Protection (OCP) and Overvoltage Protection (OVP)

1. Press [Menu].
2. Turn the knob to **OCP Set** or **OVP Set** and press the knob.
3. Press the knob again to choose OCP Delay or OVP Level.
4. Turn the knob to the desired OCP or OVP limit value. Then press the knob.
5. Turn the knob to **OCP On**, **OCP Off**, **OVP On**, or **OVP Off** and press the knob to enable or disable OCP or OVP.
6. Turn the knob to **Exit Menu** and press the knob.

NOTE **If OCP or OVP is enabled, the instrument will display a triangle above the OCP or OVP annunciator.**

Clear an OCP or OVP event

The instrument prominently displays an OCP TRIPPED or OVP TRIPPED message to indicate an overcurrent or overvoltage event. The triangle above OCP or OVP flashes continuously until the event is cleared.

NOTE **The output will be automatically turned OFF when OCP/OVP occurs.**

1. To begin, correct the condition that caused the OCP or OVP event. There are three ways to do this:
   a. Turn off OCP or OVP as described above.
   b. Set the current or voltage level to be less than the OCP or OVP level. You may be able to do this by adjusting the voltage setting, the current setting, or the resistance of the load.
   c. Set the OCP or OVP limit value to be above the current or voltage level.
2. Press [Menu].
3. Turn the knob to **OCP Set** or **OVP Set** and press the knob.
4. Turn the knob to the desired OCP or OVP limit value (if it needs to be changed). Then press the knob.
5. Turn the knob to **OCP Clear** or **OVP Clear** and press the knob.

Clear an overtemperature protection (OTP) event

The instrument prominently displays an OTP TRIPPED message to indicate an OTP event. In addition, the triangle above ERR will flash continuously until the error event is cleared.

NOTE **The output will be automatically turned OFF when OTP occurs.**

The overtemperature event will be logged in the Error list, and you must clear the OTP event before the output can be turned ON again.

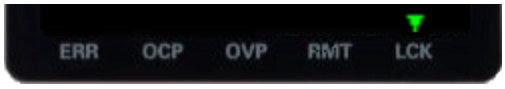
1. To begin, correct the condition that caused the OTP event and allow the instrument to cool.
2. Press [Menu].
3. Turn the knob to Error and press the knob. The instrument will briefly display a message like 3 ERRORS (the number will vary) to indicate how many errors are in the queue.
4. Turn the knob to cycle through the error codes, recording them as you go. Press the knob to view the error description. Press [Menu] to exit and clear the error list.

NOTE **An OTP event will occur again after it is cleared if the instrument remains overheated.**

Lock and unlock the front panel

NOTE **If you are in a menu, you must exit the menu before locking the front panel.**

1. Press [Lock / Unlock] to lock the front panel. This produces an LCK annunciator triangle, as shown below.



2. If you press a key after the front panel is locked, the display will read HOLD KEY. That message indicates that you must press and hold the [Lock / Unlock] key to unlock the front panel and clear the LCK triangle.

Save or recall the instrument's state

The instrument allows you to save and recall the instrument state in one of 10 memory locations, labeled 0 through 9. This allows you to quickly configure the instrument for commonly used applications.

An instrument state includes the instrument's output enable status, voltage and current settings, and OCP and OCV settings. It does not include error codes or LAN configuration information.

To save or recall the instrument state

1. Press [Menu].
2. Turn the knob to Store (or Recall) and press the knob.
3. Turn the knob to an option from Store 0 to Store 9 (or Recall 0 to Recall 9) and press the knob to store or recall the present state of the instrument in the specified memory location.
4. The instrument will briefly display DONE.

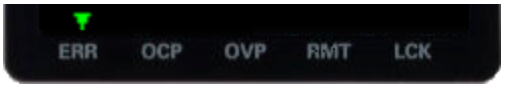
Configure the Power-on State

The instrument allows you to recall the power-on state as either the default (*RST) state or the state stored in one of 10 memory locations (0 through 9). To configure the power-on state:

1. Press [Menu].
2. Turn the knob to Power-on and press the knob.
3. Turn the knob to Default, or a state from Recall 0 to Recall 9 and press the knob to make your selection.
4. The instrument will briefly display CHANGED SAVED if the recall state is different from the previous state, and NO CHANGE if the same state was selected.

Read error codes

NOTE **You only need to do this if there is a triangle over ERR in the lower left corner of the screen, as shown below. Be sure to follow the procedure below carefully, and record each error code in order. Once you exit this menu, there is no way to retrieve the error codes again.**



1. Press [Menu].
2. Turn the knob to Error and press the knob. The instrument will briefly display a message like 3 ERRORS (the number will vary) to indicate how many errors are in the queue.
3. Turn the knob to cycle through the error codes, recording them as you go.

Remote Control

You can control the instrument remotely in two ways. To program the instrument via SCPI, use Keysight IO Libraries. To control the instrument via a simulated front panel, use the instrument's Web interface.

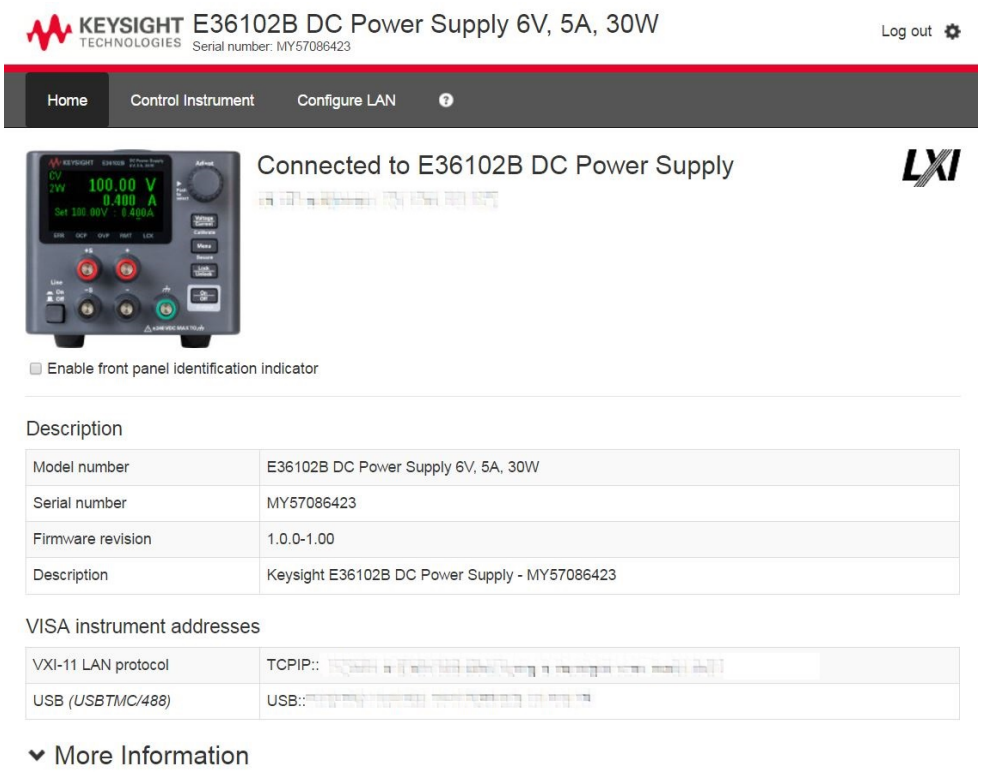
Keysight IO Libraries Suite

Keysight IO Libraries Suite is a collection free instrument control software that automatically discovers instruments and allows you to control instruments over the LAN, USB, GPIB, RS-232, and other interfaces. For more information, or to download IO Libraries, go to www.keysight.com/find/iosuite.

E36100B Series Web interface

You can monitor control the instrument from a Web browser by using the instrument's Web interface. To connect, simply enter the instrument's IP address or hostname in your browser's address bar and hit Enter.

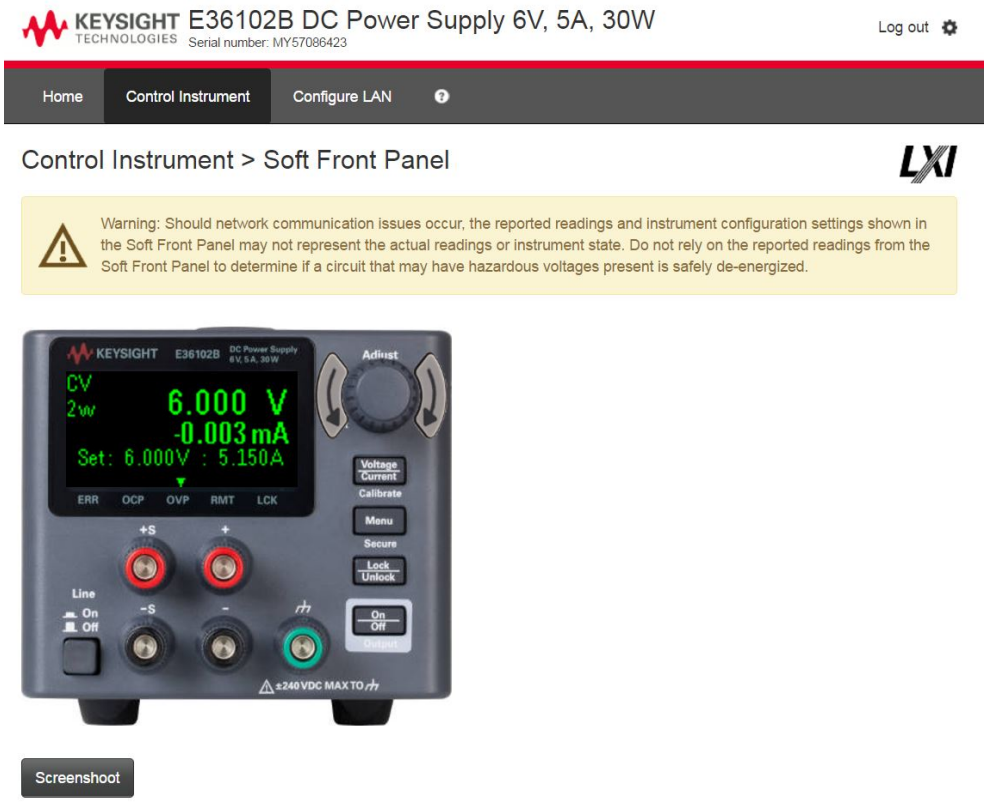
NOTE **If you see an error indicating 400: Bad Request, that is related to an issue with "cookies" in your Web browser. To avoid this issue, either start the Web interface by using the IP address (not host name) in the address bar), or clear cookies from your browser immediately before starting the Web interface.**



Check the checkbox below the picture of the instrument to enable an indicator on the instrument's front panel. This is helpful if you have several E36100B Series instruments and you wish to identify the one to which you are connected.

The Configure LAN tab on the top allows you to change the instrument's LAN parameters; exercise caution when doing so, as you may interrupt your ability to communicate with the instrument.

When you click the Control Instrument tab, the instrument will ask you for a password (default is ***keysight***, all lower case), and then it will open a new page, shown below.



This interface allows you to use the instrument just as you would from the front panel. Note the curved arrow keys that allow you to "turn" the knob. You can click the knob to "push" it, just as you would push any of the other keys on the front panel.

WARNING Read warning

Be sure to read and understand the warning at the top of the Control Instrument page.

Technical connection details

In most cases, you can easily connect to the instrument with the IO Libraries Suite or Web interface. In certain circumstances, it may be helpful to know the following information.

Interface	Details
VXI-11 LAN	VISA String: TCPIP0::<IP Address>::inst0::INSTR Example: TCPIP0::192.168.10.2::inst0::INSTR
Web UI	Port number 80, URL http://<IP address>/
	USB0::0x2A8D::<Prod ID>::<Serial Number>::0::INSTR Example: USB0::0x2A8D::0x0902::MY55160003::0::INSTR The vendor ID: 0x2A8D, the product ID is 0x0902, and the instrument serial number is MY55160003. The product ID varies by model: 0x0602 (E36102B), 0x0702 (E36103B), 0x0802 (E36104B), 0x0902 (E36105B), 0x0A02 (E36106B).

Using sockets

NOTE Power supplies allow data socket to be made.

Keysight instruments have standardized on using port 5025 for SCPI socket services. A data socket on this port can be used to send and receive ASCII/SCPI commands, queries, and query responses. All commands must be terminated with a newline for the message to be parsed. All query responses will also be terminated with a newline.

Rack Mounting the Instrument

NOTE Use the Rack Mount kit as stated below to rack mount the instrument. Installation instructions are provided with the rack mount kit.

Be sure to use the support rails in the rack cabinet.

CAUTION To prevent overheating, do not block airflow to or from the instrument. Allow enough clearance at the rear, sides, and bottom of the instrument to permit adequate internal air flow.

The power supply can be mounted in a standard 19-inch rack cabinet. They are designed to fit in two rack-units (2U) of space.

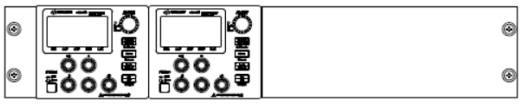
Remove the feet before rack mounting the unit. Do not block the air intake and exhaust at the sides and rear of the unit.

Rack mounting a single instrument

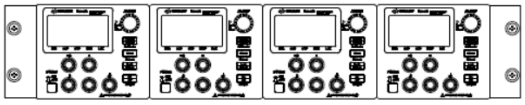
To rack mount a single instrument, order E36102-66502.



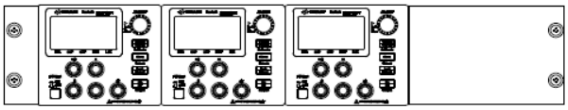
Rack mounting multiple instruments side-by-side



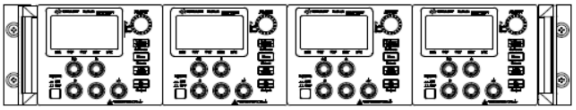
Rack mount kit with flange for 2 units (E36102-66503)



Rack mount kit with flange for 4 units (E36102-66505)



Rack mount kit with flange for 3 units (E36102-66504)



Rack mount kit with flange and handles for 4 units (E36102-66506)

2 SCPI Programming

Introduction to the SCPI Language

Error Messages

SCPI Status Registers

APPLy Subsystem

CALibration Subsystem

CURRent Subsystem

DISPlay Subsystem

IEEE-488 Subsystem

MEASure Subsystem

OUTPut Subsystem

STATus Subsystem

SYSTem Subsystem

Triggering Commands

VOLTage Subsystem

This chapter describes the programming information for the E36100B Series programmable DC power supplies.

Introduction to the SCPI Language

Standard Commands for Programmable Instruments (SCPI) is an ASCII- based instrument command language designed for test and measurement instruments. Refer to Simplified Programming Overview for basic techniques for programming the power supply over the remote interface.

SCPI commands are based on a hierarchical structure, also known as a tree system. In this system, associated commands are grouped together under a common node or root, thus forming subsystems. A portion of the SOURce subsystem is shown below to illustrate the tree system.

```
[SOURce:]
        CURRent {<current>|MIN|MAX|UP|DOWN} CURRent? [MIN|MAX]
        CURRent:
                        TRIGgered {<current>|MIN|MAX} TRIGgered? {MIN|MAX}
        VOLTage {<voltage>|MIN|MAX|UP|DOWN} VOLTage? [MIN|MAX]
        VOLTage:
                        TRIGgered {<voltage>|MIN|MAX} TRIGgered? {MIN|MAX}
```

SOURce is the root keyword of the command, CURRent and VOLTage are second-level keywords, and TRIGgered is the third- level keyword. A colon (:) separates a command keyword from a lower- level keyword.

Command format used in this manual

The format used to show commands in this manual is shown below:

CURRent {<current>|MINimum|MAXimum|UP|DOWN}

The command syntax shows most commands (and some parameters) as a mixture of upper- case and lower- case letters. The upper- case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, send the long form.

For example, in the above syntax statement, CURR and CURRENT are both acceptable forms. You can use upper- case or lower- case letters. Therefore, CURRENT, curr, and Curr are all acceptable. Other forms, such as CUR and CURREN, will generate an error.

Braces ({}) enclose the parameter choices for a given command string. The braces are not sent with the command string.

A vertical bar (|) separates multiple parameter choices for a given command string.

Triangle brackets (< >) indicate that you must specify a value for the enclosed parameter. For example, the above syntax statement shows the current parameter enclosed in triangle brackets. The brackets are not sent with the command string. You must specify a value for the parameter (such as CURR 0.1).

Some parameters are enclosed in square brackets ([]). The brackets indicate that the parameter is optional and can be omitted. The brackets are not sent with the command string. If you do not specify a value for an optional parameter, the power supply chooses a default value.

A colon (:) separates a command keyword from a lower-level keyword. You must insert a blank space to separate a parameter from a command keyword. If a command requires more than one parameter, you must separate adjacent parameters using a comma as shown below:

SOURce:CURRent:TRIGgered

APPLy 3.5,1.5

Command separators

A colon (:) separates a command keyword from a lower- level keyword as shown below:

SOURce:CURRent:TRIGgered

A semicolon (;) is used to separate two commands within the same subsystem, and can also minimize typing. For example, sending the following command string,

SOUR:VOLT MIN;CURR MAX

is the same as sending the following two commands:

SOUR:VOLT MIN

SOUR:CURR MAX

Use a colon and a semicolon to link commands from different subsystems. For example, in the following command string, an error is generated if you do not use the colon and semicolon:

DISP:TEXT:CLE;:SOUR:CURR MIN

Using the MIN and MAX parameters

You can substitute MINimum or MAXimum in place of a parameter for many commands. For example, consider the following command:

CURRent {<current>|MIN|MAX}

Instead of selecting a specific current, you can substitute MINimum to set the current to its minimum value or MAXimum to set the current to its maximum value.

Querying parameter settings

You can query the value of most parameters by adding a question mark (?) to the command. For example, the following command sets the output current to 5 A:

CURR 5

You can query the value by executing:

CURR?

You can also query the maximum or minimum value allowed with the present function as follows:

CURR? MAX CURR? MIN

CAUTION **If you send two query commands without reading the response from the first, and then attempt to read the second response, you may receive some data from the first response followed by the complete second response. To avoid this, do not send a query command without reading the response. When you cannot avoid this situation, send a device clear before sending the second query command.**

SCPI command terminators

A command string sent to the power supply must terminate with a <new line> character. The IEEE- 488 EOI (end-or-identify) message is interpreted as a <new line> character and can be used to terminate a command string in place of a <new line> character. A <carriage return> followed by a <new line> is also accepted. Command string termination will always reset the current SCPI command path to the root level. The <new line> character has the ASCII decimal code of 10.

IEEE-488.2 common commands

The IEEE- 488.2 standard defines a set of common commands that perform functions like reset, self- test, and status operations. Common commands always begin with an asterisk (*), are four to five characters in length, and may include one or more parameters. The command keyword is separated from the first parameter by a blank space. Use a semicolon (;) to separate multiple commands as shown below:

*RST; *CLS; *ESE 32; *OPC?

SCPI parameter types

The SCPI language defines several different data formats to be used in program messages and response messages.

Numeric parameters

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation. Special values for numeric parameters like MINimum, MAXimum, and DEFault are also accepted.

You can also send engineering unit suffixes (V, A, or SEC) with numeric parameters. If only specific numeric values are accepted, the power supply will automatically round the input numeric parameters. The following command uses a numeric parameter:

CURR {<current>|MIN|MAX|UP|DOWN}

Discrete parameters

Discrete parameters are used to program settings that have a limited number of values such as BUS and IMM. Query responses will always return the short form in all upper- case letters. The following command uses discrete parameters:

TRIG:SOUR {BUS|IMM}

Boolean parameters

Boolean parameters represent a single binary condition that is either true or false. For a false condition, the power supply will accept OFF or 0. For a true condition, the power supply will accept ON or 1. When you query a boolean setting, the power supply will always return 0 or 1. The following command uses a boolean parameter:

DISP {OFF|ON}

String parameters

String parameters can contain virtually any set of ASCII characters. A string must begin and end with matching quotes; either with a single quote or with a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between. The following command uses a string parameter:

DISP:TEXT <quoted string>

Error Messages

The instrument returns error messages in accordance with the SCPI standard.

- Up to 20 errors can be stored in the instrument's error queue, and the triangle annunciator above ERR turns on when one or more errors are in the error queue.
- Error retrieval is first-in-first-out (FIFO), and errors are cleared as you read them. When you have read all errors from the error queue, the ERR annunciator turns off.
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350,"Queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0,"No error".
- Send SYSTem:ERRor? to read the most recent error. Each error is in the format: -104,"Data type error".
- To read the error queue from the front panel, press [Menu], then turn the knob to Error and press the knob to select it. Then rotate the knob to view the error codes. Be sure to record the error messages, because they will be cleared when you exit the error list.
- The error queue is cleared by power cycles and *CLS., but not *RST.

Error codes

The instrument's error codes are listed below:

-440,"Query UNTERMINATED after indefinite response"

-430,"Query DEADLOCKED"

-420,"Query UNTERMINATED"

-410,"Query INTERRUPTED"

-400,"Query error"

-363,"Input buffer overrun"

-350,"Queue overflow"

-330,"Self-test failed"

-310,"System error"

-277,"Macro redefinition not allowed"

-276,"Macro recursion error"

-273,"Illegal macro label"

-272,"Macro execution error"

-270,"Macro error"

-241,"Hardware missing"

-230,"Data corrupt or stale"

-225,"Out of memory"

-224,"Illegal parameter value"

-223,"Too much data"

-222,"Data out of range"

-221,"Settings conflict"

-213,"Init ignored"

-211,"Trigger ignored"

-200,"Execution error"

-183,"Invalid inside macro definition"

-181,"Invalid outside macro definition"

-178,"Expression data not allowed"

-171,"Invalid expression"

-170,"Expression error"

-168,"Block data not allowed"

-161,"Invalid block data"

-158,"String data not allowed"

-151,"Invalid string data"

-150,"String data error"

-148,"Character data not allowed"

-141,"Invalid character data"

-138,"Suffix not allowed"

-134,"Suffix too long"

-131,"Invalid suffix"

-128,"Numeric data not allowed"

-124,"Too many digits"

-123,"Exponent too large"

-121,"Invalid character in number"

-114,"Header suffix out of range"

-113,"Undefined header"

-112,"Program mnemonic too long"

-109,"Missing parameter"

-108,"Parameter not allowed"

-105,"GET not allowed"

-104,"Data type error"

-103,"Invalid separator"

-102,"Syntax error"

-101,"Invalid character"

-100,"Command error"

514,"LAN config error"

561,"Analog board - failed to save to EEPROM"

564,"Analog board - failed to load from EEPROM"

565,"Analog board - over temperature"

566,"Analog board - command timed out"

601,"Front panel does not respond"

609,"System ADC test failed"

610,"I/O board not plugged in"

611,"Unsupported I/O board"

612,"Analog board does not respond"

613,"Analog bias output ±15V test failed"

614,"EEPROM test failed"

615,"EEPROM save failed"

616,"Model no mismatched"

630,"Fan test failed"

631,"System DAC test failed"

701,"Cal security disabled by jumper"

702,"Invalid state. Cal secured"

703,"Invalid secure code"

704,"Secure code too long"

708,"Cal output disabled"

717,"Cal OVP or OCP status enabled"

721,"Failed to calibrate voltage DAC"

722,"Failed to calibrate voltage ADC"

723,"Failed to calibrate OVP"

724,"Failed to calibrate current DAC"

725,"Failed to calibrate current ADC"

726,"Failed to calibrate OCP"

727,"Invalid Calibration sequence"

728,"Calibration failed"

SCPI Status Registers

All SCPI instruments implement status registers in the same way. The status system records various instrument conditions in three register groups: the Status Byte register, the Standard Event register, and the Questionable Status register groups. The Status Byte register records high-level summary information reported in the other register groups.

What is an event register?

An event register is a read-only register that reports defined conditions within the instrument. Bits in an event register are latched. Once an event bit is set, subsequent state changes are ignored. Bits in an event register are automatically cleared by a query of that register (such as *ESR? or STAT:QUES:EVEN?) or by sending the *CLS (clear status) command. A reset (*RST) or device clear will not clear bits in event registers. Querying an event register returns a decimal value corresponding to the binary-weighted sum of all bits set in the register.

What is an enable register?

An enable register defines which bits in the corresponding event register are logically ORed together to form a single summary bit. Enable registers are both readable and writable. Querying an enable register will not clear it. The *CLS (clear status) command does not clear enable registers but it does clear the bits in the event registers. To enable bits in an enable register, you must write a decimal value which corresponds to the binary- weighted sum of the bits you wish to enable in the register.

Standard Event Status Enable Register

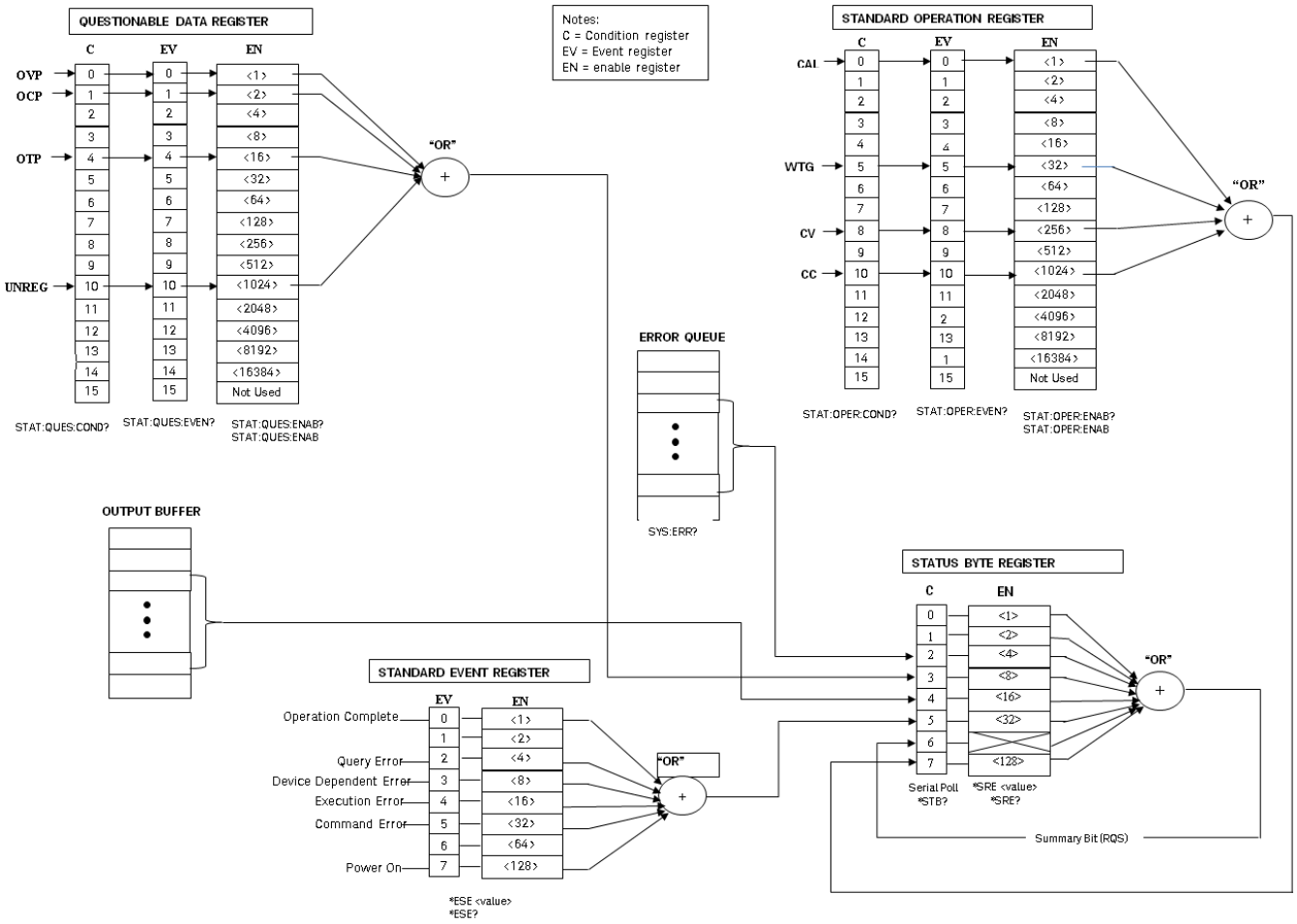
Bit	Value	Name	Description
0	1	OPC	Operation complete
1	2	(unused)	(reserved for future use)
2	4	QYE	Query error
3	8	DDE	Device dependent error
4	16	EXE	Execution error
5	32	CME	Command error
6	64	(unused)	(reserved for future use)
7	128	PON	Power-on

Operation Status Register

Bit	Value	Name	Description
0	1	CAL	The output is computing new calibration constants
1-4	2-16	(unused)	(reserved for future use)
5	32	WTG	The output is waiting for a trigger.
6-7	64-128	(unused)	(reserved for future use)
8	256	CV	The output is in constant voltage mode.
9	512	(unused)	(reserved for future use)
10	1024	CC	The output is in constant current mode.

Questionable Register

Bit	Value	Name	Description
0	1	OV	Output disabled by overvoltage protection
1	2	OC	Output disabled by overcurrent protection
2-3	4-8	(unused)	(reserved for future use)
4	16	OT	Output disabled by overtemperature protection
5-9	32-512	(unused)	(reserved for future use)
10	1024	UNR	Output is unregulated


QUESTIONABLE DATA REGISTER
C
EV
EN
OVP
OCP
OTP
UNREG
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
<1>
<2>
<4>
<8>
<16>
<32>
<64>
<128>
<256>
<512>
<1024>
<2048>
<4096>
<8192>
<16384>
Not Used
"OR"
STAT:QUES:COND?
STAT:QUES:EVEN?
STAT:QUES:ENAB?
STAT:QUES:ENAB
Notes:
C = Condition register
EV = Event register
EN = enable register
STANDARD OPERATION REGISTER
CAL
WTG
CV
CC
STAT:OPER:COND?
STAT:OPER:EVEN?
STAT:OPER:ENAB?
STAT:OPER:ENAB
ERROR QUEUE
SYS:ERR?
OUTPUT BUFFER
STATUS BYTE REGISTER
Serial Poll
*STB?
*SRE <value>
*SRE?
Summary Bit (RQS)
STANDARD EVENT REGISTER
Operation Complete
Query Error
Device Dependent Error
Execution Error
Command Error
Power On
*ESE <value>
*ESE?

APPLy <*voltage*>| DEFault | MINimum | MAXimum[,<*current*>| DEFault | MINimum | MAXimum]
APPLy?

Specifies and changes the output voltage and current in one command.

– The DEFault, MINimum, and MAXimum values for each mode are shown in Programming Ranges.

– The query returns a quoted string with the voltage setting before the current setting.

– Both values returned by the query have five decimal points: "25.00000,0.75000"

CALibration Subsystem

For a detailed discussion on the calibration procedures, see Calibration Adjustment Procedures.

CALibration:COUNt?

Returns the number of times the instrument has saved calibration data as a signed whole number, for example +21. Your instrument was calibrated at the factory; read and record the initial count when you receive the instrument.

CALibration:CURRent[:DATA][:HIGH] <*value*>

Enters an output current value (in amps) that you obtained by reading a DMM. You must first select a calibration level (CAL:CURR:LEV) for the value being entered. This command can only be used when calibration is unsecured and output is ON.

CALibration:CURRent[:DATA]:LOW <*value*>

Enters an output current value (in amps) that you obtained by reading a DMM. This is similar to CALibration:CURRent[:DATA][:HIGH], but it is only used for small current calibration. This command can only be used when calibration is unsecured and output is ON.

CALibration:CURRent:LEVel[:HIGH] MINimum|MAXimum

Initiates calibration for a specific current level. The MINimum calibration must be performed before the MAXimum, and you must unsecure this instrument to use this command.

CALibration:CURRent:LEVel:LOW MINimum|MAXimum

Initiates small current calibration for a specific current level. The MINimum calibration must be performed before the MAXimum, and you must unsecure this instrument to use this command.

CALibration:STATe <*state*>,<*code*>
CALibration:STATe?

Unsecures or secures the power supply with the calibration security code Of up to nine digits. The query returns 1 (ON - unsecured for calibration) or 0 (OFF - secured against calibration).

- The query only returns the state; it does not return the passcode.
- The security code is nonvolatile, and does is not changed by power cycling or *RST.
- The front panel limits the user to entering codes of up to six digits.
- The default passcodes are 36102, 36103, 36104, 36105, and 36106.
- Example: Unlock the instrument to enable calibration: CAL:STATe 1,36102

CALibration:STRing "<*string*>"
CALibration:STRing?

Record or read up to 40 characters of instrument calibration information.

– You can store any information related to calibration, such as date or contact information.

– The power supply must be unsecured before sending a calibration message.

– You can read the string regardless of whether the supply is secured.

CALibration:VOLTage[:DATA] <*value*>

Enters an output voltage value (in volts) that you obtained by reading a DMM.

– You must first select a calibration level (CAL:CURR:LEV) for the value being entered.

– This command can only be used when calibration is unsecured and output is ON.

CALibration:VOLTage:LEVel MINimum|MAXimum

Initiates calibration for a specific voltage level. You must do the MINimum calibration before the MAXimum, and this command can only be used when calibration is unsecured.

CURRent Subsystem

[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude] <*current*> | MINimum | MAXimum | UP | DOWN
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]? [MINimum | MAXimum]

Programs the immediate current level of the instrument's output. See Programming Ranges for details.

This command changes the output immediately. The UP and DOWN parameters increase or decrease the immediate current by the amount specified by CURRent:STEP. A setting that exceeds the maximum or minimum rated current will cause error -222 (Data out of range).

[SOURce:]CURRent[:LEVel][:IMMediate]:STEP[:INCRement] <*current*> | DEFault
[SOURce:]CURRent[:LEVel][:IMMediate]:STEP[:INCRement]? [DEFault]

Sets the step size for current programming with the CURRent UP and CURRent DOWN commands. The query returns a number of the form +#.########E+##.

[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude] <*current*> | MINimum | MAXimum
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]? [MINimum | MAXimum]

Sets the triggered current level in amps. The query returns a number of the form +#.########E+##.

[SOURce:]CURRent:PROTection:CLEar

Clears an overcurrent protection event.

[SOURce:]CURRent:PROTection:DELay[:TIME] <*time*> | MINimum | MAXimum
[SOURce:]CURRent:PROTection:DELay[:TIME]? [MINimum | MAXimum]

Sets the time (in milliseconds) that the overcurrent protection is temporarily disabled after a current level change. The query returns a number of the form +#.########E+##.

[SOURce:]CURRent:PROTection:STATe ON|1|OFF|0
[SOURce:]CURRent:PROTection:STATe?

Enables or disables overcurrent protection, which causes the instrument to go into a protected state when the power supply status is in constant current mode. The query returns 1 (ON) or 0 (OFF).

[SOURce:]CURRent:PROTection:TRIPped?

Indicates whether an overcurrent protection occurred (1) or not (0). This is reset to 0 by CURRent:PROTection:CLEar.

DISPlay[:WINDow]:TEXT:CLEar

Clears the message displayed on the front panel.

DISPlay[:WINDow]:TEXT[:DATA] "<string>"
DISPlay[:WINDow]:TEXT[:DATA]

Displays a message of up to 12 characters on the front panel. Additional characters are truncated.

DISPlay[:WINDow][:STATe] ON | 1 | OFF | 0
DISPlay[:WINDow][:STATe]?

Turns the display off or on. When the display is turned off, outputs are not sent to the display and all annunciators except ERROR are disabled. The display state is automatically turned on when you return to the local mode. Press and hold [Lock/Unlock] for a few seconds to return to the local mode.

*CLS

Clears all event registers, the Status Byte register, and the error queue.

*ESE <enable value>
*ESE?

Enables bits in the Standard Event Enable register. The selected bits are then reported to the Status Byte. The query returns a decimal value corresponding to the binary-weighted sum of all bits in the register. All of the enabled events of the Standard Event Status Event Register are logically ORed to cause the Event Summary Bit (ESB) of the Status Byte Register to be set.

Standard Event Status Enable Register

Bit	Value	Name	Description
0	1	OPC	Operation complete
1	2	0	(reserved for future use)
2	4	QYE	Query error
3	8	DDE	Device-dependent error
4	16	EXE	Execution error
5	32	CME	Command error
6	64	0	(reserved for future use)
7	128	PON	Power-on has occurred

*ESR?

Returns a decimal value corresponding to the binary-weighted sum of all bits in the Standard Event register and clears the register to 0. The bit configuration is the same as the Standard Event Status Enable register (see *ESE).

*IDN?

Returns the power supply's identification string in the form shown below.

Keysight Technologies,E36102B,MY87654321,0.3.2-0.32

The four comma-separated fields are the manufacturer name, instrument model number, instrument serial number, and revision code.

*OPC
*OPC?

Sets the “Operation Complete” bit (bit 0) of the Standard Event register after the command is executed. The query returns 1 to the output buffer after the command is executed.

*OPT?

Returns the option number of the instrument.

*PSC 0|1
*PSC?

(*Power- on status clear*) Enables (1) or disables (0) the clearing of the Status Byte and the Standard Event register enable masks when power is turned on.

*RST

Resets the instrument to its default state, but does not clear any of the status registers or the error queue. It also does not affect any interface error conditions.

Parameter	Default value
OCP delay	50 ms
OVP level	Maximum (varies by model)
Voltage	0
Current	Maximum (varies by model)
OCP state	Off
OVP state	Off
Output state	Off
Relay sense	Internal

*RCL <*state*>
*SAV <*state*>

Saves (*SAV) the current instrument state or recalls (*RCL) a previously saved state file. All state storage locations (0 through 9) are nonvolatile.

- The parameters stored in a state file are the same parameters affected by *RST.
- States are not affected by the *RST command.
- Saving a state overwrites the previous state (if any) stored in that location.
- When shipped from the factory, storage locations 0 through 9 are empty.

*SRE <enable value>
*SRE?

Enables bits in the Status Byte enable register. The query returns the decimal value corresponding to the binary-weighted sum of all bits set in the register.

*STB?

Queries the Status Byte summary register. This is similar to a serial poll but it is processed like any other instrument command. The *STB? command returns the same result as a serial poll but the “Request Service” bit (bit 6) is not cleared if a serial poll has occurred.

*TRG

Generates an event trigger to the trigger system when the trigger system has a BUS (software) trigger as its trigger source (TRIG:SOUR BUS). If the trigger system is not initiated, the *TRG command is simply ignored.

*TST?

Performs a complete self-test of the power supply and returns “0” (pass) or a non-zero value (fail). If the self-test fails, an error message is also generated with additional information on why the test failed.

The bits added together to produce a non-zero value in the case of a failing self-test are shown below.

Bit	Value	Name	Description
0	1		EEPROM status
1	2		Voltage monitor for +15 V
2	4		Model number detection failure
3	8	(unused)	(reserved for future use)
4	16	(unused)	(reserved for future use)
5	32		ADC failure
6	64		DAC failure
7	128	(unused)	(reserved for future use)

*WAI

Waits for all pending operations to complete before executing any additional remote interface commands. This command is used only in the triggered mode to wait for a pending delayed trigger.

MEASure:CURRent[:DC]?

Returns the sensed DC output current in amps in the format 1.23456789E+00.

MEASure[:VOLTage][:DC]?

Returns the sensed DC output voltage in volts in the format 1.23456789E+00. Use the [SOURce:]VOLTage:SENSe [:SOURce] command to specify whether the voltage uses internal or external (remote) sensing.

OUTPut Subsystem

OUTPut[:STATe] ON | 1 | OFF | 0
OUTPut[:STATe]?

Enables or disables the instrument's output.The query returns 0 (OFF) or 1 (ON). At *RST, the output state is off.

OUTPut:PROTection:CLEar

Clears the latch that disables the output due to an overvoltage or overcurrent condition. You must clear the conditions that cause the fault before executing this command. You can then restore the output to the state that existed before the fault condition occurred.

OUTPut:PON:STATe RST|RCL0|RCL1|RCL2|RCL3|RCL4|RCL5|RCL6|RCL7|RCL8|RCL9|
OUTPut:PON:STATe?

Specifies whether the instrument's power-on state is the *RST state (default) or the state stored in one of ten memory locations.

STATus:OPERation:[EVENT]?

Returns a decimal value corresponding to the binary-weighted sum of the bits in the event register of the Operation Status group. This read-only register stores (latches) all events that are passed by the Operation NTR and/or PTR filter.

- Reading the Operation Status Event register clears it.
- *RST has no effect on this register.

STATus:OPERation:CONDition?

Returns a decimal value corresponding to the binary-weighted sum of the bits in the condition register of the Operation Status group. This read-only register holds the live (unlatched) operational status of the instrument.

- Reading the Operation Status Condition register does not clear it.
- *RST clears this register, other than those bits where the condition still exists after *RST.

STATus:OPERation:ENABle <value>

Sets the value of the enable register for the Operation Status group. The enable register is a mask for enabling specific bits from the Operation Event register to set the OPER (operation summary) bit of the Status Byte register.

- STATus:PRESet clears all bits in the enable register.
- *CLS does not clear the enable register, but does clear the event register.

STATus:PRESet

Sets the all registers to their power-on values.

STATus:QUEStionable:CONDition?

Returns a decimal value corresponding to the binary-weighted sum of the bits in the Questionable Status condition register.

- This register is a read-only register, which holds the instrument's live (unlatched) operational status.
- Reading the Questionable Status Condition register does not clear it.
- *RST clears this register, other than those bits where the condition still exists after *RST

STATus:QUEStionable:ENABle <enable value>
STATus:QUEStionable:ENABle?

Enables bits in the Questionable Status enable register, which is a mask for enabling specific bits from the Operation Event register to set the QUES (questionable summary) bit of the Status Byte register. The selected bits are then reported to the Status Byte.

– STATus:PRESet clears all bits in the enable register.

– *CLS does not clear the enable register, but does clear the event register .

STATus:QUEStionable[:EVENt]?

Returns a decimal value corresponding to the binary-weighted sum of all bits in the Questionable Status event register.

– These bits are latched.

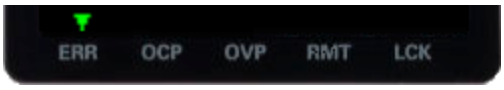
– Reading the event register clears it, but *RST has no effect on this register.

SYSTem:COMMunicate:RLSTate LOCal | REMote | RWLock
SYSTem:COMMunicate:RLSTate?

Places the instrument in remote or local mode. The LOCal parameter is the same as SYSTem:LOCal, the REMote parameter is the same as SYSTem:REMote, and the RWLock parameter is the same as SYSTemRWLock. The query returns LOC, REM, or RWL.

SYSTem:ERRor[:NEXT]?

Queries the power supply's error queue. When the front-panel ERR annunciator turns on, one or more errors have been detected. Up to 20 errors can be stored in the error queue. See Error Messages.



- Errors are retrieved in first-in-first-out (FIFO) order. The ERR annunciator turns off after the last error is read.
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350, “Queue overflow”. No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the power supply responds with +0, “No error”.
- The error queue is cleared when power has been off or after a *CLS (clear status) command has been executed. The *RST (reset) command does not clear the error queue.

SYSTem:LOCal

Places the power supply in the local mode. All keys on the front panel are fully functional.

SYSTem:REMote

Places the power supply into remote mode for remote operation. When the unit is being controlled remotely, the power supply will go to remote mode automatically. You can switch the instrument to local mode using SYSTem:LOCal or by pressing any key on the front panel.

SYSTem:RWLock

Places the power supply in the remote mode. This command is the same as SYSTem:REMote, except that all front-panel keys, excluding the [Lock/Unlock] key are disabled. You can unlock the front panel by holding the [Lock/Unlock] key. This switches the instrument to local mode at the same time. The front panel will be unlocked when the instrument is switched to remote or local mode.

SYSTem:SECurity:IMMediate

Clears and sanitizes all user memory (states, LAN information, and so on), usually to prepare the instrument for removal from a secure area. Instrument identification data (instrument firmware, model number, serial number, MAC address and calibration data) is not erased. This procedure is not recommended for routine use because of the possibility of unintended data loss.

SYSTem:VERSion?

Returns the SCPI version on which the instrument's command set is based, which is 2005.0.

Triggering Commands

ABORt

Clears any pending delayed trigger and returns the trigger system to idle. If INIT:CONT is enabled, the trigger system is continuously initiated.

INITiate[:IMMediate]

Cause the trigger system to initiate. When the trigger system is initiated, an event on the specified trigger source causes the corresponding trigger action on the power supply output. This command completes one full trigger cycle when the trigger source is IMMediate or initiates the trigger subsystem when the trigger source is BUS.

INITiate:CONTinuous ON | 1 | OFF | 0
INITiate:CONTinuous?

Enables or disables continuous initiation of the trigger system. If this is disabled, an INIT initiates the trigger system for only one trigger action. If this is enabled, the trigger system is continuously initiated and INIT is redundant. The query returns 1 (ON) or 0 (OFF).

*TRG

Generates an event trigger to the trigger system when the trigger system has a BUS (software) trigger as its trigger source (TRIG:SOUR BUS). If the trigger system is not initiated, the *TRG command is simply ignored.

TRIGger[:SEQuence]:DELay <*seconds*> MINimum | MAXimum
TRIGger[:SEQuence]:DELay? [MINimum | MAXimum]

Sets the time delay (in seconds, from 0 to 32.767) from the detection of a bus trigger to the start of any corresponding trigger action on the power supply output. The default is 0, and the query returns a number of the form +#.########E+##.

TRIGger[:SEQuence]:SOURce BUS | IMMediate
TRIGger[:SEQuence]:SOURce?

Specifies the source from which the instrument will accept a trigger, either a bus (software) trigger or an internal immediate trigger. At *RST, the bus trigger source is selected. To ensure synchronization when the bus source is selected, send the *WAI (wait) command. You can also use the *OPC? (operation complete) query or the *OPC command to indicate when the operation has completed. The query returns BUS (wait for trigger command) or IMM (continuous triggering).

VOLTage Subsystem

[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <voltage>|MINimum|MAXimum|DEFault
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]? [MINimum | MAXimum]

Sets the output voltage in volts.The query returns a number of the form +#.########E+##.

[SOURce:]VOLTage[:LEVel][:IMMediate]:STEP[:INCRement] <numeric value>|DEFault
[SOURce:]VOLTage[:LEVel][:IMMediate]:STEP[:INCRement]? [DEFault]

Sets the step size for voltage programming with the VOLTage UP and VOLTage DOWN commands. The query returns a number of the form +#.########E+##.

[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude] <voltage>|MIN|MAX
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX]

Sets the triggered voltage level in amps. The query returns a number of the form +#.########E+##.

[SOURce:]VOLTage:PROTection:CLEar

Clears an overvoltage protection event.

[SOURce:]VOLTage:PROTection:STATe ON|1|OFF|0
[SOURce:]VOLTage:PROTection:STATe?

Enables or disables overvoltage protection, which causes the instrument to go into a protected state when the power supply goes above the protection level specified by the VOLTage:PROTection[:LEVel]. The query returns 1 (ON) or 0 (OFF).

[SOURce:]VOLTage:PROTection:TRIPped?

Indicates whether an overvoltage protection occurred (1) or not (0). This is reset to 0 by VOLTage:PROTection:CLEar.

[SOURce:]VOLTage:PROTection[:LEVel] <*voltage*>|MINimum | MAXimum[SOURce:]VOLTage:PROTection[:LEVel]? [MINimum|MAXimum]

Sets the level at which overvoltage protection trips, in volts. The query returns a number of the form +#.########E+##.

[SOURce:]VOLTage:SENSe[:SOURce] INTernal | EXTernal

Specifies whether the instrument uses remote or local sensing. The query returns 0 (INT) or 1 (EXT).

The internal setting sets a relay within the power supply to connect the output and sensing connector. This means that only two wires are used; and remote sensing is disabled. The external setting sets a relay within the power supply to disconnect the output and remote sensing inputs. This means that four wires are used; and remote sensing is enabled. The Internal setting displays 2W in the upper left corner of the display, and the External setting shows 4W in the upper left corner.

3 Service and Support

Service and Repair

Performance Verification

Test Record Forms

Calibration Adjustment Procedures

Specifications and Typical Characteristics

This chapter describes the service information for the E36100B Series programmable DC power supplies.

Service and Repair

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 power-line fuse is installed:
    - Use the 2.0 AT, 250 V fuse for 100 or 115 Vac operation.
    - Use the 1.0 AT, 250 V fuse for 230 Vac operation.
- Verify the power-line voltage setting.
    - See Getting Started > Options and Fuse Information for details.

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.

The complete self-test of the power supply is enabled by pressing the Recall key or any front panel keys except the Error key and the power-line switch simultaneously . Then continue to press the Recall key for 5 seconds. It will take another 2 seconds for the complete self-test to end.

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

– If the self-test is successful, "PASS" is displayed on the front panel.

– If the self-test fails, "FAIL" is displayed and the ERROR annunciator turns on. 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.

To replace the power-line fuse

The power-line fuse is located within the power supply's fuse-holder assembly on the rear panel see Getting Started > Options and Fuse Information for details. For 100 or 115 Vac operation, you must use a 2.0 AT time-delay fuse. For 230 Vac operation, you must use a 1.0 AT time-delay fuse.

User replaceable parts

You can find the instrument support part list at Keysight's Test & Measurement Parts Catalog http://www.keysight.com/find/parts.

Performance Verification

Performance verification ensures that the instrument performs within the specifications stated in the data sheet. Some specifications are included in this document and were accurate at the time of publication, but the latest data sheet from the Keysight website should be referred to see if there are any changes since this document was published.

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	Guildline 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
LAN / USB Controller		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 µV	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, 1/8 W termination resistors	
Variable voltage transformer or AC source	Adjustable to highest rated input voltage range. Power: 500 VA	Keysight 6813B or equivalent
Calibration resistors for small current	300 Ω (E36102B) 1/8 W minimum 2.5 kΩ (E36103B) 1/8 W minimum 9 kΩ (E36104B) 1/8 W minimum 20 kΩ (E36105B) 1/8 W minimum 51 kΩ (E36106B) 1/8 W minimum	

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.

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

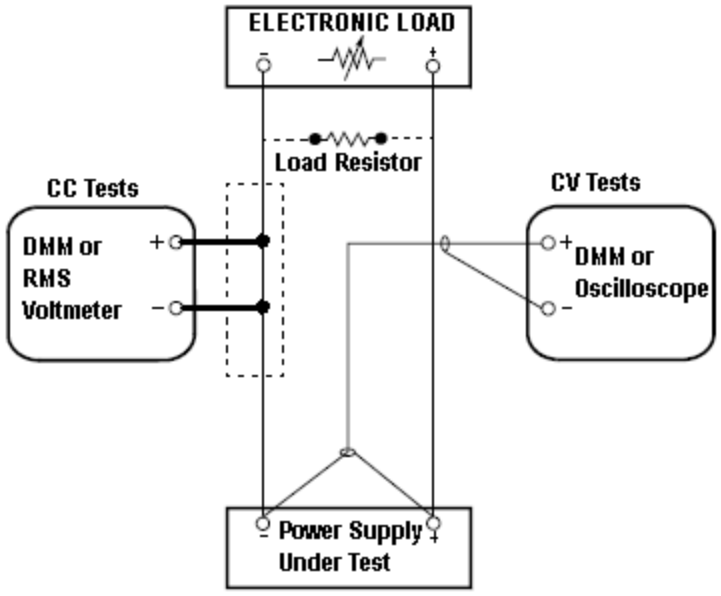
The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

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 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; CURR 5 (for example for the E36102B, 6 V, 5 A output)
6.	Enable the output by pressing the Output ON key.	OUTP ON

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? (for example for the E36102B, 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

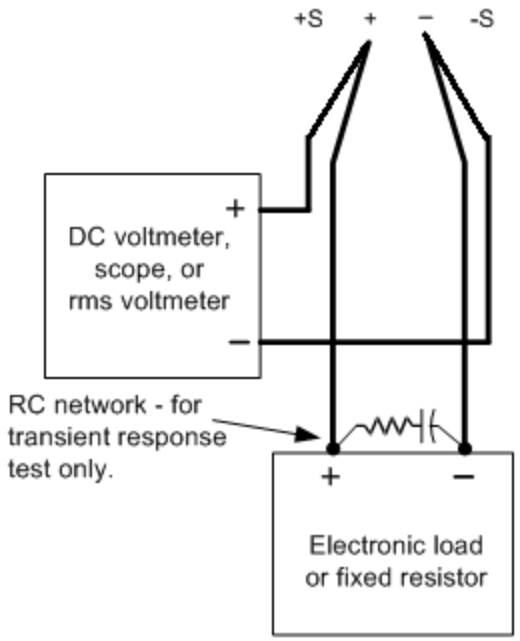
This test measures the change in output voltage that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

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 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 ($V_{lowline} - V_{highline}$). 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 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 ½ 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 (t2-t1) of the transient at the voltage settling band, for example 15 mV for the E36102B from the base line is no more than 50 ms.



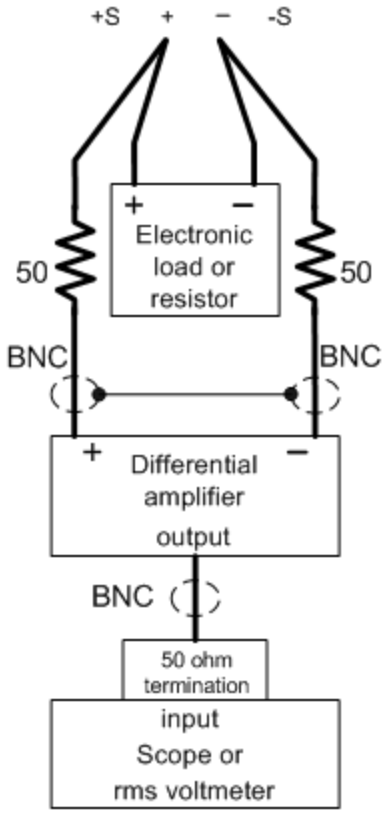
NOTE The oscilloscope cursors X1 and X2 represent t1 and t2.

8. Transient response specification is met when the voltage recovers within 50 µs.

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 load resistor or electronic load, differential amplifier, and an oscilloscope (AC coupled) to the output as shown below.



3. Use an appropriate load resistor (see load resistor 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 MΩ 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.

Constant Current (CC) verification

Current programming and readback accuracy

These tests verify that the current programming and the LAN 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 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; CURR 5 (for example for the E36102B, 6 V, 5 A output)
6.	Enable the output by pressing the Output ON key.	OUTP ON

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

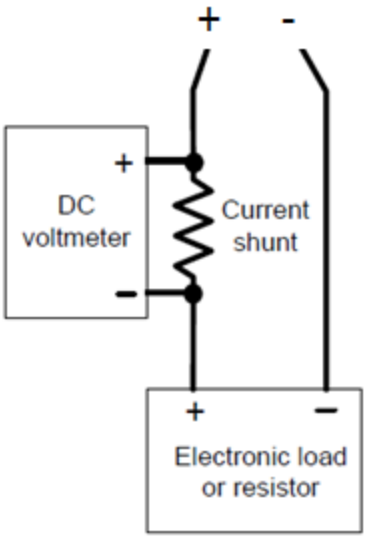
Step	Front Panel	SCPI
10.		MEAS:CURR? (for example for the E36102B, 6 V, 5 A output)

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 ($I_{lowline} - I_{highline}$). The difference of the readings during the immediate change should be within the specification limits.

Test Record Forms

Test Record Form - Keysight E36102B

Test Record Form - Keysight E36103B

Test Record Form - Keysight E36104B

Test Record Form - Keysight E36105B

Test Record Form - Keysight E36106B

Test Record Form - Keysight E36102B

E36102B	Report Number _____ Date _____		
Description	**Lower limit**	**Result**	**Upper limit**
Constant Voltage Tests			
Voltage Programming			
Zero Voltage Output (V_0)	-0.003 V	_____	0.003 V
Maximum Voltage Output (V_{max})	5.994 V	_____	6.006 V
Voltage Readback			
Zero Voltage measured over interface	V_0 - 0.003 V	_____	V_0 + 0.003 V
Maximum Voltage measured over interface	V_{max} - 0.006 V	_____	V_{max} + 0.006 V
CV Load Regulation (V_{load} - V_{noload})	-2.6 mV	_____	2.6 mV
CV Line Regulation ($V_{lowline}$ - $V_{highline}$)	-1.6 mV	_____	1.6 mV
CV Ripple and Noise			
peak-to-peak	–	_____	8 mV
rms	–	_____	350 µV
Transient Response	–	_____	50 µs
Constant Current Tests			
Correct Programming			
Zero Current Output (I_0)	-0.004 A	_____	0.004 A
Maximum Current Output (I_{max})	4.9925 A	_____	5.0075 A
Current Readback			
Zero Current measured over interface	I_0 - 0.004 A	_____	I_0 + 0.004 A
Maximum Current measured over interface	I_{max} - 0.0065 A	_____	I_{max} + 0.0065 A

E36102B	Report Number _____ Date _____		
Description	**Lower limit**	**Result**	**Upper limit**
CC Load Regulation (I_{load} - I_{short})	-1250 µA	_____	1250 µA
CC Line Regulation ($I_{lowline}$ - $I_{highline}$)	-1250 µA	_____	1250 µA

Test Description	Instrument settings	
Voltage Programming & Readback, Zero Voltage (V_0)	0 V	5 A
Voltage Programming & Readback, Maximum Voltage (V_{max})	6 V	5 A
CV Load Regulation, Line Regulation, Ripple and Noise	6 V	5 A
Transient Response	6 V	2.5 A to 5 A
Current Programming & Readback, Zero Current (I_0)	0 A	6 V
Current Programming & Readback, Maximum Current (I_{max})	5 A	6 V
CC Load Regulation, Line Regulation, Ripple and Noise	5 A	6 V

Test Record Form - Keysight E36103B

E36103B	Report Number _____ Date _____		
Description	**Lower limit**	**Result**	**Upper limit**
Constant Voltage Tests			
Voltage Programming			
Zero Voltage Output (V_0)	-0.007 V	_____	0.007 V
Maximum Voltage Output (V_{max})	19.983 V	_____	20.017 V
Voltage Readback			
Zero Voltage measured over interface	V_0 - 0.005 V	_____	V_0 + 0.005 V
Maximum Voltage measured over interface	V_{max} - 0.015 V	_____	V_{max} + 0.015 V
CV Load Regulation (V_{load} - V_{noload})	-5 mV	_____	5 mV
CV Line Regulation ($V_{lowline}$ - $V_{highline}$)	-4 mV	_____	4 mV
CV Ripple and Noise			
peak-to-peak	–	_____	15 mV
rms	–	_____	0.8 mV
Transient Response	–	_____	50 µs
Constant Current Tests			
Correct Programming			
Zero Current Output (I_0)	-0.001 A	_____	0.001 A
Maximum Current Output (I_{max})	1.998 A	_____	2.002 A
Current Readback			
Zero Current measured over interface	I_0 - 0.001 A	_____	$_0$ + 0.001 A
Maximum Current measured over interface	I_{max} - 0.002 A	_____	I_{max} + 0.002 A
CC Load Regulation (I_{load} - I_{short})	-500 µA	_____	500 µA
CC Line Regulation ($I_{lowline}$ - $I_{highline}$)	-500 µA	_____	500 µA

Test Description	Instrument settings	
Voltage Programming & Readback, Zero Voltage (V_0)	0 V	2 A
Voltage Programming & Readback, Maximum Voltage (V_{max})	20 V	2 A
CV Load Regulation, Line Regulation, Ripple and Noise	20 V	2 A
Transient Response	20 V	1 A to 2 A
Current Programming & Readback, Zero Current (I_0)	0 A	20 V
Current Programming & Readback, Maximum Current (I_{max})	2 A	20 V
CC Load Regulation, Line Regulation, Ripple and Noise	2 A	20 V

Test Record Form - Keysight E36104B

E36104B	Report Number _____ Date _____		
Description	**Lower limit**	**Result**	**Upper limit**
Constant Voltage Tests			
Voltage Programming			
Zero Voltage Output (V_0)	-0.012 V	_____	0.012 V
Maximum Voltage Output (V_{max})	34.9705 V	_____	35.0295 V
Voltage Readback			
Zero Voltage measured over interface	V_0 - 0.008 V	_____	V_0 + 0.008 V
Maximum Voltage measured over interface	V_{max} - 0.0255 V	_____	V_{max} + 0.0255 V
CV Load Regulation (V_{load} - V_{noload})	-9.5 mV	_____	9.5 mV
CV Line Regulation ($V_{lowline}$ - $V_{highline}$)	-7.5 mV	_____	7.5 mV
CV Ripple and Noise			
peak-to-peak	–	_____	20 mV
rms	–	_____	1.2 mV
Transient Response	–	_____	50 µs
Constant Current Tests			
Correct Programming			
Zero Current Output (I_0)	-0.0006 A	_____	0.0006 A
Maximum Current Output (I_{max})	0.9989 A	_____	1.0011 A
Current Readback			
Zero Current measured over interface	I_0 - 0.0005 A	_____	I_0 + 0.0005 A
Maximum Current measured over interface	I_{max} - 0.001 A	_____	I_{max} + 0.001 A
CC Load Regulation (I_{load} - I_{short})	-250 µA	_____	250 µA
CC Line Regulation ($I_{lowline}$ - $I_{highline}$)	-250 µA	_____	250 µA

Test Description	Instrument settings	
Voltage Programming & Readback, Zero Voltage (V_0)	0 V	1 A
Voltage Programming & Readback, Maximum Voltage (V_{max})	35 V	1 A
CV Load Regulation, Line Regulation, Ripple and Noise	35 V	1 A
Transient Response	35 V	0.5 A to 1 A
Current Programming & Readback, Zero Current (I_0)	0 A	35 V
Current Programming & Readback, Maximum Current (I_{max})	1 A	35 V
CC Load Regulation, Line Regulation, Ripple and Noise	1 A	35 V

Test Record Form - Keysight E36105B

E36105B	Report Number _____ Date _____		
Description	**Lower limit**	**Result**	**Upper limit**
Constant Voltage Tests			
Voltage Programming			
Zero Voltage Output (V_0)	-0.02 V	_____	0.02 V
Maximum Voltage Output (V_{max})	59.95 v	_____	60.05 V
Voltage Readback			
Zero Voltage measured over interface	V_0 - 0.012 V	_____	V_0 + 0.012 V
Maximum Voltage measured over interface	V_{max} - 0.042 V	_____	V_{max} + 0.042 V
CV Load Regulation (V_{load} - V_{noload})	-16 mV	_____	16 mV
CV Line Regulation ($V_{lowline}$ - $V_{highline}$)	-13 mV	_____	13 mV
CV Ripple and Noise			
peak-to-peak	–	_____	30 mV
rms	–	_____	1.5 mV
Transient Response	–	_____	50 µs
Constant Current Tests			
Correct Programming			
Zero Current Output (I_0)	-0.0004 A	_____	0.0004 A
Maximum Current Output (I_{max})	0.5993 A	_____	0.6007 A
Current Readback			
Zero Current measured over interface	I_0 - 0.0003 A	_____	I_0 + 0.0003 A
Maximum Current measured over interface	I_{max} - 0.0006 A	_____	I_{max} + 0.0006 A
CC Load Regulation (I_{load} - I_{short})	-150 µA	_____	150 µA
CC Line Regulation ($I_{lowline}$ - $I_{highline}$)	-150 µA	_____	150 µA

Test Description	Instrument settings	
Voltage Programming & Readback, Zero Voltage (V_0)	0 V	0.6 A
Voltage Programming & Readback, Maximum Voltage (V_{max})	60 V	0.6 A
CV Load Regulation, Line Regulation, Ripple and Noise	60 V	0.6 A
Transient Response	60 V	0.3 A to 0.6 A
Current Programming & Readback, Zero Current (I_0)	0 A	60 V
Current Programming & Readback, Maximum Current (I_{max})	0.6 A	60 V
CC Load Regulation, Line Regulation, Ripple and Noise	0.6 A	60 V

Test Record Form - Keysight E36106B

E36106B	Report Number _____ Date _____		
Description	**Lower limit**	**Result**	**Upper limit**
Constant Voltage Tests			
Voltage Programming			
Zero Voltage Output (V_0)	-0.04 V	_____	0.04 V
Maximum Voltage Output (V_{max})	99.91 V	_____	100.09 V
Voltage Readback			
Zero Voltage measured over interface	V_0 - 0.02 V	_____	V_0 + 0.02 V
Maximum Voltage measured over interface	V_{max} - 0.07 V	_____	V_{max} + 0.07 V
CV Load Regulation (V_{load} - V_{noload})	-30 mV	_____	30 mV
CV Line Regulation ($V_{lowline}$ - $V_{highline}$)	-22 mV	_____	22 mV
CV Ripple and Noise			
peak-to-peak	–	_____	40 mV
rms	–	_____	2.5 mV
Transient Response	–	_____	50 µs
Constant Current Tests			
Correct Programming			
Zero Current Output (I_0)	-0.0003 A	_____	0.0003 A
Maximum Current Output (I_{max})	0.3995 A	_____	0.4005 A
Current Readback			
Zero Current measured over interface	I_0 - 0.0002 A	_____	I_0 + 0.0002 A
Maximum Current measured over interface	I_{max} - 0.0004 A	_____	I_{max} + 0.0004 A
CC Load Regulation (I_{load} - I_{short})	-100 µA	_____	100 µA
CC Line Regulation ($I_{lowline}$ - $I_{highline}$)	-100 µA	_____	100 µA

Test Description	Instrument settings	
Voltage Programming & Readback, Zero Voltage (V_0)	0 V	0.4 A
Voltage Programming & Readback, Maximum Voltage (V_{max})	100 V	0.4 A
CV Load Regulation, Line Regulation, Ripple and Noise	100 V	0.4 A
Transient Response	100 V	0.2 A to 0.4 A
Current Programming & Readback, Zero Current (I_0)	0 A	100 V
Current Programming & Readback, Maximum Current (I_{max})	0.4 A	100 V
CC Load Regulation, Line Regulation, Ripple and Noise	0.4 A	100 V

Calibration Adjustment Procedures

This chapter includes calibration adjustment procedures for Keysight E36100B Series power supplies. Instructions are applicable for performing the procedures from either the front panel or a controller over the LAN or USB.

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 E36100B Series power supplies 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.

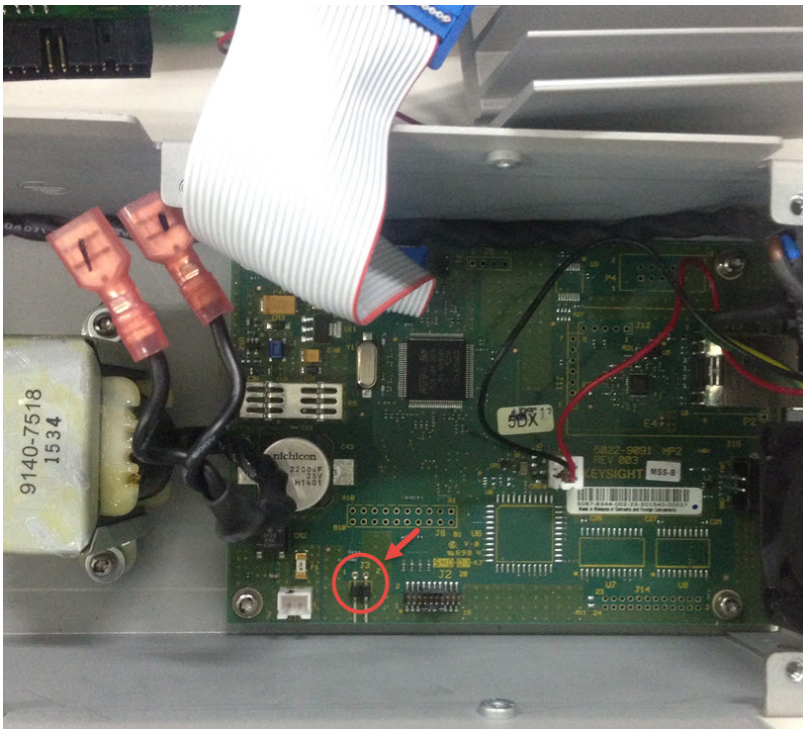
Calibration security

The instrument has a calibration security code to prevent accidental or unauthorized calibration. When you receive your power supply, it is secured by a default security code, as shown below. The security code is not changed by a power cycle or *RST.

Model	Default code
E36102B	036102
E36103B	036103
E36104B	036104
E36105B	036105
E36106B	036106

You can enter a security code of up to 6 digits on the front panel or up to 9 digits from the remote interface.

NOTE To reset a forgotten security code to its factory default, you can turn on the instrument after shorting CAL SECURE jumper J3 inside the instrument as shown below.



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 and hold [Calibrate] while powering ON the unit.	
2	Press [Secure], then turn the knob to the security code, pressing the knob to move between digits. Press [Secure] when done.	CAL:STAT ON, <*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	Turn the knob to 'Cal Voltage' and press the knob.	CAL:VOLT:LEV MIN
2	Measure the output voltage (low point) with the DMM.	
3	Enter the measured value, and press the knob.	CAL:VOLT <*reading*> CAL:VOLT:LEV MAX
4	Measure the output voltage (high point) with the DMM.	
5	Enter the measured value, and press the knob.	CAL:VOLT <*reading*>
6	Read DONE or FAIL on the display.	(wait 10 seconds) SYST:ERR?

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	Turn the knob to Cal Current and press the knob.	CAL:CURR:LEV MIN
2	Measure the low output current with the DMM (DMM reading / shunt resistance).	
3	Enter the measured value, and press the knob.	CAL:CURR <*reading*> CAL:CURR:LEV MAX
4	Measure the high output current with the DMM (DMM reading / shunt resistance).	
5	Enter the measured value, and press the knob.	CAL:CURR <*reading*>
6	Read DONE or FAIL on the display.	

Calibrate small current

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

Step	Front panel	SCPI
1	Turn the knob to Cal Current and press the knob.	CAL:CURR:LEV:LOW MIN
2	Wait approximately 40 seconds for the 'Cal in Prog' message to leave the display.	
3	When the display shows second point calibration, connect the DMM current input with the appropriate calibration resistor (see Performance Verification > Recommended test equipment) for your instrument model to the power supply.	
4	Measure output current with the DMM.	CAL:CURR:LEV:LOW MAX
5	Enter the measured value, and press the knob.	CAL:CURR:LOW <rdg>
6	Read DONE or FAIL on the display.	(wait 25 seconds) SYST:ERR?

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 Small 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 OFF, 036102

Specifications and Typical Characteristics

NOTE **For the characteristics and specifications of the E36100B Series programmable DC power supplies, refer to the data-sheet at http://literature.cdn.keysight.com/litweb/pdf/5992-2437EN.pdf.**

This information is subject to change without notice.

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